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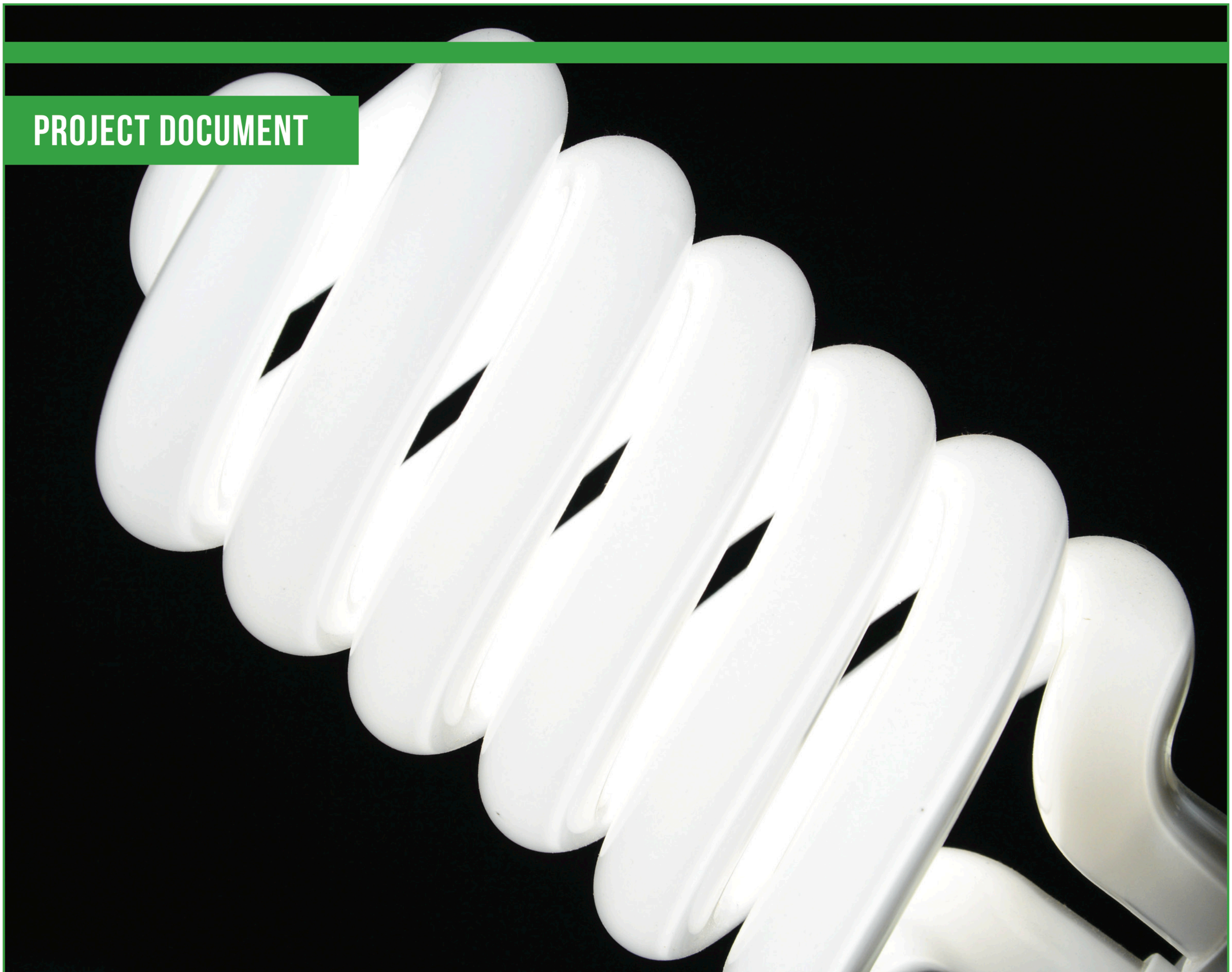

Sustainable Energy in the Caribbean: Reducing the Carbon Footprint in the Caribbean through the Promotion of Energy Efficiency and the Use of Renewable Energy Technologies

Energy efficiency policies in the Caribbean: a manual to guide the discussion

Sergio Guerra

UNITED NATIONS
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Abstract

This paper was prepared to guide the first session of the training workshop Introduction to Financial Feasibility Assessment of EE and RE Projects in the Caribbean. We explore two potential reasons that might be hindering the adoption of energy efficiency policies in the Caribbean. The first reason is related to the availability of primary infrastructure. Countries with deficits on their primary infrastructure might not consider energy efficiency policies as a priority for a national discussion. The second reason is debt overhang. In this type of scenario, countries might be dissuaded to conduct new investments since earnings/savings from projects would go directly to debt holders. Having a clear understanding of a country's macro environment and its competing needs is an important preliminary step before promoting energy efficiency projects. Evidence suggests that debt overhang is the most likely reason to explain the lack of adoption of energy efficiency policies. Given this result the Caribbean region could take advantage of international initiatives that mobilize funds to promote climate-sensitive investments.

Introduction

This paper was prepared to guide the first session of the training workshop on Introduction to Financial Feasibility Assessment of EE and RE Projects in the Caribbean. We explore two potential reasons that might be hindering the adoption of energy efficiency policies in Caribbean countries. The first one is that of competing needs. Caribbean countries might face important constraints in terms of primary physical infrastructure (for example, for the provision of public water and/or waste management) leaving no room for energy efficiency policies to be discussed domestically. The second one is debt overhang. Most countries in the Caribbean are net importers of fossil fuel energy. During the 2004-2014 period they were exposed to a commodity price supercycle that could have affected their external sector, (mainly because payments to energy exporting countries grew between 2 to 4 times nominally). More generally, we explore whether the binding constraint for the adoption of energy efficiency policies is related to a financial problem or to a political economy restriction.

For the countries in our sample, evidence suggests that the problem is related to their indebtedness situation. Compared to their Latin America (LATAM) counterparts, Caribbean countries tend to have larger debt stocks, higher debt services, and smaller reserve to debt ratios. On the other hand, Caribbean countries tend to be above the LATAM median in terms of improved sanitation facilities, improved water source, and public expenditure in health and education (as percentage of total public expenditure).

Some studies suggest that as much as 60 per cent of the energy is lost between the time it is generated and the time it is consumed.[1] Even a fraction of that percentage could have important implications for developing and developed countries. To the former group, –especially to net energy importers– improvements in their energy sector could provide an important relief to their financial situation and foster economic growth. To the latter group, energy efficiency may calm their concerns about greenhouse gas emissions.

Some authors have documented these claims. Dufresne et al. (2012) state that investments on energy efficiency programs reduce climate change's effects, ensures energy security, reduces the expenditure on primary energy, and might improve the balance of trade. Khatun & Ahmad (2015)

1 Eikeland, J. (2015, July 2). What Energy Shortage? Retrieved November 1, 2015, from http://www.project-syndicate.org/commentary/energy-storage-alevo-by-jostein-eikeland-2015-07

conclude that there is a causal relationship running from energy efficiency investments to energy use and from energy use to GDP growth.[2]

Since we are concerned about the state of energy efficiency policies in the Caribbean, the first question that we need to ask is whether Caribbean countries *need* energy efficiency policies. Most international development institutions have claimed that Latin America and the Caribbean has one of the cleanest energy matrix in the world,[3] therefore, it is reasonable to believe that the answer to this question is that they do not need further advances. That answer could be misleading, however.

To have a clear picture of the Caribbean region, we present a summary of the *energy matrix* for a group of Caribbean countries. An important observation that arose from this exercise is that nearly 81 per cent of their energy supply comes from oil products. This sole fact poses an important challenge to the question stated in the previous paragraph.

Our next step is to present alternative measures of energy efficiency in the Caribbean region. Our conclusion for this section is that heterogeneity at the country level needs to be revised carefully. Aggregates for the Caribbean region in terms of their energy composition may end in inaccurate conclusions.

After exploring some stylized facts of the energy matrix for Caribbean countries, we analyze potential reasons that might be hindering the adoption of energy efficiency policies. We begin exploring the relative position of these countries in terms of their provision of primary infrastructure (i.e., electric power, potable and waste water, transportation and communication). As mentioned previously, Caribbean countries seem to be in a better position than their LATAM counterparts.

Next, we explore the overall situation of Caribbean countries in terms of their financial situation with a special focus on their debt position. We review a battery of indicators and conclude that debt could be an important candidate to explain why Caribbean countries might be underestimating the need for energy efficiency policies.

Comparing debt positions among different countries requires a *one-size-fits-all* normative judgment that may end in erroneous conclusions, however. To overcome this obstacle, we conducted a literature review on debt sustainability analysis for Caribbean countries identifying that most of their conclusions are aligned with our findings.

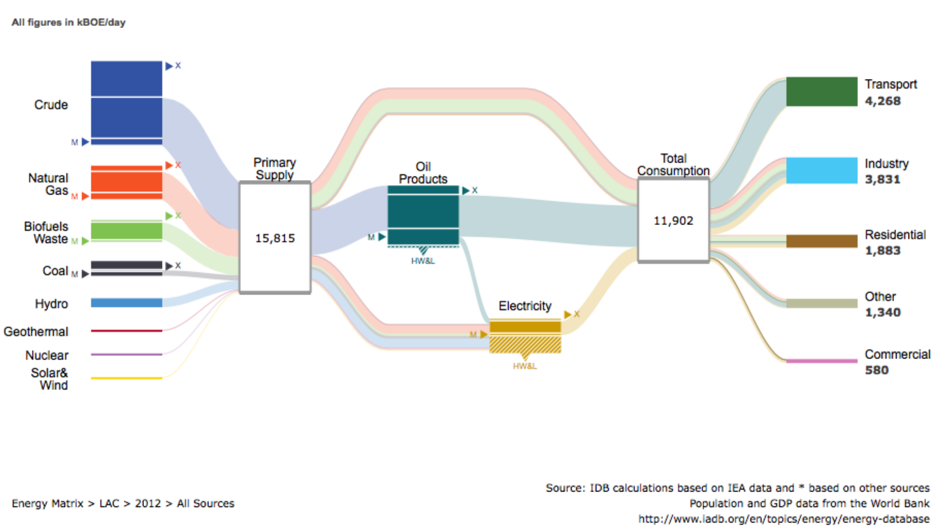
In our last section we compile a set of existing energy efficiency policies in the region to understand the gaps and holes in their strategies, and hypothesize how the road can be paved for a deeper adoption of energy efficiency measures.

[2] FDI investments.
[3] See for example UNDP (2015).

I. Energy matrix in Latin American countries

The energy matrix is a representation of energy sources consumed by a given country during a particular period of time. In its most extensive version, it differentiates between primary and secondary sources of energy, and also between final energy consumption by sector. For some applications it can be presented only to account for the sources of energy used in the production of electricity, but the way it is presented usually depends on the availability of relevant data. Figure 1 is an extensive representation of the energy matrix for Latin America in 2012.

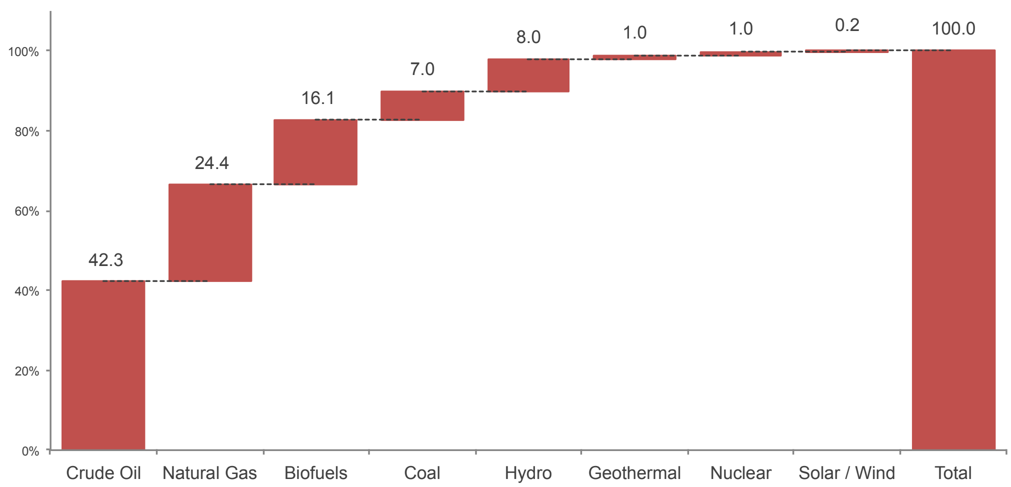
Figure 1
Latin America energy matrix, 2012



Source: IDB 2015.

At first sight, figure 1 shows that LATAM has a relatively diversified primary energy supply with nearly 42 per cent coming from crude oil as the most important source. Although there are important heterogeneities across countries, the regional picture suggests that only 10 per cent of its primary energy comes from clean energy sources.[4] Figure 2 presents the distribution of primary energy by source for the Latin American region for the year 2012.

Figure 2
Primary supply of energy in Latin America, by source



Source: Consultant's elaboration based on IDB (2015).

Besides the distribution of its primary energy sources, there are other important factors to consider while observing LATAM energy matrix:

- It is a region with positive net exports of primary energy (mostly crude oil)
- Primary energy supply is 32 per cent greater than the region's total energy consumption
- Nearly half the production of electricity is lost during the transformation, transmission and distribution processes[5]

The most important sector in terms of consumption is transportation (more than two times the size of the residential sector).

[4] Clean energy is defined by its origin as coming from hydro, geothermal, nuclear, solar and wind sources.

[5] Espinasa (2015) defines Heat, Waste and Losses as "heat, Waste, and losses is defined as energy dissipated due to heat and waste during the process of electricity generation, technical losses in transmission and distribution, losses in the refining process if any, and in the transport of coal. Crude oil losses represent the volume of crude oil reported by petroleum refineries as being lost in their operations. These losses are due to spills, contamination, fires, etc., as opposed to refining processing losses."

II. Facts about the energy matrix in Caribbean countries

For a group of eight countries of the Caribbean we were able to identify a similar coverage and full comparable data of their energy matrices.[6] Their graphical representations can be found in annex 1 of this manual, and here we are going to refer to some of its most important findings.

We discuss four facts that arose from the case-by-case analysis of energy matrices in the Caribbean. Results can be compared across countries and also with the Latin American average. Although most of the insights are probably not new for policymakers in the region, the way they are presented seeks to capture the relevance of each result in the simplest possible way.

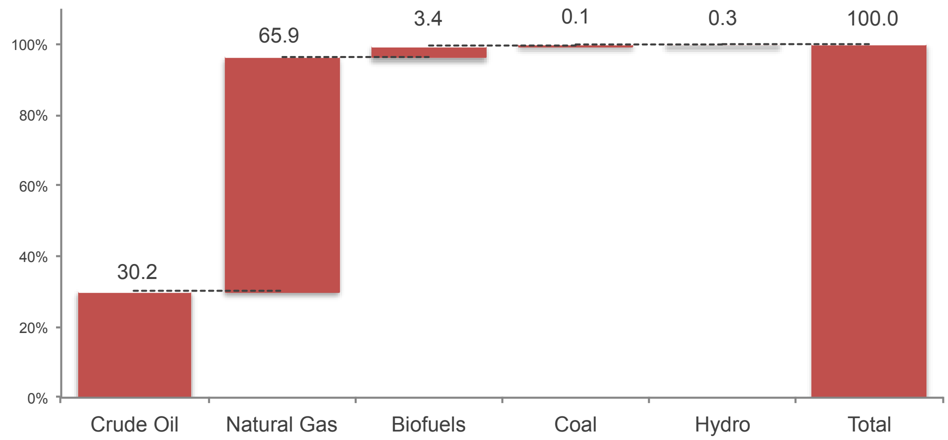
There are important heterogeneities in the energy matrices of Caribbean countries, being the most relevant the position of Trinidad and Tobago as a net primary energy exporter. For example, in 2012 the country produced twice as much primary energy than its local consumption. This situation is atypical in the sense that the median Caribbean country consumes 25 per cent more energy than its primary supply. As a consequence, it is important to analyze the energy matrix on a country base rather than the region's aggregate; otherwise the analysis would be strongly biased by the case of Trinidad and Tobago (because of its size and nature).

To illustrate this fact, figure 3 presents the distribution of primary energy by source for the Caribbean region with and without Trinidad and Tobago in the analysis. Note particularly how the share of natural gas and biofuels changes as we include Trinidad and Tobago in Panel A and Exclude Trinidad and Tobago from Panel B in the analysis below.

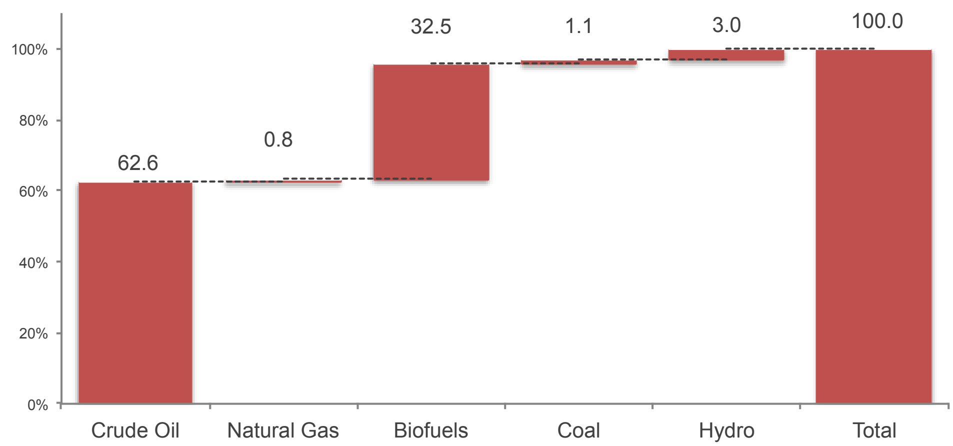
[6] Bahamas, Barbados, Belize, Dominican Republic, Guyana, Jamaica, Suriname, and Trinidad and Tobago.

Figure 3
Primary supply of energy in the Caribbean, by source

Panel A



Panel B



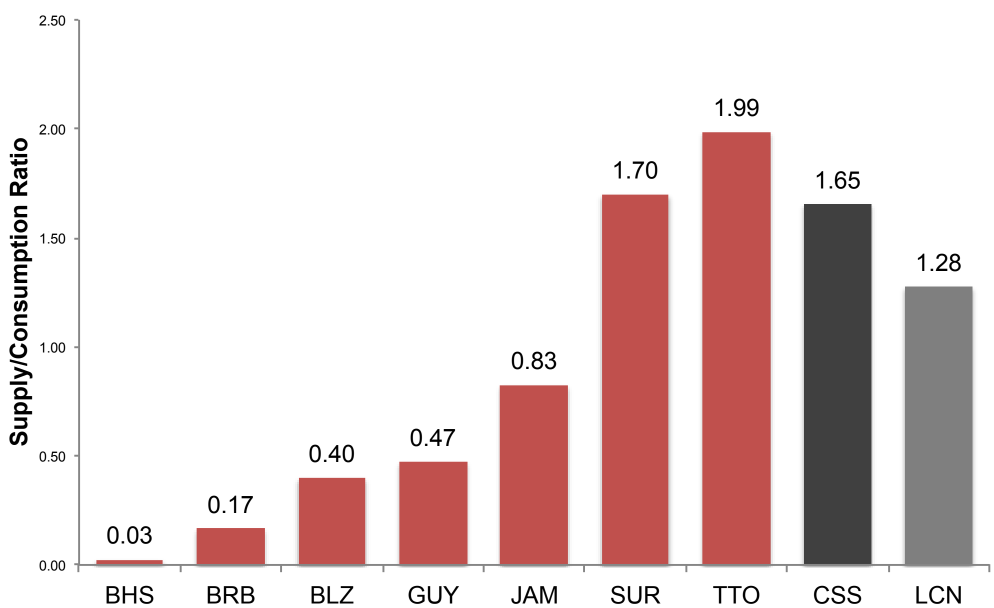
Source: Consultant's elaboration based on IDB (2015).

As mentioned before, our next step is to identify some of the most relevant findings of the energy matrices in the Caribbean presenting some statistics at the country level for a better understanding of the region's current situation.

A. Most Caribbean countries are net energy importers

Most Caribbean countries are net importers of some form of energy. Total consumption exceeds primary energy supply in every country with the sole exception of Suriname and Trinidad and Tobago. These exceptions are explained by the dynamism of their natural gas and crude oil sector. Most energy imports are oil (refined) products. Figure 4 presents the relation between primary energy supply and final consumption for the set of countries with available data. A ratio below one suggests that the country will inevitably need to import some form of energy (either primary or secondary). On the other hand, a ratio above one does not imply that the country will not need to import energy, it only says that primary energy supply is greater that their final consumption.[7] Figure 4 presents total primary energy supply expressed in units of total consumption for a group of selected countries in the Caribbean. A number below one (1) suggest that primary energy supply is smaller than total consumption forcing that country to some form of import energy.

Figure 4
Primary energy supply in terms of total consumption, circa2012



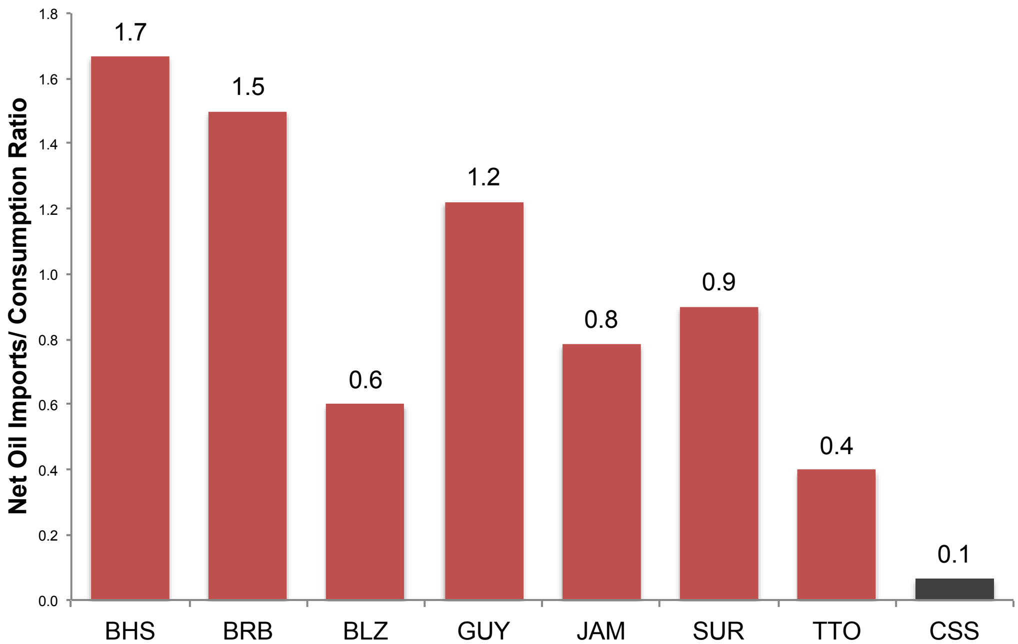
Source: Author's personal elaboration based on Espinasa (2015)
[a] List of acronyms: The Bahamas (BHS), Barbados (BRB), Belize (BLZ), Guyana (GUY), Jamaica (JAM), Suriname (SUR), Trinidad and Tobago (TTO), Caribbean Small States (CSS), Latin America & the Caribbean (LCN).

7 Countries might decide to export some (or all) of their sources of (transportable) primary energy and import secondary sources. Also, some primary energy might not be easily transformed for final consumption forcing them to import energy regardless of their apparent surplus of primary sources.

B. Most energy imports come from oil products

Most of the energy that is imported in Caribbean countries comes from oil products. This idea is illustrated in figure 5, where we present net imports of oil products relative to total energy consumption. The *unweighted* average of the eight countries suggests that imports are equivalent to the total amount of energy consumed in every country. The *weighted* average suggests that nearly a tenth of the amount of energy consumed is imported in oil products. The apparent contradiction between both figures disappears if we exclude Trinidad and Tobago from the analysis[8]. Figure 5 presents net imports of oil products (absolute value) relative to total energy consumption for a group of selected countries in the Caribbean.

Figure 5
Net imports of oil products relative to total energy consumption, circa 2012



Source: Author's personal elaboration based on Espinasa (2015).
[a] List of acronyms similar to figure 2.

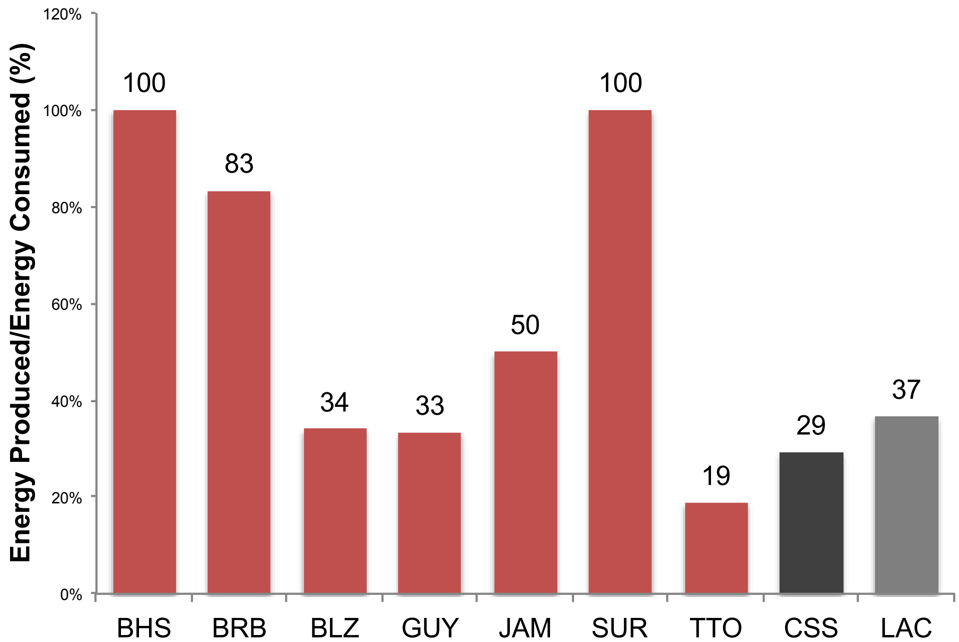
C. There are inefficiencies in the electricity generation process

The production of electricity in the Caribbean requires more "energy inputs" than the Latin American region. This result is presented in figure 6 where we present the ratio of energy used to produce electricity vs. the total amount of energy consumed for a group of selected countries. Although the dark grey bar in the right side of the figure suggests that the ratio for the Caribbean region is relatively similar to that of LATAM, that conclusion does not hold if we exclude Trinidad and Tobago from our estimates. The unweighted average for the region is nearly 60 per cent, 23 percentage points above the

[8] Values above 1 (100 per cent) are possible due to losses during the energy transformation, transmission and distribution processes. See footnote 8 for a detailed explanation of energy losses in Espinasa (2015) database.

Latin American region. This result is shown in figure 4 which presents the amount of energy used in the production of electricity relative to total energy consumption for some Caribbean countries. It highlights the amount of "inputs used" to produce electricity in terms of total energy consumption

Figure 6
Energy used in the production of electricity relative to total energy consumption, circa 2012

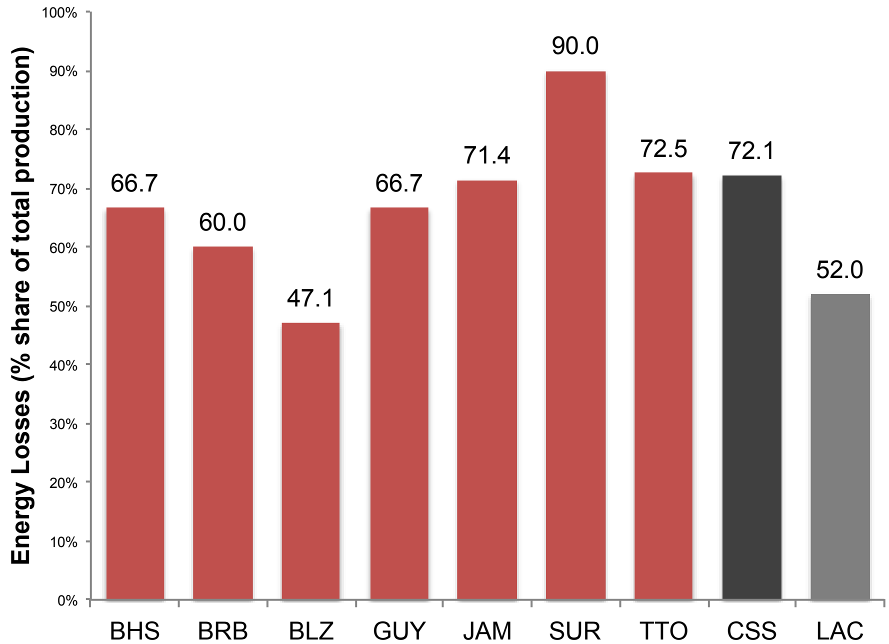


Source: Author's personal elaboration based on Espinasa (2015).
[a] List of acronyms similar to figure 2.

D. Energy losses in the Caribbean are greater than in Latin America

Energy losses in the electricity generation, transmission, and distribution processes are greater in the Caribbean than in Latin America (see figure 7). For the majority of countries in our region of study, losses coming from heat, waste and others exceed 65 per cent of the total amount of energy used to produce electricity. In this case, the weighted and unweighted average for the countries in our list ends up being very similar. This is an expected result based on our previous finding. More energy inputs needed to produce electricity suggest inefficiencies during the process. Figure 7 presents energy losses in electricity relative to total energy used during production (generation, transmission and distribution).

Figure 7
Energy losses during the production of electricity, circa 2012



Source: Author's personal elaboration based on Espinasa (2015).
[a] List of acronyms similar to figure 2.

All these figures suggest that, regardless of the sources of energy used, the Caribbean region has important spaces to think and promote energy efficiency policies.

E. Other sources of information

Energy data in the Caribbean is scarce and heterogeneous. Here we present data of the United States National Renewable Energy Laboratory (NREL) for a group of Caribbean countries. Most of them have important similarities in economic and geographic aspects: GDP per capita below world's average, net importers of fossil fuels, most of them are islands with similar weather conditions and energy sources. This would suggest that all these countries have a similar energy matrix. Table 1 summarizes the energy composition for a group of Caribbean countries according to NREL. The table describes the energy sources used in the Caribbean countries as percentage (%) of total energy supply.

Table 1
Energy composition of Caribbean countries, 2011

Country	Oil products	Natural gas	Solar energy	Biomass	Wind	Hydro	Coal
Antigua and Barbuda	100.0	n.a	n.a	n.a	n.a	n.a	n.a
Aruba	84.6	n.a	1.5	0.9	13.0	n.a	n.a
Bahamas	73.5	26.5	n.a	n.a	n.a	n.a	n.a
Barbados	97.0	n.a	n.a	n.a	n.a	3.0	n.a

Table 1 (concluded)

Country	Oil products	Natural gas	Solar energy	Biomass	Wind	Hydro	Coal
Belize	43.2	n.a	0.1	5.1	n.a	51.6	n.a
Cayman Islands	100.0	n.a	n.a	n.a	n.a	n.a	n.a
Dominica	71.4	n.a	0.3	0.9	n.a	27.4	n.a
Dominican Rpublic	40.0	31.0	n.a	n.a	1.0	13.0	15.0
Grenada	98.8	n.a	1.0	n.a	0.2	n.a	n.a
Guyana	71.0	n.a	n.a	29.0	n.a	n.a	n.a
Jamaica	94.2	n.a	n.a	2.9	0.0	2.9	n.a
Saint Lucia	99.9	n.a	0.1	n.a	n.a	n.a	n.a
Saint Vincent and the Grenadines	78.0	n.a	n.a	n.a	n.a	22.0	n.a
Saint Kitts and Nevis	94.3	n.a	1.8	n.a	3.9	n.a	n.a
Suriname	84.0	n.a	n.a	n.a	n.a	16.0	n.a
Trinidad and Tobago	1.0	99.0	n.a	n.a	n.a	n.a	n.a
Turks and Caicos Islands	n.a	99.6	0.4	n.a	n.a	n.a	n.a
United States Virgin Islands	90.0	n.a	n.a	n.a	n.a	10.0	n.a

Source: Consultant's elaboration based on the United States National Renewable Energy Laboratory and Inter-American Development Bank datasets.

F. Closing remarks

Summing up, despite of some heterogeneities at the country level we can conclude that, on average, Caribbean countries: (a) are net energy importers, (b) imports come primarily from crude oil products, and (c) the process of generating, transmitting and distributing electricity shows important inefficiencies and energy losses.

The fall in commodity prices that started during the second half of 2014 provides an important window of opportunity for Caribbean countries to think and plan strategically their energy sector for the future. On the one hand, the business as usual scenario might look comfortable given the new global equilibrium with low energy prices. On the other hand, a structural transformation at every stage of their energy matrix might be possible, and it seems it is part of the plan for some countries.

However, what is common with both alternatives is the possibility to promote energy efficiency policies. In the next section we explore efforts made by Caribbean countries on this topic.

III. Energy efficiency policies in the Caribbean

One of the most important remarks of our previous section is that the Caribbean region is currently facing an important window of opportunity to re-think and plan strategically their energy sector for the future. Although a complete transformation of their energy matrix to a greener and more efficient one is a desirable goal, it requires important (sizeable) investments and a credible and realistic commitment to develop and follow through a master plan that guides all required structural changes. An alternative (and complimentary) path for countries in the Caribbean is to deepen their efforts to promote energy efficiency. As the IEA (2014) suggests "*energy efficiency is widely recognized as the most cost-effective and readily available means to address numerous energy-related issues, including energy security, the social and economic impacts of high-energy prices and concerns about climate change*."

In this section our main goal is to discuss and synthesize a (non-exhaustible) set of energy efficiency policies that are available for policymakers in the region. Our three major topics to explore will be the following: (a) where is the Caribbean in terms of efforts to promote energy efficiency, (b) review a typology of energy efficiency policies available for the specificities of the region and, (c) some behavioral nudges that can (or should) be used to foster the impact of these policies.

The main message from this section is that there are important opportunities to conduct cost-efficient energy policies in the Caribbean region. Furthermore, if correctly planned, these policies can be enhanced using up-to-date insights from the behavioral economy field.

In this section we present a brief summary of the energy efficiency policies that are currently implemented (or in planning phase) in Caribbean countries. Most of the information that we used here was compiled from the United States National Renewable Energy Laboratory (NREL) and from the United Nations Sustainable Energy Action Plan documents.[9]

The list of energy efficiency policies considered for the analysis includes the following: (a) energy efficiency standards for building constructions, (b) tax credits for the adoption of energy efficiency policies, (c) tax reductions/exemptions, (d) public demonstration (mostly education and awareness), (e) restrictions on incandescent bulbs and, (f) appliance labeling standards. Although this

[9] Studies used for the elaboration of this section were conducted during the 2013-2015 period.

list is certainly not exhaustible, it provides a common ground to analyze Caribbean countries using a homogeneous criterion.

On average, each Caribbean country has one (1) energy policy in place (being tax reduction the most likely among our list) and one (1) energy policy in planning phase (usually promoting standards for building constructions). That is, the typical Caribbean country has only considered out of 6 possible alternatives to promote energy efficiency within its boundaries.

Four out of a list of seventeen countries do not have a single policy related to energy efficiency in place and/or in a planning phase, and four countries have considered only one policy. Therefore, it is possible to affirm that nearly half of the Caribbean has done no efforts to promote energy efficiency policies in their countries.

The regional picture is heterogeneous, however. Table 2 presents a list of 16 countries and six alternatives to promote energy efficiency. It shows if a country X (rows) has adopted policy Y (columns) and if that particular policy is in place, in planning phase, or not considered (n.a.).

Table 2
Energy efficiency programs and policies in the Caribbean countries

	Energy efficiency standards	Tax Credits	Tax Reduction / Exemption	Public Demonstration	Restrictions on Incandescent Bulbs	Appliance Labeling Standards	N.A.	Planning	In Place
Antigua and Barbuda	Planning	n.a.	n.a.	Planning	Planning	Planning	2	4	0
Aruba	n.a.	n.a.	In place	In place	n.a.	n.a.	4	0	2
Bahamas	n.a.	n.a.	n.a.	n.a.	In place	n.a.	5	0	1
Barbados	Planning	Planning	n.a.	Planning	n.a.	n.a.	3	3	0
Belize	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	6	0	0
Cayman Islands	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	6	0	0
Dominica	Planning	n.a.	In place	In place	Planning	Planning	1	3	2
Grenada	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	6	0	0
Guyana	n.a.	n.a.	In place	In place	n.a.	n.a.	4	0	2
Jamaica	n.a.	In place	In place	n.a.	n.a.	In place	3	0	3
Dominican Republic	n.a.	n.a.	In place	In place	In place	n.a.	3	0	3
St. Kitts and Nevis	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	6	0	0
St. Vincent and the Grenadines	Planning	Planning	In place	In place	In place	Planning	0	3	3
St. Lucia	n.a.	n.a.	Planning	n.a.	n.a.	n.a.	5	1	0
Trinidad and Tobago	Planning	In place	In place	n.a.	Planning	Planning	1	3	2
Turks and Caicos Islands	n.a.	n.a.	n.a.	n.a.	In place	n.a.	5	0	1
Virgin Islands	n.a.	n.a.	n.a.	n.a.	In place	n.a.	5	0	1
							Average Caribbean Country		
N.A.	12	13	9	10	9	12	4	1	1
Planning	5	2	1	2	3	4			
In Place	0	2	7	5	5	1			

Source: Consultant's elaboration based on the United States National Renewable Energy Laboratory and the International Renewable Energy Agency reports.
[a] There is no official legislative framework for energy policies in Suriname.

As presented in table 2, countries that have done more efforts to promote energy efficiency have at most three policies currently implemented (Jamaica and Saint Vincent and the Grenadines), and six out of 16 countries are considering new measures to promote efficiency in their energy sector. Dominica, Saint Vincent and the Grenadines, and Trinidad and Tobago are the countries with more revealed effort to promote this type of initiatives in their countries.[10]

Summing up, the Caribbean region seems to be in a suboptimal position in terms of its energy matrix: countries are net energy importers, imports come from crude oil products, there are important

[10] Defined as the sum of energy efficiency policies in place and in planning phase.

inefficiencies related to their production of electricity, and there are little to no efforts in terms of promoting energy efficiency policies. In the next sections we explore two potential reasons that might explain this situation.

A. Typology of energy efficiency policies

In this section we present a typology of energy efficiency policies available for policymakers in the Caribbean region. Initiatives that promote energy efficiency are usually organized by the final consumption sector. Thus, it is common to find them presented in a way that mimics the right-most column of the energy flow that we described in section two (i.e., transport, industry, residential, commercial and other sectors).[11]

Our main reference for this section will be the International Energy Agency (IEA) (2011) entitled *25 Energy Efficiency Policy Recommendations*. IEA, in their effort to promote energy policies, suggests seven priority areas: (a) cross-sectoral, (b) appliances and equipment, (c) lighting, (d) buildings, (e) transport, (f) industry and, (g) energy utilities. Their list includes only cost-effective policies that establish market signals to motivate action, accelerate new technologies and promote energy standards.

1. Cross-sectoral (or transversal) policies

Cross-sectoral policies require important public involvement since they affect nearly all energy consumption sectors. They are usually related to *regulation* (either to set national objectives, promote market competition and, foster private investments) and also to *measure* accurately and timely outcomes of energy efficiency policies. Cross-sectoral policies arise mainly because of standard market failures: time-inconsistent preferences, asymmetries of information, non-competitive markets, externalities and public goods. The International Energy Agency recommends the following list:

- ***Promote the collection of reliable, timely and detailed data*** on energy end uses and market technologies to contribute to the development of effective energy efficiency strategies and policies.
- ***Regularly update strategies and policies*** based on up-to-date evidence. In particular the IEA suggest a close monitoring of:
    - Barriers that hinder cost-effective investments
    - Sectors that can yield the largest improvements
    - National objectives and timelines
    - International experiences
- ***Minimize market distortions*** caused by subsidies since they impede retail prices to reflect the full cost of energy
- ***Facilitate private investments*** in energy efficiency via:
    - Public-Private Partnerships (PPP) to facilitate financing
    - Promote the dissemination of knowledge through networks or energy advisory services
    - Provide standards to effectively quantify the benefits of energy efficiency investments.

[11] Hoffmann et al. (2013) suggests that there is not a unique typology to organize energy efficient policies and proposes a new simplified standard.

2. Appliances and equipment policies

Policies oriented towards appliances and equipment targets (but is not limited to) the residential sector. They are part of IEA list for two reasons: (a) facilitate the entrance of new energy technologies and (b) promote the exit of outdated high-energy consuming appliances. Since appliances and equipment policies are related mostly with setting standards they are close (conceptually) to our previous list. In this area governments could:

- Enforce Minimum Energy Performance Standards (MEPS) and labels thinking ahead about future sales and technologies (such as network-connected appliances)[12]
- Ensure that test standards are updated and in line with international practices to guarantee accurate comparisons.
- Provide financial incentives for the adoption of high-efficiency appliances. If possible, coordinated internationally.[13]

3. Lighting policies

Similarly to our two previous cases, the motivation and recommendations for lighting policies are related to set broad standards (implicitly or explicitly) to all energy consumer sectors. IEA recommendations for governments can be summarized as follows: phase-out inefficient lighting products and promote those that comply with MEPS. Furthermore, since lighting tends to be part of an integral design system, building codes that promote the use of natural light should be encouraged.[14]

4. Building policies

According to IEA estimates, the potential energy savings of this sector will be equivalent (by 2030) to the 2011 annual electricity consumption of the United States and Japan combined. According to this institution, the most important factors that could hinder the materialization of these savings are the following: (a) high initial investment costs and (b) lack of awareness of efficient technologies. Recommendations are thus the following:

- Actively encourage buildings to adopt energy codes and MEPS. IEA goes a step further and suggests that codes should be mandatory to new buildings and also to buildings undergoing renovations.[15]
- Improve energy efficiency in existing buildings.[16] This suggestion is encouraged through:
  - Energy audits, ratings and certifications
  - Promote the improvement of energy performance of critical building components (such as windows and HVAC systems)

[12] Davis and Metcaff (2014) provide evidence in favor of this recommendation with relevant caveats. For a summary see box 1 in the next section.

[13] Davis et al (2014) provide evidence against this recommendation for the case of A/C systems.

[14] Levinson (2014) provides evidence against the effectiveness of building codes in reducing energy consumption.

[15] For an active discussion about Levinson (2014) results see: (1) http://www.hks.harvard.edu/news-events/news/articles/building-energy-codes, (2) http://aceee.org/blog/2015/02/california-building-codes-analyze, (3) http://energyinnovation.org/2015/03/03/energy-innovation-responds-to-california-building-codes-study/ and (4) http://switchboard.nrdc.org/blogs/dgoldstein/statistical_analysis_can_be_a.html

[16] See Fowlie et al. (2015) for a interesting counterargument to this recommendation.

  - Provide incentives to encourage investments (with useful information on financing options)
  - Establish an realistic timeline and renovation rate in existing building

5. Transport policies

Transportation policies to promote energy efficiency are more complicated to implement relative to our previous cases because they are mostly systemic and depend on radical technological transformations. Therefore, IEA suggestions are less ambitious and (probably) less costly from the government's perspective. Although transportation is the biggest consumption sector (in terms of energy demand) in Latin America (and the second most important in the Caribbean) governments have less degrees of freedom to effectively promote policies in this area[17]. The big picture is not that dismal, however. Evidence has shown that consumers respond rapidly to fiscal incentives in the transportation sector. For example, IEA (2010) suggests that the introduction of a differentiated annual motor and vehicle registration taxes in Ireland soared the percentage of cars sold in the lowest CO2 emissions bands. The challenge should encourage governments to follow closely technological changes and the consumer's response to tax policies, to nourish and enhance transformations in this area. To date, IEA recommendations can be summarized as follows:

- Adopt (and measure) vehicle fuel efficiency standards
- Provide incentives (labels, subsidies and infrastructure) to boost vehicle efficiency
- Adopt stricter standards in a vehicle's non-engine components (particularly tires and A/C systems)
- Take into account that urban planning should incorporate the transport implications on energy demand.

6. Industry policies

- Require Energy Management protocols (such as ISO 50001) that include strategies to identify energy savings opportunities, and action plans to materialize those savings, and publicly report the results.
- Encourage the adoption of industrial equipment and systems that meet MEPS (such as motors, compressors, pumps, etc.), while addressing barriers to the optimization of energy efficiency operations.
- A package targeted towards small and medium-sized enterprises (SMEs). This package should include energy audits, relevant information on proven practices and an energy performance benchmarking so that SMEs can compare their energy consumptions to relevant peers.

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17 Körner (2012) suggests that governments need to implement a comprehensive strategy exclusively to gather useful information to guide energy efficiency policies in the transport sector. According to the author, national statistical offices need a top-down and bottom-up approach to collect data on: transport activity, transport structure, energy intensity data and, carbon intensity data. He also summarizes the complexity of the problem with the following idea "The most energy efficient trip is the one that is not performed [and that] can be addressed by: (1) Land use planning, (2) Parking policy (3) Urban design and, (4) Alternative work concepts: Tele working". All proposed solutions require interventions of the government at the national and subnational levels.

- Promote efficiency in the industrial sector by removing subsidies (to internalize externalities, e.g. environmental ones) and guarantee access to finance, while allowing for tax incentives on energy-efficient investments.

Summing up, in this section we presented a set of policy recommendations to address every sector of the demand side of the energy market. Most of these recommendations fall into any of three broad categories: (a) provide rigorous and transparent standards, (b) minimize market distortions for non-efficient consumption of energy and, (c) facilitate access to energy-efficiency private investors (via tax-incentives and finance alternatives). In our next section we will discuss about some behavioral nudges that can be used to enhance the cost-benefit effects of these policies.

B. Behavioral nudges to enhance energy efficiency policies

In this section we present a group of studies that have shown to be effective at changing behavioral attitudes of energy consumers. These types of initiatives are useful mainly for two reasons: (a) they complement and enhance results of the energy efficiency policies presented in the previous section and, (b) they have shown to be cost-effective for consumers, producers and also for the government.

Most of the information gathered for this section comes from three institutions: the Abdul Latif Jameel Poverty Action Lab (J-PAL), E2e (a joint initiative of the University of California – Berkeley, the Massachusetts Institute of Technology, and the University of Chicago) and the National Bureau of Economic Research (NBER). Our goal was to look for randomized experiments and other state-of-the-art evaluation strategies that seek to measure and enhance the impact of energy efficiency initiatives.

We identified three relevant studies and presented a summary of each one in a separate box. The subjects of the study in all three cases were households, therefore interventions were intended to enhance energy efficiency policies in the *residential* sector. Similarly, all studies are related to the type of information that is given (and the way it is presented) to energy consumers. Therefore, they are demand-type interventions.

Summing up briefly, the most important message of this section is that more (and better) information leads households to take better decisions in terms of their energy consumption.

Box 1
Does better information lead to better choices? Evidence from energy efficiency labels

Motivation
All major appliances in the United States are required by law to have the yellow Energy Guide label. In a nutshell, this label shows to the potential buyer the estimated yearly energy cost that would incur by purchase the appliance under two main assumptions: (a) the national average energy price and, (b) the average national usage. The idea of the study was to test if consumers react different in their consumption decision if the yellow label contains state-specific information instead of national averages.

Summary of the program (intervention)
In their study, the authors conducted an online hypothetical air conditioner purchase decision. The control group was shown standard yellow labels while the treatment group was shown a yellow label with the estimated energy cost that would incur under their state-specific energy average price and appliance usage.

Results
State-specific labels led to higher (lower) investments in energy efficient air conditioners in states with higher (lower) energy price and appliance usage. Nationwide the amount of investment was roughly the same regardless of the label used but the distribution was more efficient.

Box 1 (concluded)

Main lessons

"More accurate labels lead to better choices. While customers use the information on labels, they do so without analyzing it carefully. The implied savings are larger than the estimated costs of implementing state-specific labels."

Authors: Lucas Davis and Gilbert Metcalf. E2e Working Paper WP-015, March 2015
References: Davis, L. and Gilbert Metcalf. (2015). Does better information lead to better choices? Evidence from energy efficiency labels, E2e Working paper Wp-015

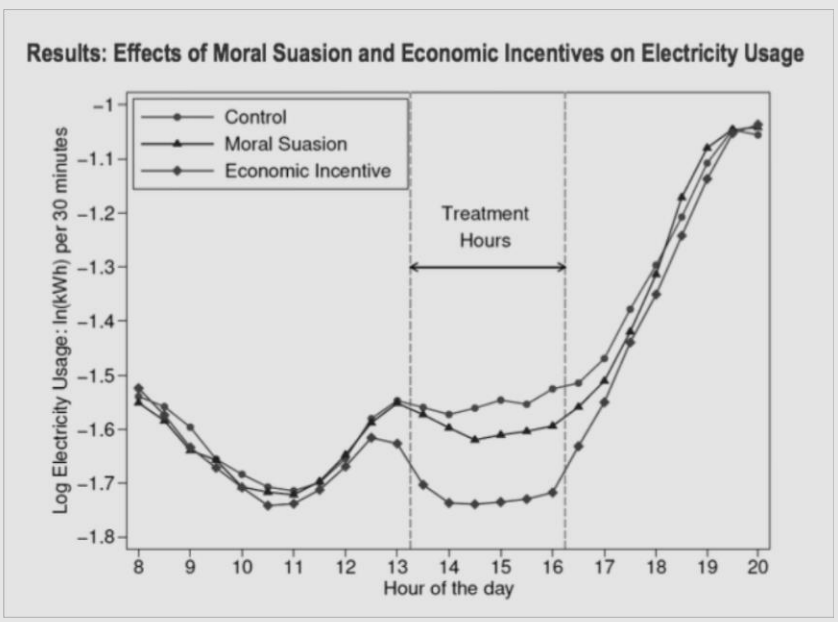
Box 2
The persistence of moral suasion and economic incentives: field experimental evidence from energy demand

Ito et al. (2015) conducted an experiment to test whether moral suasion or economic incentives can motivate households to conserve electricity during times of peak demand, i.e., precisely when the marginal costs of supply are high.

In the experiment the authors randomly assigned households into two categories: (a) a control group and (b) a treatment group that were divided into two subcategories: (b.1) the moral suasion category that was told that substantial energy conservation would be required for society during "critical peak demand hours" on summer and winter peak demand days, (b.2) a economic incentive category that was informed that they would be charged high electricity prices during the critical peak demand hours on the critical peak days.

Result suggested that the moral suasion treatment group had an 8 per cent reduction in electricity usage in the short run, but effects diminished over repeated interventions. The economic incentive treatment group had a 14-17 percent reduction in electricity usage, which persisted over repeated interventions. Furthermore, economic incentives cemented conservative energy habits, which persisted after the experiment ended.

The main policy lesson from the study was that while both moral suasion and economic incentives can provide efficiency gains, the gains from economic incentives are larger, and persist more over time.



Source: http://e2e.haas.berkeley.edu/pdf/briefs/labels_policy_summary.pdf on Feb 01, 2016
Authors: Koichiro Ito, Takanori Ida, and Makoto Tanaka. E2e Working Paper WP-017.

Box 3
Opower: evaluating the impact of home energy reports on energy conservation in the United States

Motivation

Since traditional alternatives to reduce greenhouse gas emissions and address climate change require important investments and are difficult to implement, researchers have focused their attention on behavioral interventions that seek to change energy consumptions habits through education or persuasion. Opower produces home reports that allow households to compare their monthly energy consumptions to their peers and also provide accurate information on how to save energy. Alcott & Roger (2014) evaluated if these reports can have long-term impact on energy conservation.

Summary of the intervention

Opower reports compare a household's energy use to that of 100 neighbors with similar square footage and the same heating type. They also include advices for conserving energy and saving money. Reports were randomly assigned to households from a pool of twelve different utility companies and monthly electricity meter were compared between treatment and control groups. There were another variations in the treatment groups to test for long-term effects of the interventions.

Results and policy lessons

The Opower program reduced energy consumption among treated households by 1.4–3.3 percent at each utility

Consumers with the highest energy consumption before the program reduced consumption more than the average consumer

Short-term effects: Reports caused immediate reduction in energy consumption but household's efforts to conserve decayed quickly

Long-term effects: Households that stopped receiving reports after two years continued to save about 0.6 kilowatt-hour per day more than the control group, which is equivalent to about two percent of electricity use.

Authors: Hunt Alcott and Todd Rogers.
References: Most of this information was taken from: https://www.povertyactionlab.org/es/node/10356 on Jan 22, 2016.

Summing up, relevant information that allows households to effectively compare themselves to close peers has a significant effect on energy efficiency outcomes with long-term implications. In our next section we will discuss (given all this evidence) why the Caribbean is still lagging in terms of adoption of energy efficiency polices.

IV. What might be hindering the adoption of energy efficiency policies in the Caribbean?

In this section we explore some of the reasons that might be hindering the adoption of energy efficiency policies in the Caribbean region. The first one is that of *competing needs*. Caribbean countries might face important constraints in terms of primary physical infrastructure (for example, for the provision of public water and/or waste management) leaving no room for energy efficiency policies to be discussed domestically. The second one is *debt overhang*. In this type of scenario, countries might be discouraged to conduct new investments since earnings/savings from projects would go directly to debt holders. For our case, the adoption of energy efficiency policies might be dissuaded because potential savings would go directly to debt creditors.

Generally speaking in this section we explore whether the binding constraint for the adoption of energy efficiency policies is related to a financial problem or to a political economy restriction.

A. The case of competing needs

Our hypothesis for this part of the study would be the following: if the Caribbean region is lagged in terms of primary infrastructure (for example, for the provision of public water and/or waste management), then there would be little space within the public arena to discuss energy efficiency policies. In other words, in this section we seek evidence to identify if there are political economy reasons behind the lack of resources for the adoption of energy efficiency policies in the Caribbean.

For this purpose our plan would be the following: (1), present how the level of primary infrastructure has evolved over time in Caribbean countries and, (2) compare current levels of primary infrastructure with the Latin American region as a benchmark.

1. Provision of primary infrastructure over time

Here we present how two relevant indicators of primary infrastructure have evolved over time during the 1990–2012 period. The fist indicator is the provision of electricity as percentage of the population. In 1990 the unweighted average for the Latin American region was 89.1 per cent of the population with access to electricity, while for the Caribbean region was 82.5 per cent, i.e., 6.6 percentage points (pp.) below our counterparts. By 2012, LATAM's average was 96.4 per cent while the Caribbean figure situated at 92 per cent.

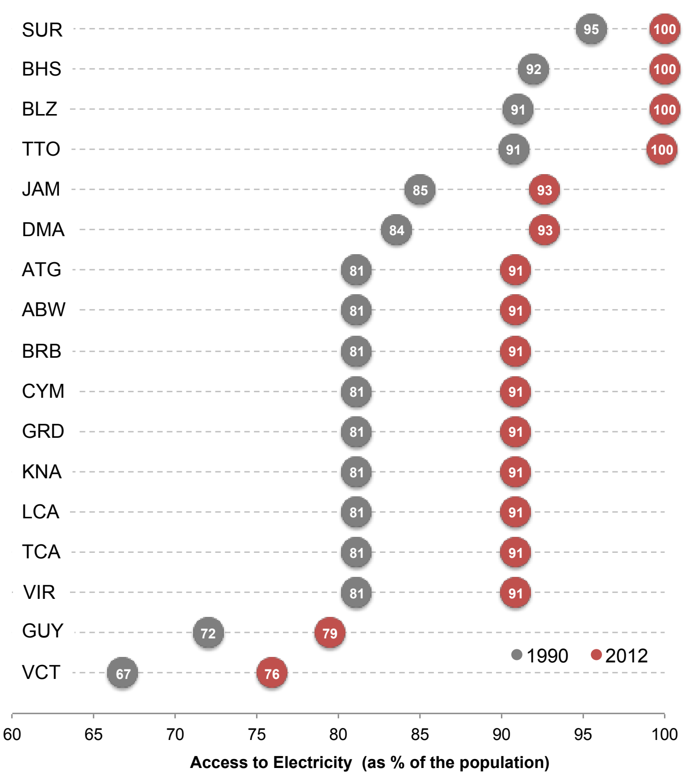
In other words, while the Latin American region increased their population share with access to electricity by 7.3pp., the Caribbean did a better effort by increasing the same number in 9.5 pp. The most important increases were made by Antigua and Barbuda, Aruba, Barbados, Cayman Islands, Grenada, Saint Kitts and Nevis, Saint Lucia, Turks and Caicos Islands, Virgin Islands (United States) with improvements of nearly 10 pp. during the same period. Panel A of figure 8 presents the data at the country level. For this indicator the overall picture is the following, the provision of electricity in the Caribbean by 2012 is above 92 per cent of the population, and the difference between the region and its Latin American counterparts has narrowed to reach a difference of 4.4 percentage points.

Our second indicator is the access to improved water as percentage of the population. For this indicator what is relevant to observe is that the Caribbean position in 1990 was above the Latin American region. The Caribbean had 91.5 per cent of the population with access to clean water while our counterpart region had only 84.9 per cent, i.e., a 6.6 percentage point difference. By 2012, the Caribbean maintained its relative position with 96.3 per cent of its population with access to improved water sources while LATAM reached a 94 per cent. Panel B of figure 8 presents relevant data at the country level for this case.

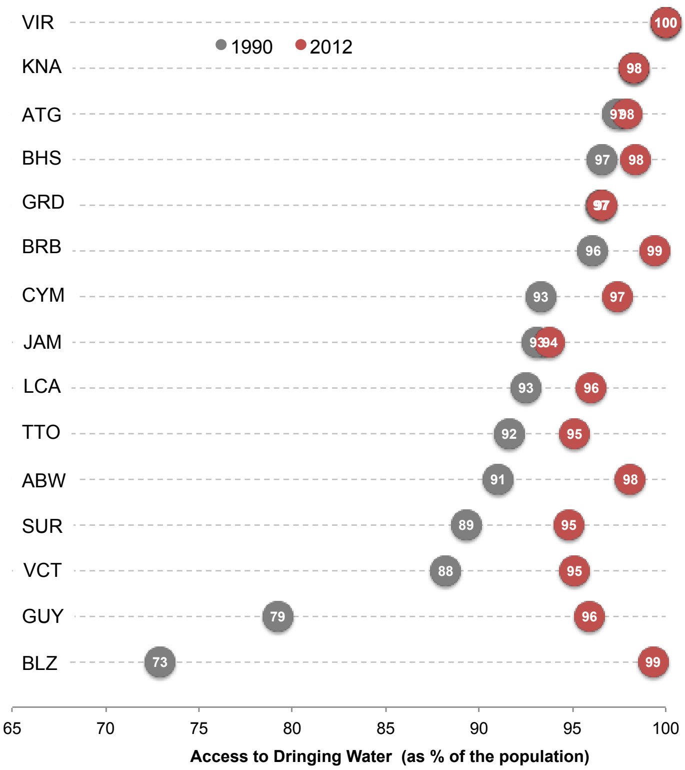
Summing up, both indicators of primary infrastructure are above 90 per cent of the population and both have shown important increases during the 1990–2012 period. Therefore, this can be interpreted as evidence against our first hypothesis.

Figure 8
Provision of primary infrastructure over time
Selected indicators

Panel A: Access to electricity



Panel B: Access to drinking water



Source: Consultant's elaboration based on World Bank's World Development Indicators 2014
[a] The figure presents how primary infrastructure has evolved in the Caribbean during the 1990–2012 period. Panel A presents the evolution of the variable "Access to Electricity" while Panel B presents the variable "Access to drinking water" both variable as percentage of the population.
[b] List of acronyms: Antigua and Barbuda (ATG), Bahamas The (BHS), Barbados (BRB), Belize (BLZ), Dominica (DMA), Grenada (GRD), Guyana (GUY), Jamaica (JAM), Saint Kitts and Nevis (KNA), Saint Lucia (LCA), Saint Vincent and the Grenadines (VCT), Suriname (SUR), Trinidad and Tobago (TTO), Aruba (ABW), Cayman Islands (CYM), Turks and Caicos Islands (TCA), Virgin Islands (VIR), Caribbean Small States (CSS), Latin America & Caribbean (LCN)

2. Primary infrastructure relative to Latin America

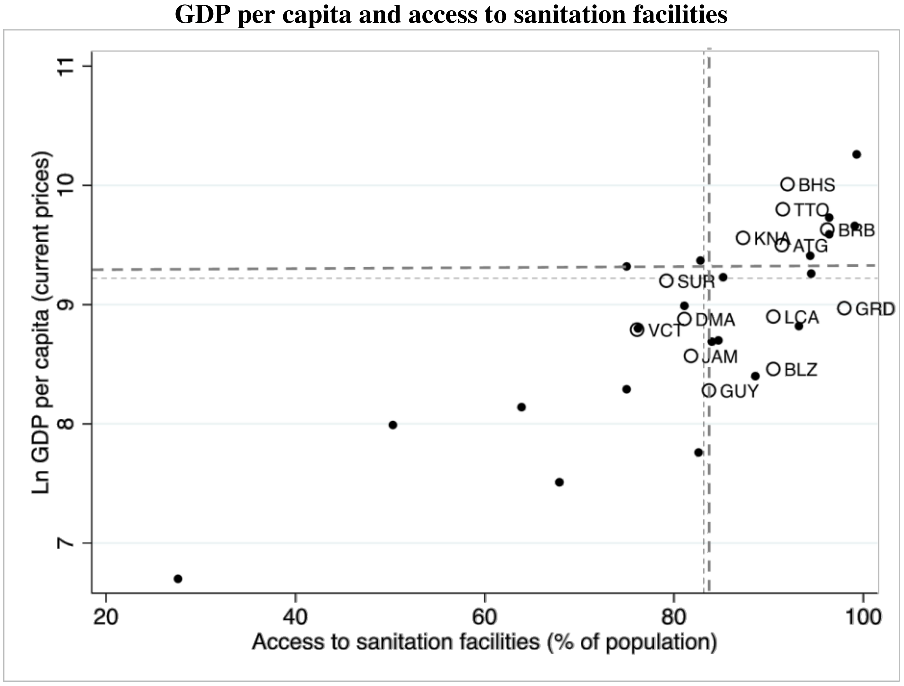
Although there would be little to no debate regarding the importance of primary infrastructure in every country, the question of how many of it is acceptable or adequate is much less clear. Here we explore levels of primary infrastructure for most countries in Latin America and our normative claim would be the related to some moments of its distribution. Thus, countries above the median or the mean of the region would be considered to have "adequate" provision levels, while countries below that line would be considered to have a lack of primary infrastructure.

Figure 9 presents our first comparison for this section. It presents the percentage of the population in Latin American and Caribbean countries with access to sanitation facilities, *versus* the GDP per capita expressed in natural logs. Caribbean countries are presented with hollowed circles. As expected, there seems to be a positive correlation between both variables, i.e., countries with greater

GDP per capita tend to have, on average, a higher share of their population with access to sanitation facilities. Dashed lines represent the average for each variable.[18]

The unweighted average suggests that nearly 84 per cent of the population in our region of study has access to sanitation facilities. If we only consider Caribbean countries, the share increases up to 87 per cent. In our graph nearly all red countries are above the region's average. Only Saint Vincent and the Grenadines, Suriname and Dominica are below that benchmark. In essence, most countries in Latin America and the Caribbean appear to be in the upper decile of the distribution for this indicator

Figure 9
GDP per capita and access to sanitation facilities

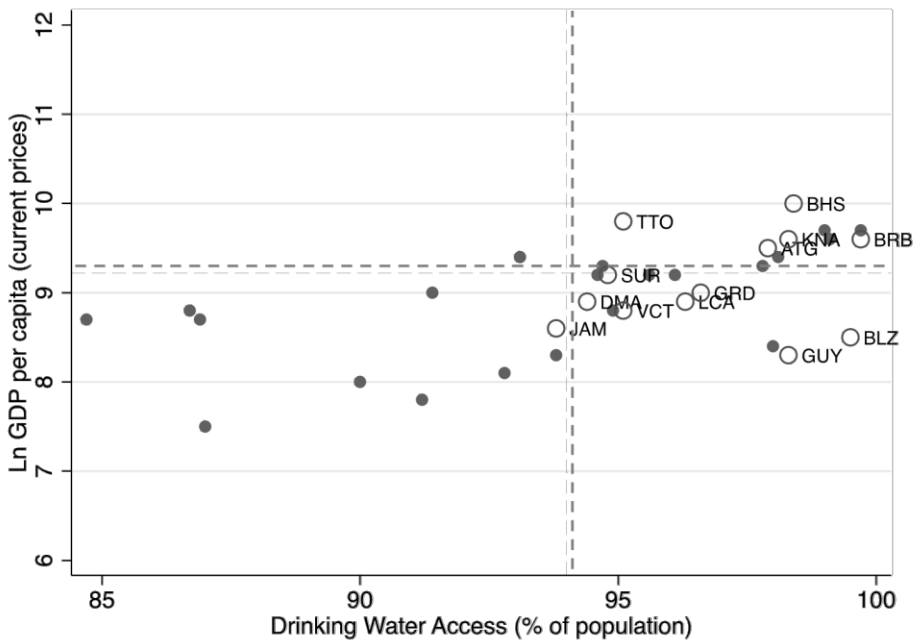


Source: World Bank and authors calculations.
[a] The graph assesses a correlation between the per capita GDP (2013) and the access to drinking water (share of the total population).
[b] Aruba , Cayman Islands , Turks and Caicos, and Virgin Islands are omitted due to data unavailability.

Figure 10 presents a similar result for the case of drinking water (improved water source). As in the previous case, there is a positive correlation between both series suggesting that, on average, countries with higher GDP per capita tend to have more access to drinking water (and/or vice versa). Most Caribbean countries are located above the regional average. The only exception appears to be Jamaica, with a national average of 93.8 per cent, 1 percentage points (pp.) below the regional average.

[18] Regional averages might differ with the previous section because of the inclusion of different countries in the analysis due to data availability.

Figure 10
GDP per capita and access to drinking water

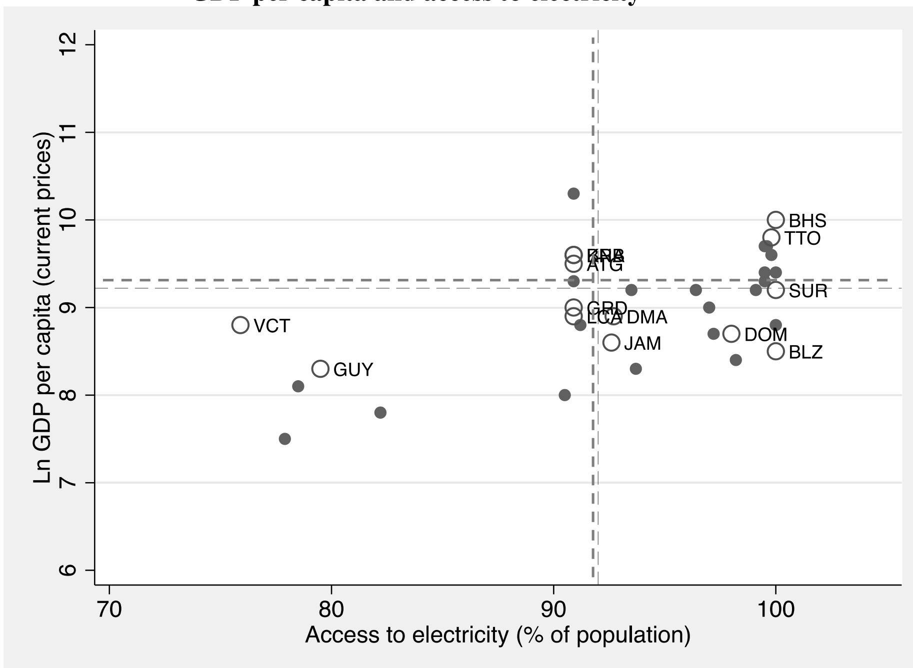


Source: World Bank and authors calculations.
[a] The graph assesses a correlation between the per capita GDP (2013) and the access to drinking water (share of the total population).
[b] Aruba, Cayman Islands, Turks and Caicos Islands, and, Virgin Islands are omitted due to data unavailability.

Figure 11 presents another relevant indicator. It shows the percentage of the population in each country with access to electricity. The unweighted average in our sample is close to 92 per cent, i.e., nearly full coverage. Half of the Caribbean countries (hollowed circles) lie below that threshold, with Saint Vincent and the Grenadines showing the smallest figure (76 per cent) and Guyana the second smallest figure (79 per cent). The correlation between access to electricity and a country's GDP per capita appears to be positive, but since access to electricity can grow above 100 per cent, the relation is likely to be non-linear.

Although there are important heterogeneities at the country level, the big picture appears to be the same for the whole group; primary infrastructure on water, sanitation and electricity seem not to be the binding constraint for the adoption of energy efficiency policies in the Caribbean.

Figure 11
GDP per capita and access to electricity

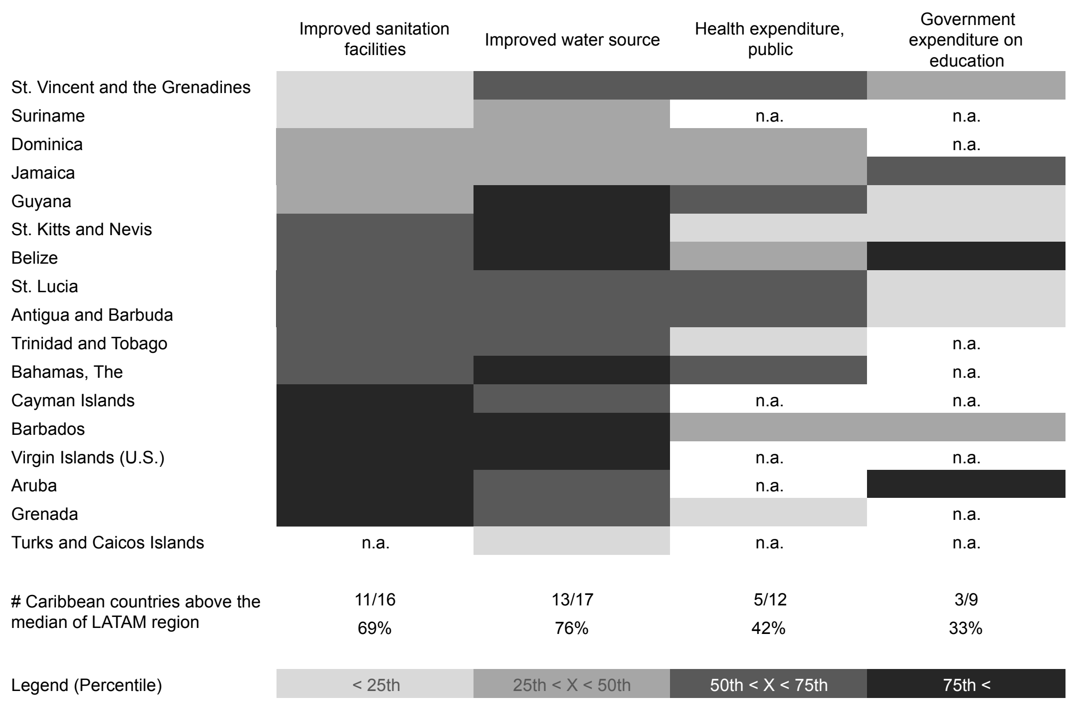


Source: World Bank and authors calculations
[a] The Graph assesses a correlation between the per capita GDP (2013) and the access to electricity (share of the total population).
[b] Aruba, Cayman Islands, Turks and Caicos Islands, Virgin Islands are omitted due to data unavailability.

The same conclusion holds if we use the median instead of the unweighted average for every indicator in our list. Figure 12 shows a "heat map" for all countries in the Caribbean region relative to four different indicators (improved sanitation facilities, improved water source, and public health and education expenditure). A darker gray suggests that the indicator is above the Latin America and Caribbean median, and lighter grays suggest the contrary (white cells represent missing data). As presented, the Caribbean region appears to be in a better relative position than their Latin American counterparts in terms of primary infrastructure. However, in terms of public health and education expenditure, the region appears to be "lagged" relative to Latin America.[19]

[19] A country's expenditure in public health (or education) below the region's average does not represent a negative outcome per se. It might suggest different development models and/or differences in government expenditure efficiency.

Figure 12
Selected health and education variables in the Caribbean compared with Latin American region.



Source: Consultant's elaboration based on WDI datasets.
[a] The graph presents the relative position of Caribbean countries relative to Latin America in four selected variables related to health and education. Darker colors suggest a relative position above the region's median. Similarly, lighter colors suggest a relative position below the region's median. White cells are missing.
[b] Latest available data in WB's World Development Indicators dataset. Columns 1,2 are expressed as percentage of population with access. Columns 3,4 are expressed as percentage of government expenditure.

Summing up, primary infrastructure indicators in the Caribbean tend to be above the Latin America's average and most of them are close to full coverage. All these results are evidence against our initial hypothesis. Nevertheless, this is not equivalent to say that the region has an optimal infrastructure provision but rather that in terms of priorities the "lack" of infrastructure does not seem to be in the top of the list.

B. Debt overhang hypothesis

In this section we explore an alternative hypothesis to explain the lack of energy efficiency policies in the Caribbean. This hypothesis is related to debt levels (and debt dynamics) faced by Caribbean countries. A situation where the debt stock of a nation exceeds its future capacity to repay it is often called debt overhang. In this type of scenario, countries might be dissuaded to conduct new investments since all earnings/savings from projects would go directly to debt holders. For our case, the adoption of energy efficiency policies might be dissuaded because potential savings would go directly to debt creditors.

Here we try to identify if debt levels (and debt dynamics) in Caribbean countries are in fact a potential cause for the lack of energy efficiency policies in the region. In other words, our relevant hypothesis can be stated as follows: if a country is facing a debt overhang situation then it would have no incentive to promote energy efficiency policies.

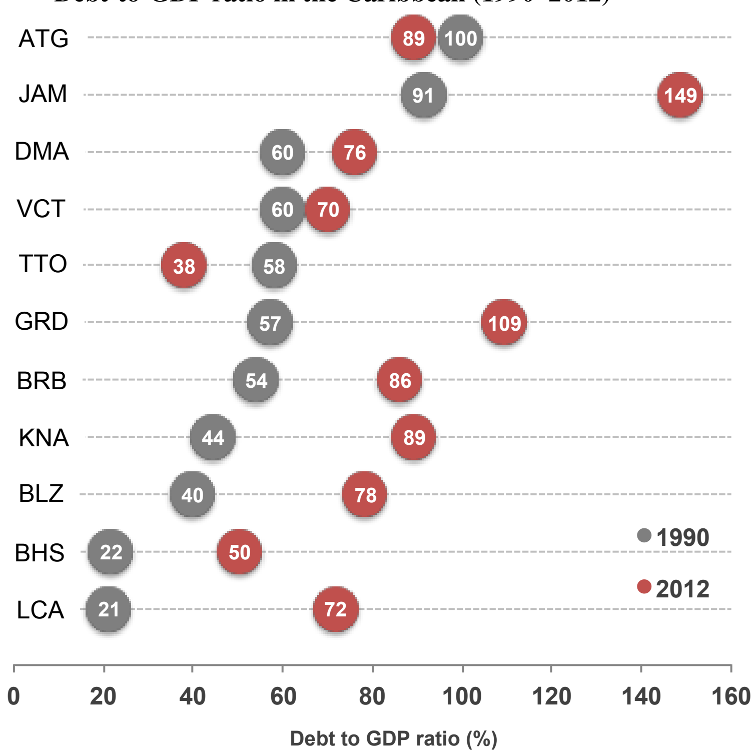
In section III we concluded that the average Caribbean country has been relatively inactive in regards to energy efficiency policies. In Chapter IV, A, 2 we identified that primary infrastructure levels in the Caribbean are not consistent with the lack of interest in energy policies. In this section, we attempt to identify if the debt situation is consistent with the same outcome.

As in our last subsection, we begin analyzing the evolution of some debt variables over time in the Caribbean. Then we continue with a more normative approach comparing current debt levels with some international benchmarks frequently used in the literature. We continue by comparing debt levels in Caribbean countries with the Latin American region, and conclude with a literature review on debt sustainability analysis.

1. Debt levels over time

During the 1990–2012 period the average Caribbean country increased its debt-to-GDP ratio by 23 percentage points (pp.). While in 1990 this statistic for the region was 55.4 per cent, by 2012 the same figure rose to 78.4 per cent. Figure 13 presents the same evidence at a country level. Out of a list of 13 countries, only three were able to decrease their debt-to-GDP ratio: Antigua and Barbuda, Dominican Republic and Trinidad and Tobago. Excluding these three cases, the average statistic for the region increased by 36.7 percentage points during the same period.

Figure 13
Debt-to-GDP ratio in the Caribbean (1990–2012)



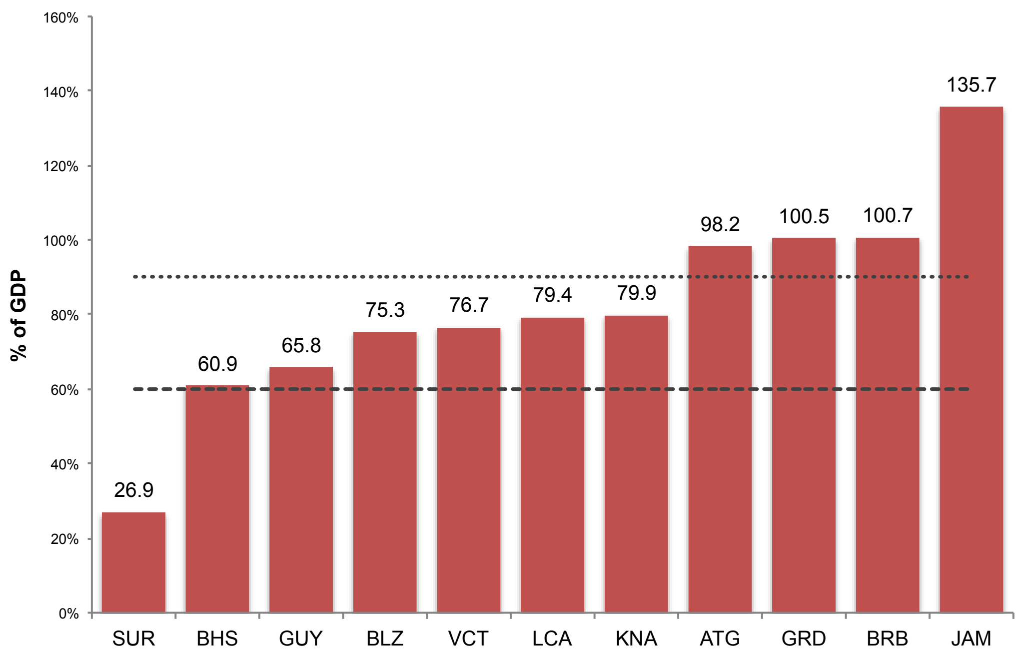
Source: Consultant's elaboration based on Abbas et al. (2010)
[a] The graph presents the debt to GDP statistics for a group of Caribbean countries during the 1990–2012 period
[b] List of acronyms: Bahamas (BHS), Barbados (BRB), Belize (BLZ), Guyana (GUY), Jamaica (JAM), Suriname (SUR), Trinidad and Tobago (TTO), Caribbean Small States (CSS), Latin America & Caribbean (LCN)

Although the picture is still incomplete, this fact can be interpreted as evidence in favor of the debt overhang hypothesis. In the next section we complement this data with some benchmarks widely used in the economic literature on debt sustainability.

2. Debt levels and international standards

Figure 14 presents the General Government Gross Debt (as GDP percentage) for a group of 11 Caribbean countries. The "adequate" debt to GDP ratio is a country specific question that requires an in-depth analysis of the external and internal sector of the economy (and is rarely static). The economic literature often proposes two *ad hoc* benchmarks to guide normative cross country analyses: the first one is part of the euro convergence criteria or Maastricht criteria, and defines a 60 per cent ratio as a sustainable debt threshold.[20] The second one defines a healthy ratio below 90 per cent.[21] Figure 14 suggests that 10 out of 11 countries in our list do not satisfy the first "Maastricht" benchmark. In fact, the unweighted average for the Caribbean is close to a 78 per cent as debt-to-GDP ratio. However, most countries in our list are below our second "Reinhart's benchmark" of 90 per cent. Since both results are not consistent, we need to explore further information at the country level.

Figure 14
General government gross debt
Percentage of GDP



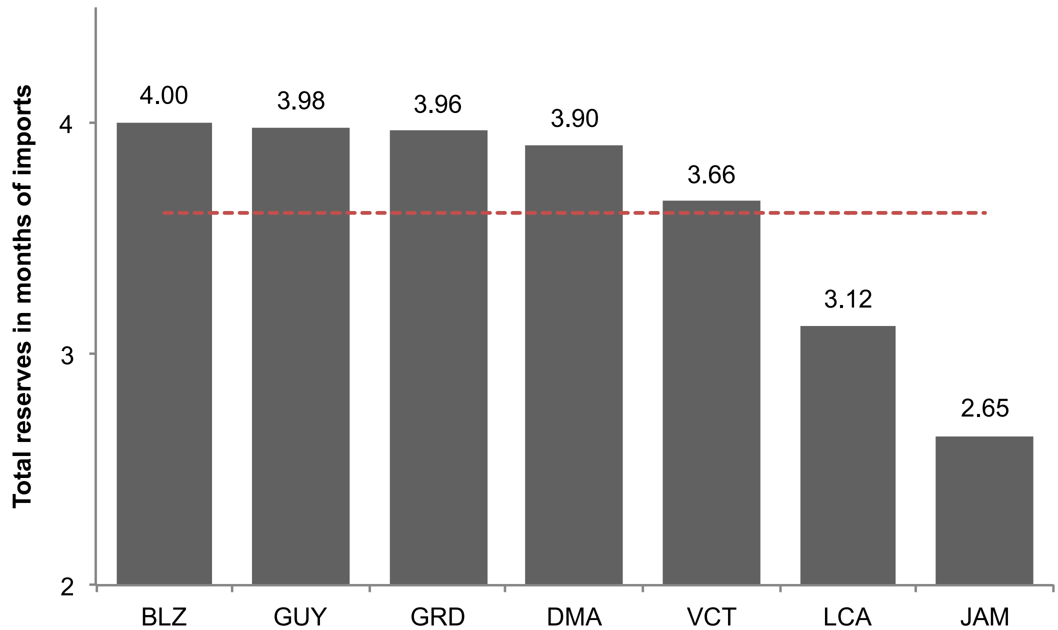
Source: Consultant's elaboration based on IMF and WDI datasets
[a] The figure presents general government gross debt as percent of the GDP in 2014 for a group of Caribbean countries.

Figure 15 presents the total amount of international reserves expressed in terms of months of imports for a group of eight Caribbean countries. The first reflection that emerges from the picture is that it is difficult to collect relevant data/information for the external sector of Caribbean countries. Series from official sources are often incomplete and not comparable among different years. Therefore, it is difficult to match arguments with adequate evidence. In figure 15 we have seven countries with relevant data, 33 per cent less than the number of countries available in figure 14

[20] See http://ec.europa.eu/economy_finance/euro/adoption/who_can_join/index_en.htm
[21] See for example Reinhart et al. (2012).

The main message from figure 15 is that the average Caribbean country has enough reserves to cover 3.6 months of imports. This figure is relevant since Caribbean countries are net energy importers; debt levels are above 75 per cent of their GDP, and reserve levels are perceived as a guarantee of payment. The usual *ad hoc* benchmark for this indicator is having enough reserves to cover 3 to 4 months of imports and the regional average is 3.6, therefore we cannot extract robust conclusions solely from this indicator.

Figure 15
Total reserves in months of imports, circa 2013



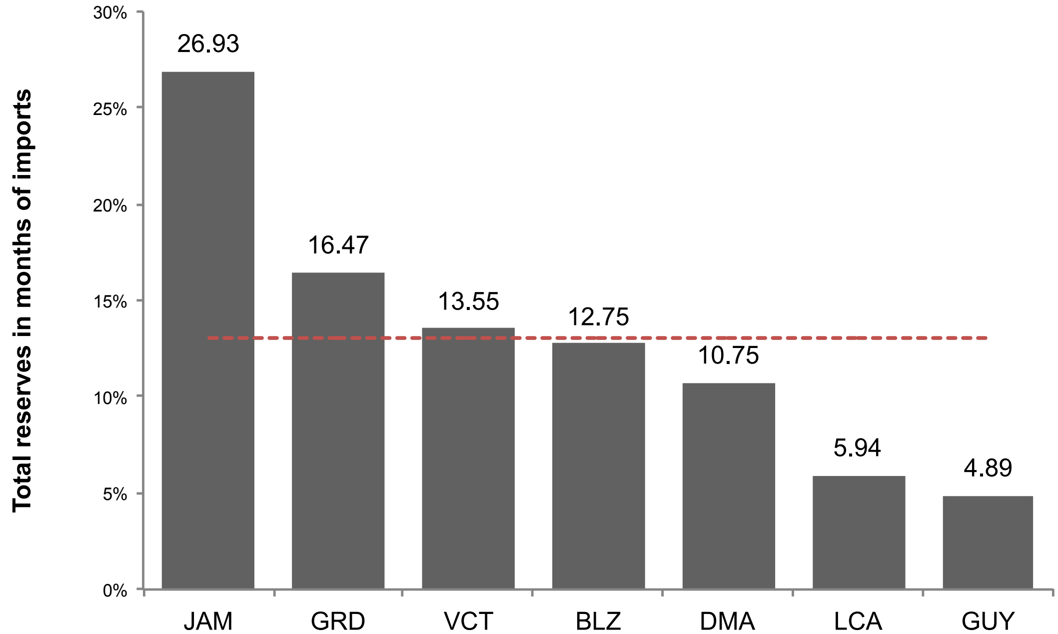
Source: Consultant's elaboration based on IMF and WDI datasets.
[a] The figure shows how much months of imports could be covered by the countries reserves.

One of the indicators used by the United Nations to monitor the Millennium Development Goals is debt service as a percentage of exports of goods and services.[22] They suggest the following: "*While there are no rules for determining when a countries' debt service is unsustainable, empirical analysis of developing countries' debt service experience shows that debt service difficulties increase when debt exceeds 200 per cent of export values*." Using an average debt rate of 15 per cent as upper bound suggests that an "adequate" debt service to total exports ratio should be below 30 per cent.

Figure 16 presents the debt service to exports ratio for a group of seven Caribbean countries. None of the countries exceed the suggested benchmark. Does that mean that debt levels in Caribbean countries are in comfortable situation? Not necessarily. An "optimal debt level" is a country specific measure that depends on several endogenous variables, but more importantly is a dynamic concept. To construct a correct assessment of the debt situation of a country it is necessary to understand how some variables evolve over time.

[22] See http://mdgs.un.org/unsd/mi/wiki/8-12-Debt-service-as-a-percentage-of-exports-of-goods-and-services.ashx

Figure 16
Debt services over total exports, 2013

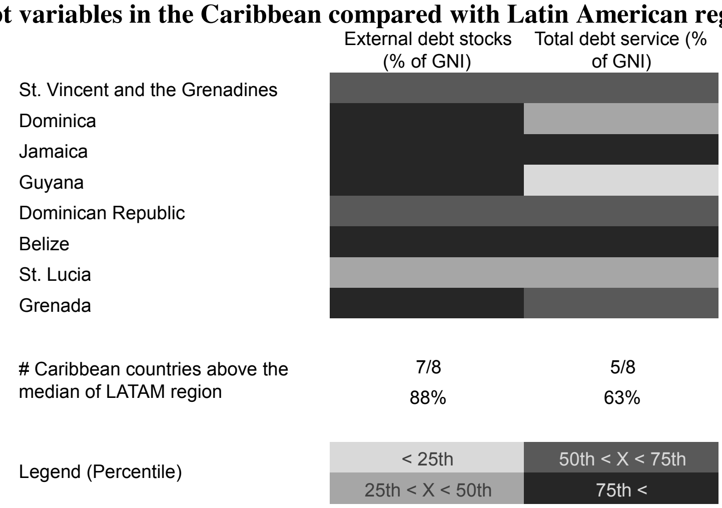


Source: Consultant's elaboration based on IMF and WDI datasets
[a] The figure shows the debt service in relation to the total exports.

3. Debt levels relative to Latin America

In figures 13-16 we presented debt indicators for a group of Caribbean countries in a particular year. In table 3 we compared Caribbean results to that of Latin America. The idea of the graph is the following; darker colors represent figures above the Latin Americans median, and lighter colors represent figures below it.

Table 3
Selected debt variables in the Caribbean compared with Latin American region.



Source: Consultant's elaboration based on WDI datasets.
[a] The graph presents the relative position of Caribbean countries relative to Latin America in two selected variables related to debt situation.
[b] Latest available data in WB's World Development Indicators dataset.

As can be observed in the first column of figure 16, Caribbean countries tend to have larger debt stocks than their Latin American counterparts. A similar situation occurs with the debt service as percentage of the Gross National Income (GNI). Both results suggest that the external situation of countries in the Caribbean is worse relative to that of Latin America.

4. Debt levels and debt sustainability

To conclude this section, Table 4 presents a summary of three different debt sustainability analyses for a group of Caribbean countries. This type of analysis incorporates debt dynamics and, on the basis of that information, concludes whether a country has sustainable debt levels or not.

Table 4
Debt sustainability in Caribbean countries

Period of analysis	**2011**	**2011**	**2012**
Country \ Author	**SELA (2015)**	**Amo-Yartey et al. (2012)**	**Andrian et al. (2013)**
Antigua and Barbuda	Not Sustainable	Not Sustainable	n.a.
Bahamas, The	Not Sustainable	Not Sustainable	Not Sustainable
Barbados	Not Sustainable	Not Sustainable	Not Sustainable
Belize	Not Sustainable	Sustainable	n.a.
Dominica	Not Sustainable	Not Sustainable	n.a.
Dominican Republic	n.a.	Not Sustainable	n.a.
Grenada	Not Sustainable	Not Sustainable	n.a.
Guyana	n.a.	Sustainable	n.a.
Jamaica	Not Sustainable	Not Sustainable	Not Sustainable
St. Kitts and Nevis	Not Sustainable	Not Sustainable	n.a.
St. Lucia	Not Sustainable	Not Sustainable	n.a.
St. Vincent and the Grenadines	Not Sustainable	Not Sustainable	n.a.
Suriname	Sustainable	Sustainable	Sustainable
Trinidad and Tobago	Not Sustainable	Not Sustainable	n.d.

Source: Consultant's elaboration based on WDI datasets
[a] The table shows the findings of three relevant papers, regarding the sustainability of the debt in the Caribbean countries
[b] Latest available data in WB's World Development Indicators dataset. Columns 1, 2 are expressed as % of population with access. Columns 3,4 are expressed as % of government expenditure

The advantage of this approach is that it allows us to understand a country's indebtedness situation during long-term periods. Table 4 suggests that most Caribbean countries have debt levels and debt dynamics not consistent with their inter-temporal budget restriction, i.e., debt is not sustainable. The sole two exceptions seem to be Belize and Suriname.

This additional piece of information complements our previous findings. For a particular year debt levels might not be above critical thresholds, but over time it seems not sustainable.

V. Conclusions

In this paper we explored two potential reasons that might be hindering the adoption of energy efficiency policies in the Caribbean. The first reason is related to the availability of primary infrastructure and the second one is related to their indebtedness situation. The evidence presented suggests that Caribbean countries are burdened by a severe debt overhang. This result is consistent with the observation that the region has lagged in the adoption of energy efficiency policies.

Our first goal was to describe the energy matrix for countries in the region. We concluded that the average Caribbean country is a net importer of energy and most imports come from oil products. We also identify that the electricity production process is inefficient in terms of energy losses, meaning that some imports might end up squandered.

We also discuss the set of alternatives that policymakers in the region could promote to foster energy efficiency outcomes. Moreover, we summarize a set of behavioral interventions that have proven to be effective in reducing energy consumption only by providing timely and accurate information to consumers. More importantly, we found that the typical Caribbean country has not been actively involved in the adoption of energy efficiency policies. On average, they have only considered two out of six possible alternatives to promote energy efficiency.

The lack of primary infrastructure seems not to be the reason behind this result because the Caribbean appears to be in a better relative position than that of Latin America. On the other hand, debt levels are close to international critical thresholds, figures are in worst position than Latin America, and most analyses suggest that debt levels are not sustainable. Therefore a debt overhang situation seems to be the most likely reason to explain the lack of adoption of energy efficiency policies in the region.

International Climate Change Funds could provide a useful alternative for the Caribbean to mobilize resources to finance energy efficiency projects. For example, the Green Climate Fund (GCF) works within the framework of the United Nations Framework Convention on Climate Change (UNFCCC) created as a mechanism to assist developing countries in adaptation and mitigation practices to counter climate change. According to their webpage the GCF "*will aim for a floor of 50 per cent of the adaptation allocation for particularly vulnerable countries, including Least Developed Countries, Small Island Developing States and African States*."[23] In fact, one of the Fund's investment priorities is to enhance resilience in Small Island Development States (SIDS).

According to the fund's investment policies, their objective is to finance projects and programs with the potential to promote a paradigm shift towards low-carbon and climate-resilient sustainable development. Additionally, policies mandate that only revenue-generating activities can qualify for loans by the fund. This condition suggests that it is important for Caribbean countries to accurately measure the potential impact of their proposals (as suggested in Chapter III, A).

The GCF criteria for funding includes the following: (a) impact/result potential (to fund's objective), (b) paradigm shift potential (i.e., projects that can be replicated or scaled have priority), (c) needs of the beneficiary country, (d) country ownership and institutional capacity, (d) economic efficiency of the project (defined as impact per US$ delivered by the fund) and (e) financial viability (for revenue generation).

Finally, it is straightforward to point out that the Caribbean region meets most of these conditions to finance their energy-efficient initiatives. Especially if they adopt international recommendations on energy-efficiency policies that have proven to be effective. It is the time for the region to re-think and plan strategically their energy sector for the future.

[23] Taken from: http://www.greenclimate.fund/ventures/funding#how-it-works on February 25, 2016.

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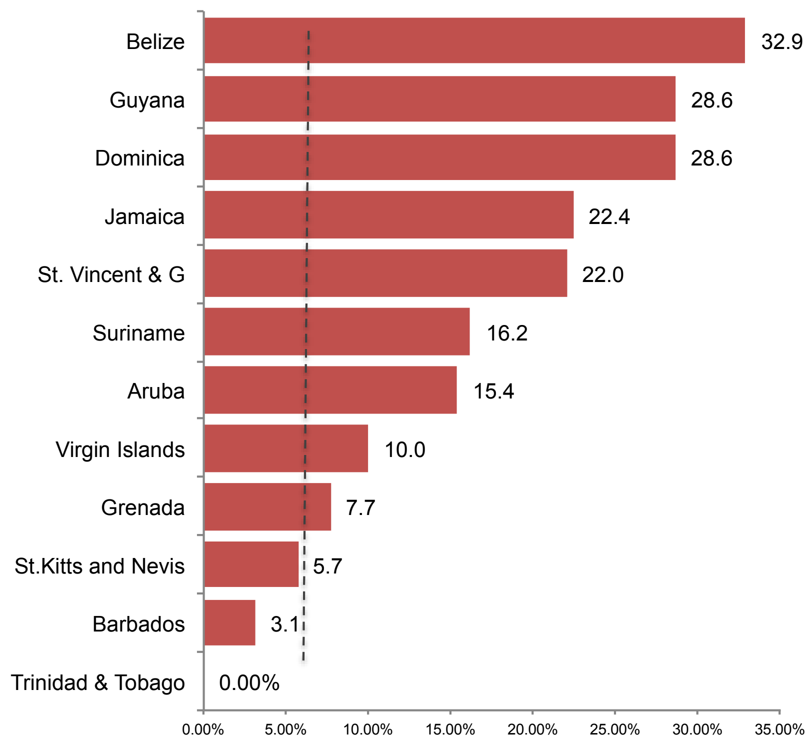
Annexes

Annex 1
Renewable energies in the Caribbean region

Caribbean countries depend on fossil fuels to supply energy. As seen on the energy matrix exploration, this leads to higher energy costs, since these countries are not oil or gas producers. One way to assess the supply of green energy is the index of renewability (IR), which measures the share of renewable energy in relation to the total production. Figure 17 summarizes this ratio for a group of 12 countries. OLADE (2013) suggest that on average,[24] 11 per cent of the energy in the Caribbean comes from renewable sources; this implies that the region is two points (pp.) below the world's average (13 per cent) and 14 points below its Latin American counterparts. However, these figures are likely to be biased by Trinidad and Tobago since their IR index is zero. For the countries in our list, the unweighted average of the IR index was 16 per cent, and excluding Trinidad and Tobago it reached up to 17.5 per cent, i.e., in both cases the unweighted index was above the world's.

Figure A.1
Index of renewable energy (IR) for the Caribbean countries, 2011

The graph shows the share of green energy in relation to the total supply:

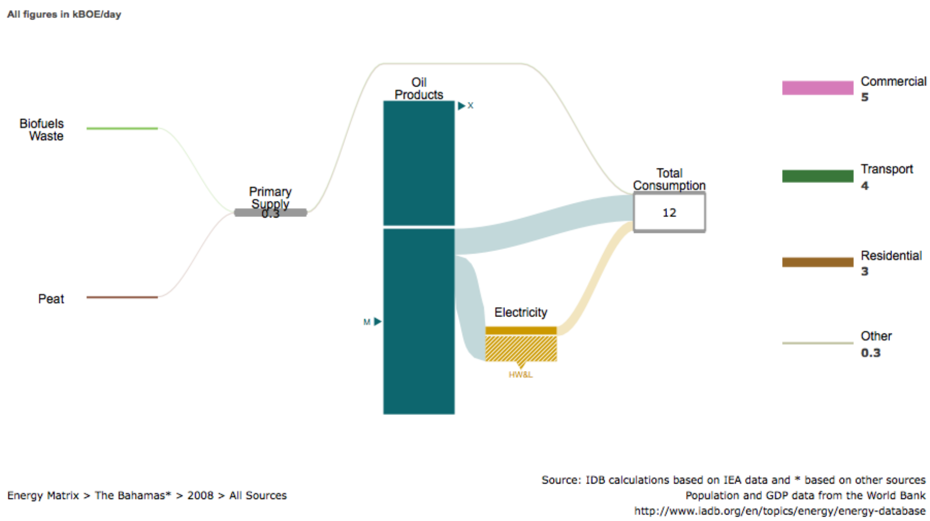


Source: Consultant's elaboration based on OLADE and the NREL.
Notes: Antigua and Barbuda, Bahamas, Saint Lucia, Trinidad and Tobago, and Turks and Caicos Islands are omitted from the graph, due to an IR lower than 1 per cent. There are no data available for the Cayman Islands. The latest data available for the World's Average IR regards the year 2010.

[24] Weighted average.

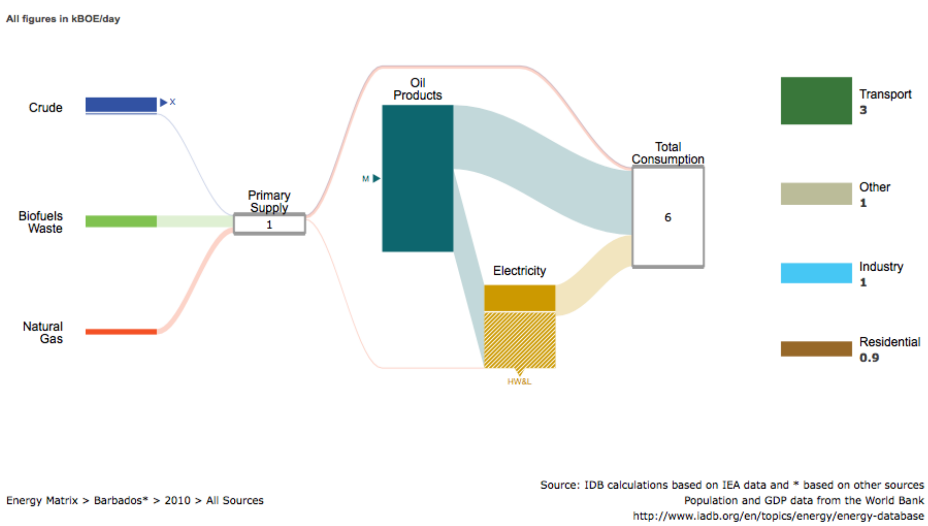
Annex 2
Extensive representation of the energy matrix for some Caribbean countries (based on Espinasa (2015))

Figure A.2
Bahamas energy matrix in 2008



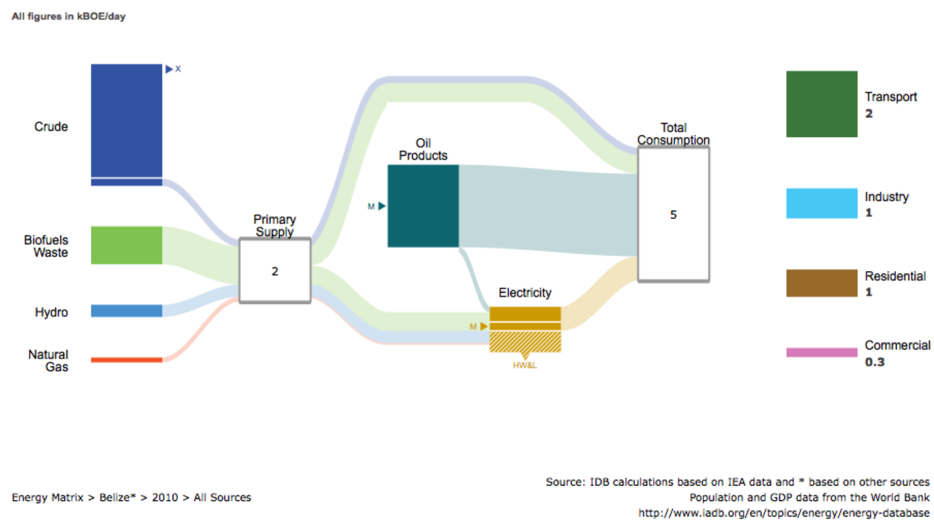
Source: IDB (2015).

Figure A.3
Barbados energy matrix in 2010



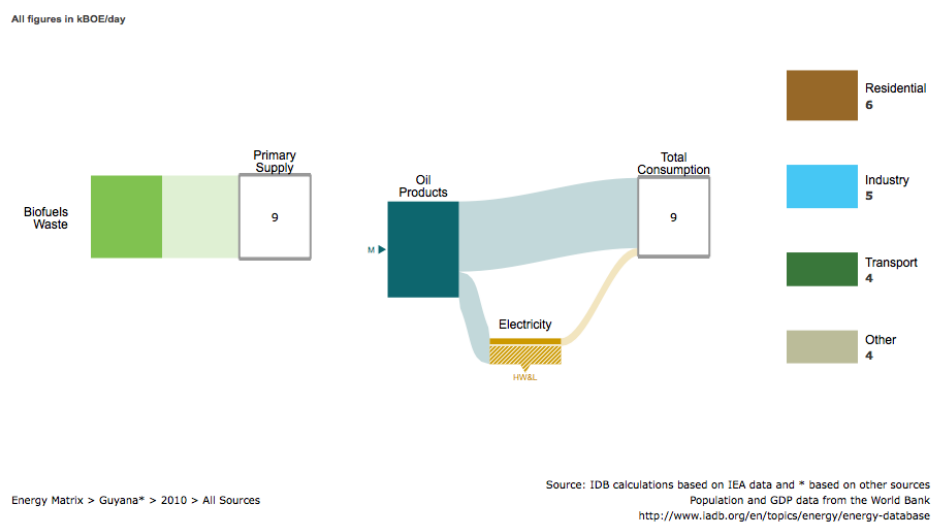
Source: IDB (2015).

Figure A.4
Belize energy matrix in 2010



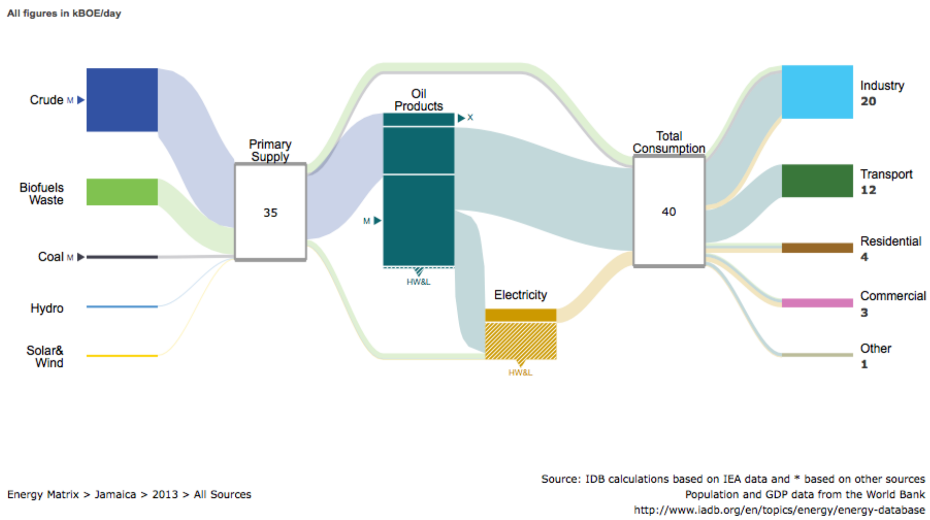
Source: IDB (2015).

Figure A.5
Guyana energy matrix in 2010



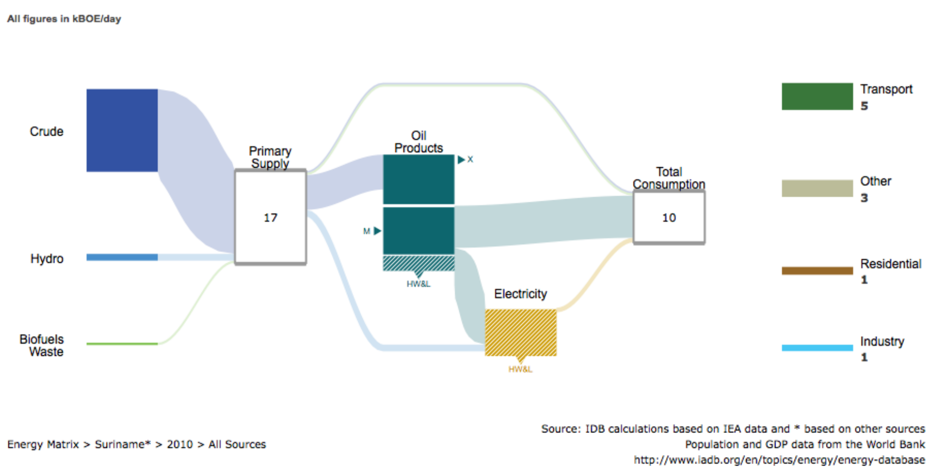
Source: IDB (2015).

Figure A.6
Jamaica energy matrix in 2013



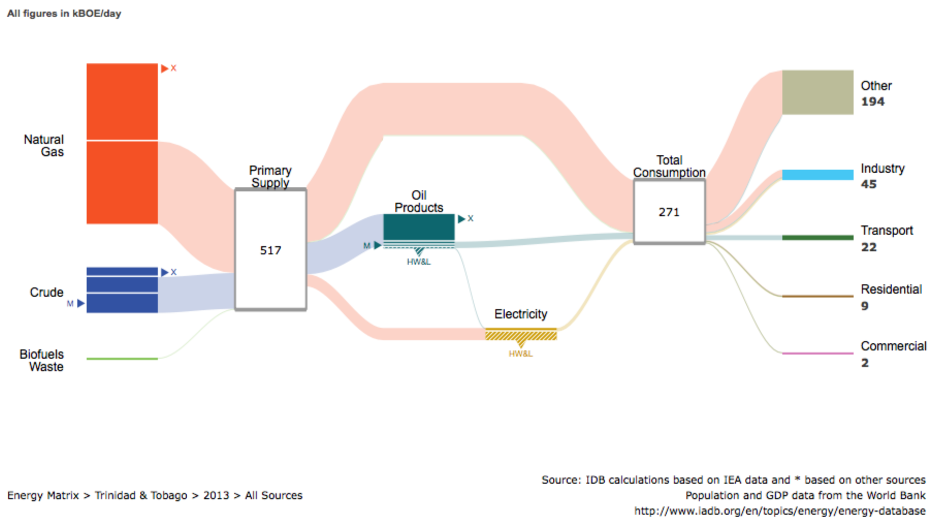
Source: IDB (2015).

Figure A.7
Suriname energy matrix in 2010



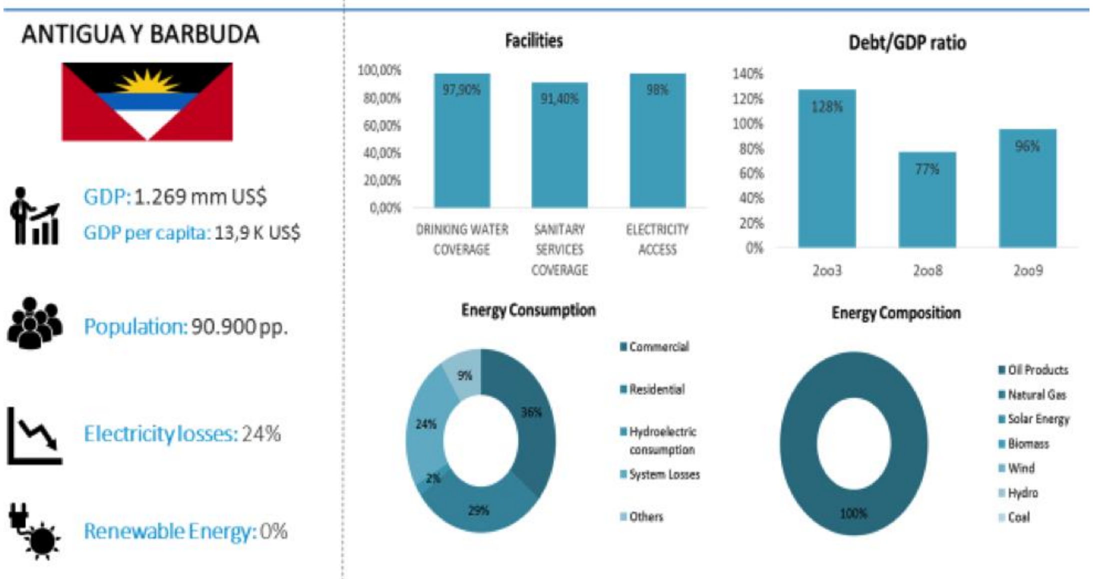
Source: IDB (2015).

Figure A.8
Trinidad and Tobago energy matrix in 2013

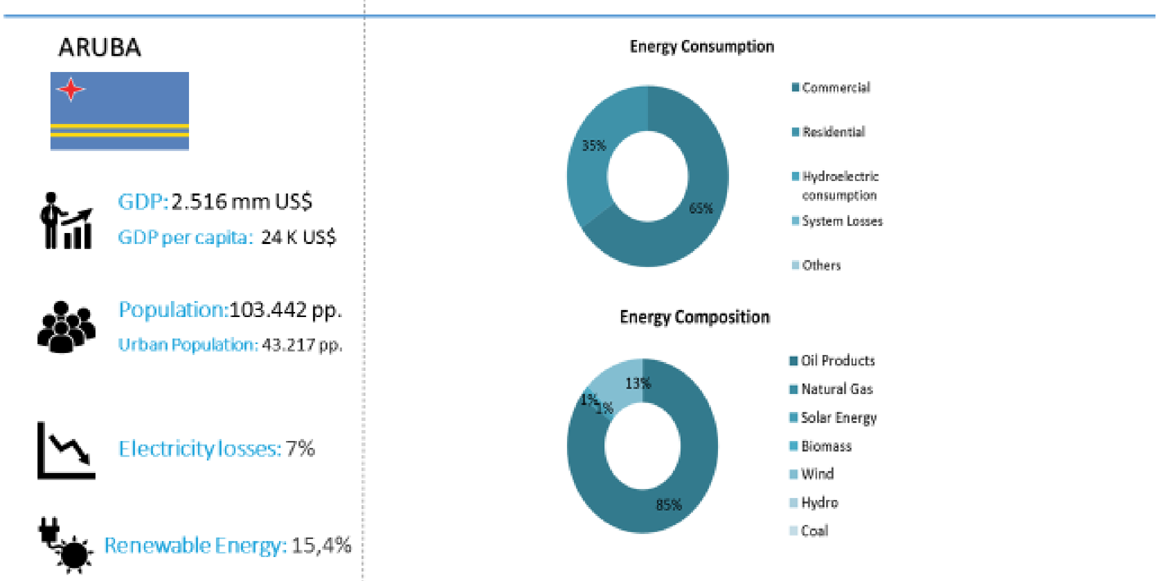


Source: IDB (2015).

Annex 3
Caribbean countries: relevant data



Notes: GDP (2013) is measured in current US$. Population data for 2013. Electricity losses and share of renewable energy for 2011
Sources: Consultant's elaboration based on World Bank and NRE'sL Data. Urban population data not available.



Notes: GDP (2013) is measured in current US$. Population data for 2013. Electricity losses and share of renewable energy for 2011
Sources: Consultant's elaboration based on World Bank and NRE'sL Data. No data available for debt and infraestructure variables.

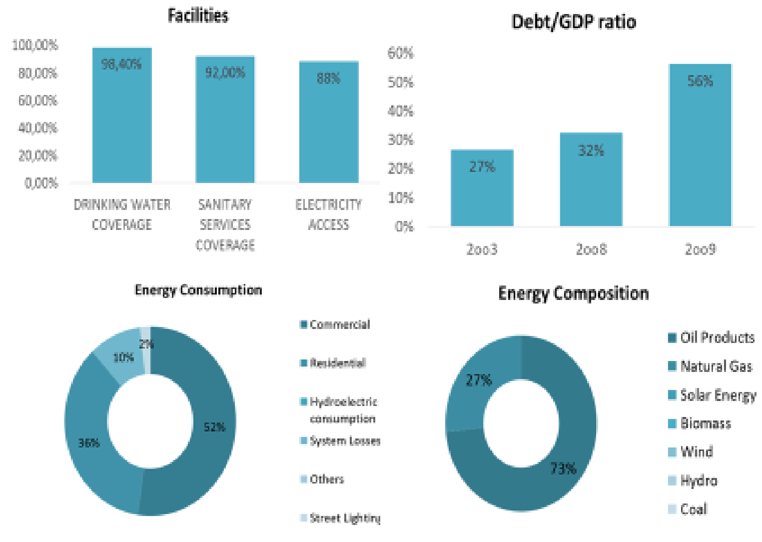
BAHAMAS

GDP: 8.511 mm US$
GDP per capita: 22 K US$

Population: 383.055 pp.
Urban Population: 317.173 pp.

Electricity losses: 12,3%

Renewable Energy: 0%



Notes: GDP (2013) is measured in current US$. Population data for 2013. Electricity losses and share of renewable energy for 2011
Sources: Consultant's elaboration based on World Bank and NRE'sL Data.

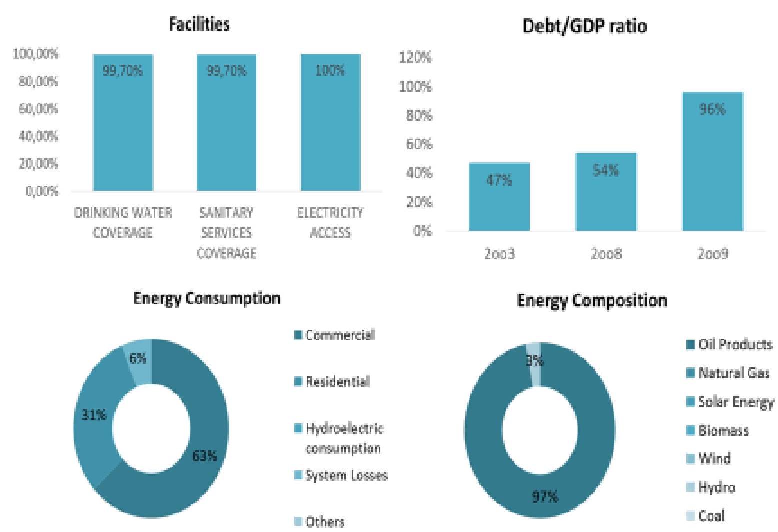
BARBADOS

GDP: 4.348 mm US$
GDP per capita: 15 K US$

Population::283.381 pp.
Urban Population: 89.418 pp.

Electricity losses: 6,2%

Renewable Energy: 3,1%



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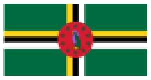
Sources: Consultant's elaboration based on World Bank and NRE'sL Data.

DOMINICA

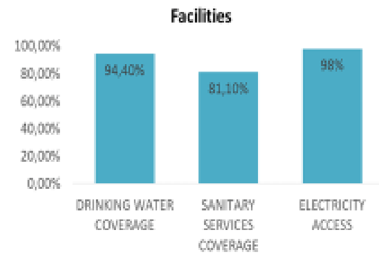


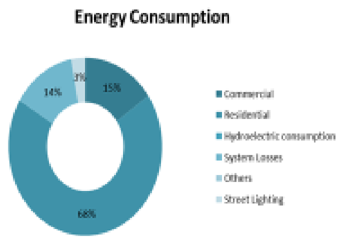
GDP: 538 mm US$
GDP per capita: 7 K US$

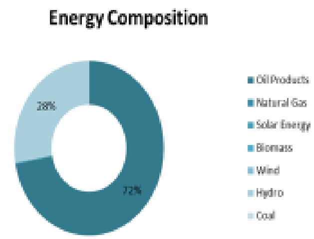
Population: 72.340 pp.
Urban Population: 50.100 pp.

Electricity losses: 8,2%

Renewable Energy: 28,6%







Notes: GDP (2013) is measured in current US$. Population data for 2013. Electricity losses and share of renewable energy for 2011
Sources: Consultant's elaboration based on World Bank and NRE'sL Data. No data available fot debt.

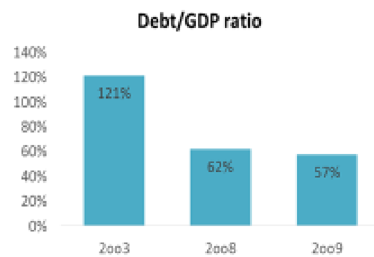
GUYANA

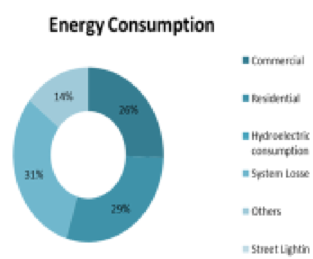
GDP: 3.228 mm US$
GDP per capita: 4,2 K US$

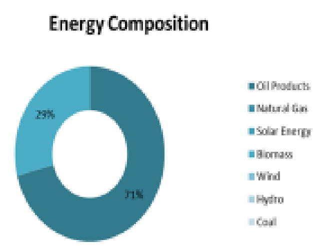
Population: 763.892 pp.
Urban Population: 217.396 pp.

Electricity losses: 31%

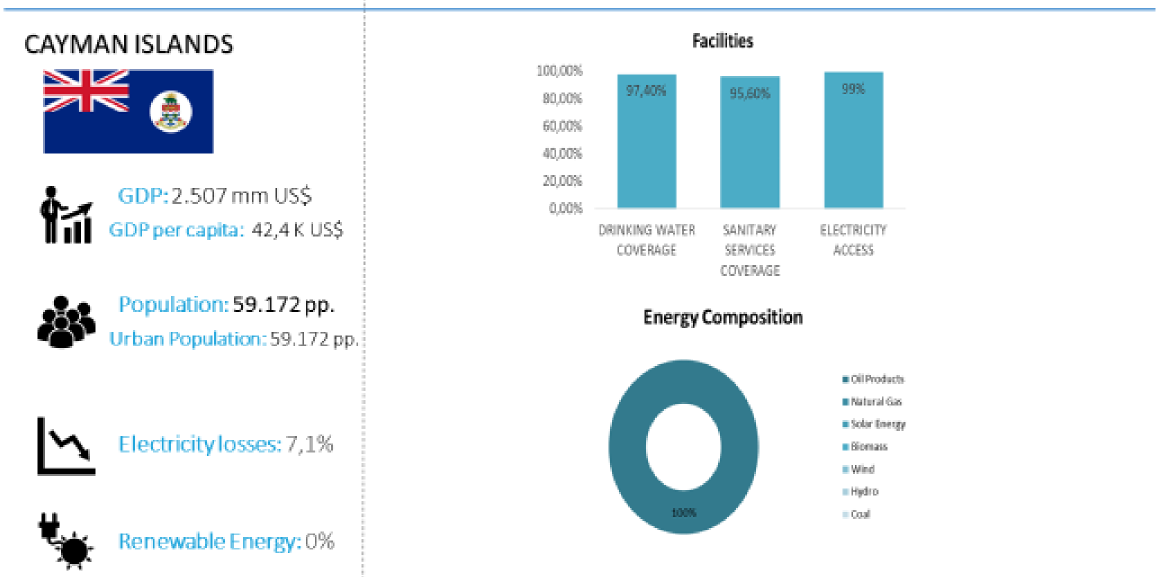
Renewable Energy: 28,6%







Notes: GDP (2013) is measured in current US$. Population data for 2013. Electricity losses and share of renewable energy for 2011
Sources: Consultant's elaboration based on World Bank and NRE'sL Data.No data available fot infraestructure variables.



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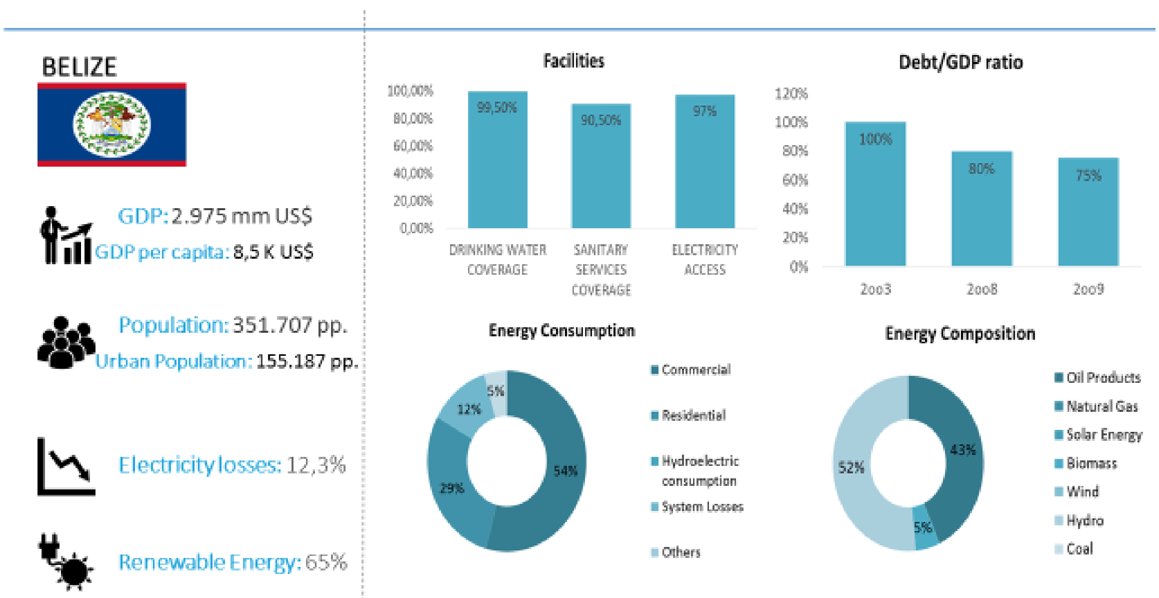
Sources: Consultant's elaboration based on World Bank and NRE'sL Data. No data available for debt and energy consumption.



Notes: GDP (2013) is measured in current US$. Population data for 2013. Electricity losses and share of renewable energy for 2011
Sources: Consultant's elaboration based on World Bank and NRE'sL Data.

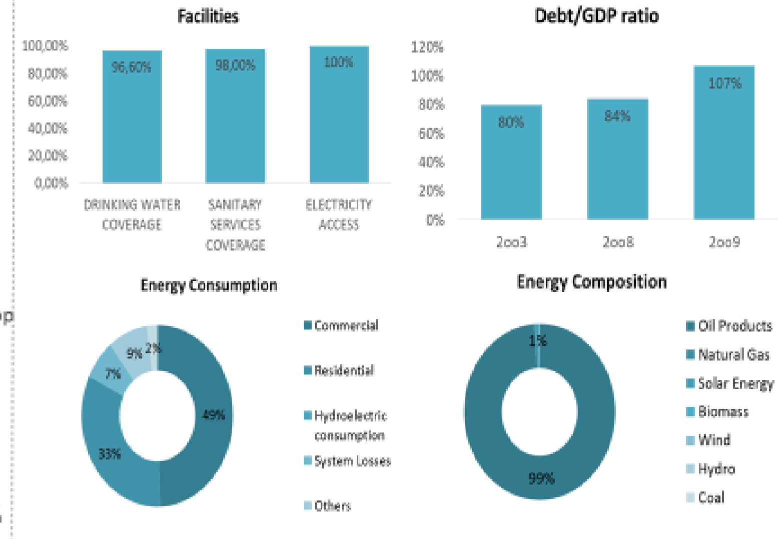
GRENADA

GDP: 882 mm US$
GDP per capita: 8,3 K US$

Population: 106.349 pp.
Urban Population: 37.839 pp

Electricity losses: 7,7%

Renewable Energy: 1,4%



Notes: GDP (2013) is measured in current US$. Population data for 2013. Electricity losses and share of renewable energy for 2011
Sources: Consultant's elaboration based on World Bank and NRE'sL Data.

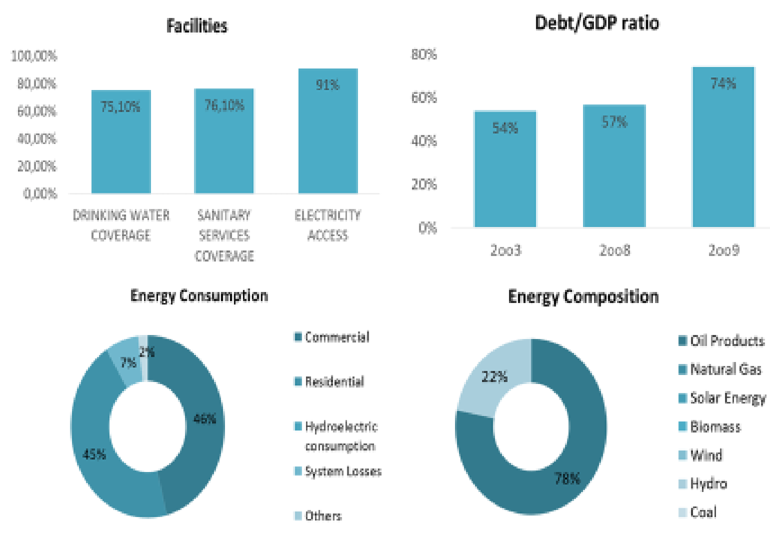
ST VINCENT

GDP: 729 mm US$
GDP per capita: 6,6 K US$

Population: 109.361 pp.
Urban Population: 54.899 pp.

Electricity losses: 7,4%

Renewable Energy: 22%



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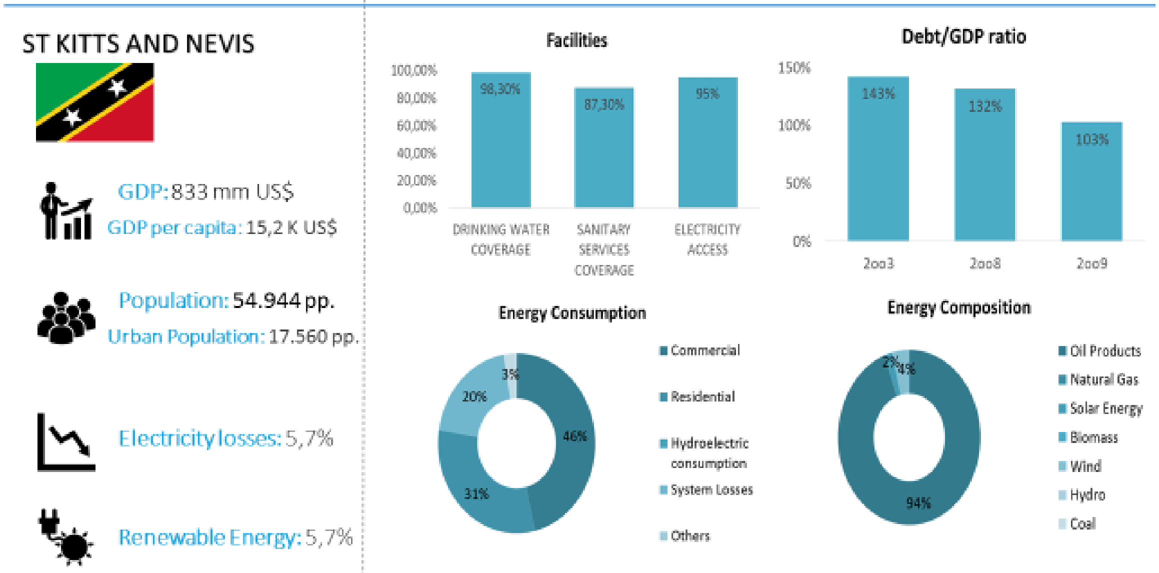

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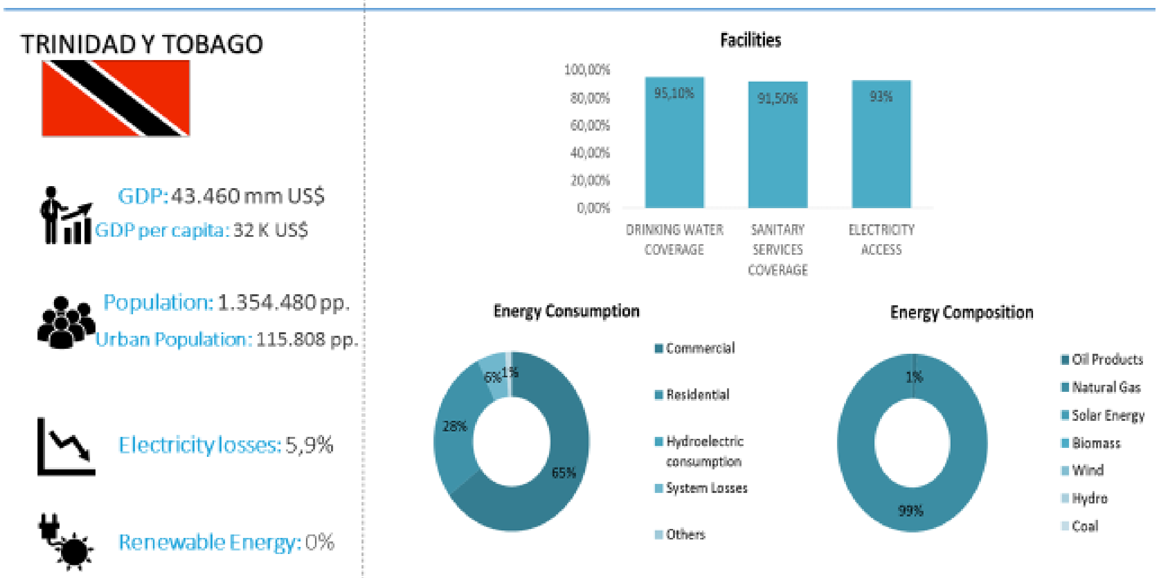
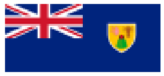
Sources: Consultant's elaboration based on World Bank and NRE'sL Data.



Notes: GDP (2013) is measured in current US$. Population data for 2013. Electricity losses and share of renewable energy for 2011
Sources: Consultant's elaboration based on World Bank and NRE'sL Data.No data available for debt.

TURKS AND CAICOS

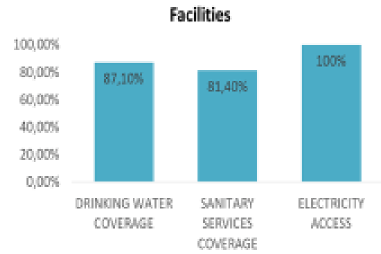


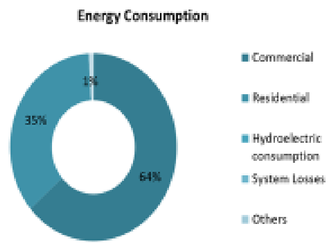
GDP: 632 mm US$
GDP per capita: 18,8 K US$

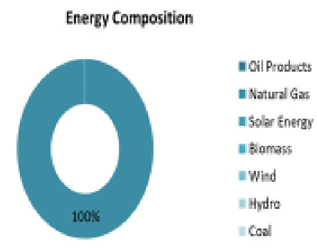
Population: 33.740 pp.
Urban Population: 30.989 pp.

Electricity losses: 10,3%

Renewable Energy: 0%







Notes: GDP (2013) is measured in current US$. Population data for 2013. Electricity losses and share of renewable energy for 2011
Sources: Consultant's elaboration based on World Bank and NRE'sL Data. No data available for debt.

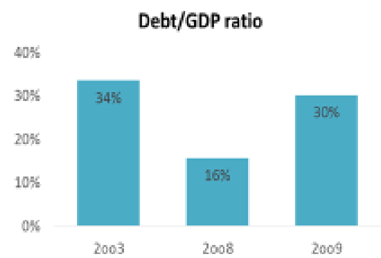
SURINAME

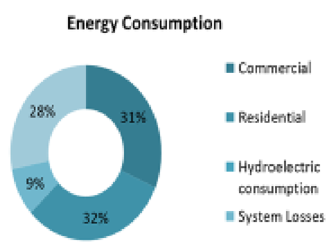
GDP: 8.987 mm US$
GDP per capita: 16,7 K US$

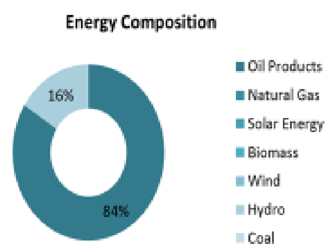
Population: 538.248 pp.
Urban Population: 355.701 pp.

Electricity losses: 9%

Renewable Energy: 16,2%







Notes: GDP (2013) is measured in current US$. Population data for 2013. Electricity losses and share of renewable energy for 2011
Sources: Consultant's elaboration based on World Bank and NRE'sL Data. No data available for infraestructura variables.

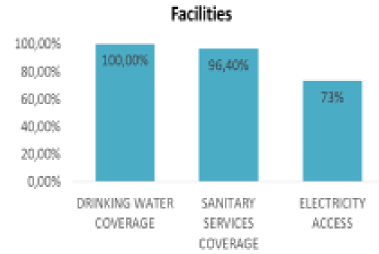
VIRGIN ISLANDS

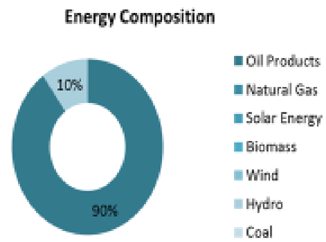
GDP: 3.792 mm US$
GDP per capita: 36,4 K US$

Population: 104.170 pp.
Urban Population: 99.173 pp.

Electricity losses: 13%

Renewable Energy: 10%





Notes: GDP (2013) is measured in current US$. Population data for 2013. Electricity losses and share of renewable energy for 2011
Sources: Consultant's elaboration based on World Bank and NRE'sL Data. No data available for debt and energy consumption.

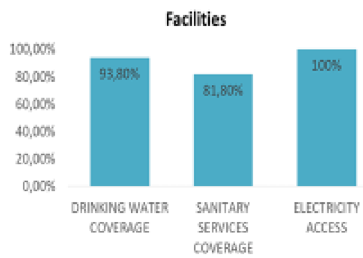
JAMAICA

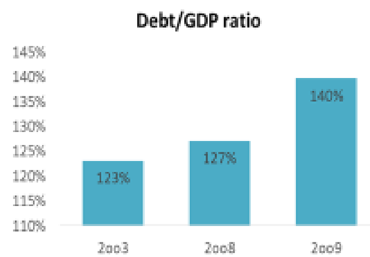
GDP: 24100 mm US$
GDP per capita: 8,9 K US$

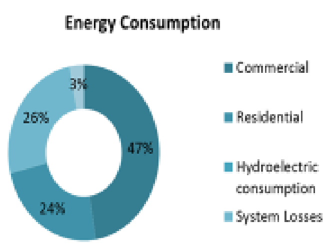
Population: 2.721.252 pp.
Urban Population: 1.484.606 pp.

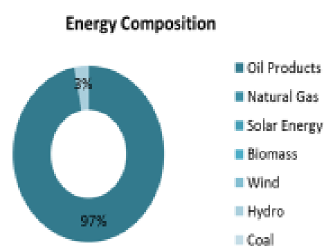
Electricity losses: 26%

Renewable Energy: 6%

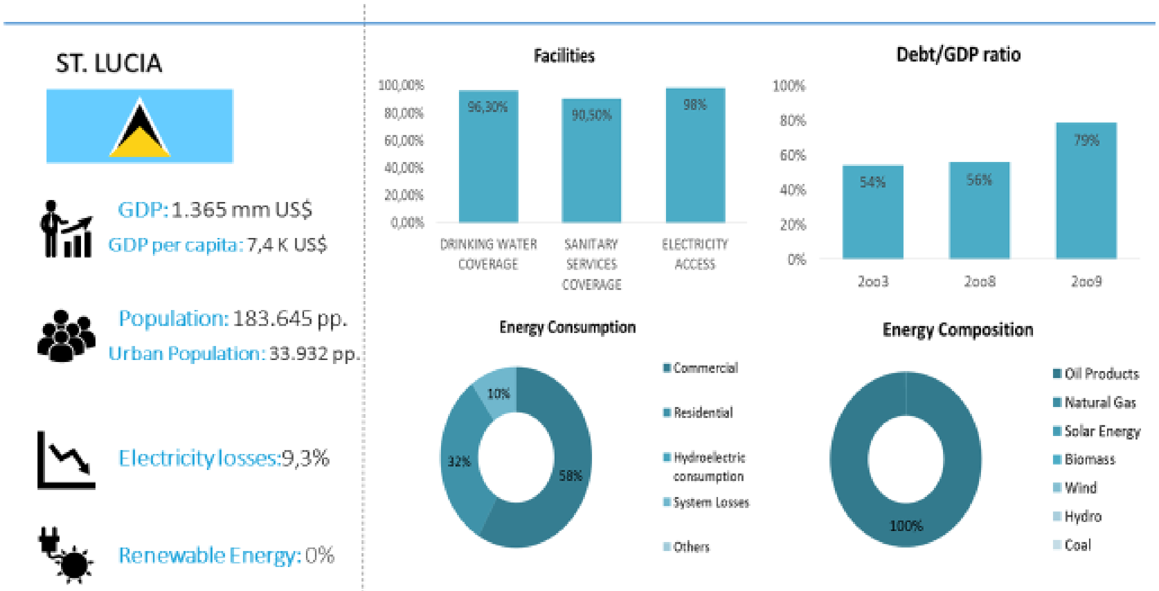








Notes: GDP (2013) is measured in current US$. Population data for 2013. Electricity losses and share of renewable energy for 2011
Sources: Consultant's elaboration based on World Bank and NRE'sL Data.



Notes: GDP (2013) is measured in current US$. Population data for 2013. Electricity losses and share of renewable energy for 2011
Sources: Consultant's elaboration based on World Bank and NRE'sL Data.

Annex 4
Energy insights for Caribbean countries

On the basis of NREL datasets and reports, we summarized their most important conclusions at the country level and present them below.

Despite having good geographic conditions for generation from renewable energies, **Antigua and Barbuda** generates its energy exclusively from oil products. According to NREL, the energy supply in this country is mostly demanded by the commercial sector. Despite the need of changing the energy matrix, further investment in the system (e.g. efficiency improvements) might be needed.

Aruba's energy supply depends mainly on oil products. However, 13 per cent of its energy is produced by wind turbines. This leads Aruba to be the biggest wind energy producer in the Caribbean region. The country produces also wind and biomass energy in a smaller scale (less than 3 per cent of its total production). Almost 70 per cent of the energy in Aruba is consumed by the commercial sector. This particularly high share is explained by the developed touristic sector of the island.

The Bahamas produces its energy mainly from fossil fuels. A quarter of its supply comes from natural gas, while the rest is produced from imported oil products. Eleven per cent of the island GDP is spent on energy imports. Around half of the energy production is consumed by the commercial sector, followed by the residential consumption with a share of 35 per cent.

Barbados energy supply derives almost exclusively from oil products. However, Barbados is one of the countries with most ambitious goals regarding the implementation of green energies. This process might be enhanced with the high electricity access of the country, and its efficient transmission system. Sixty per cent of the energy supply is consumed by the commercial sector, which is a relatively high share for the region.

Nowadays, **Belize** shows the best practices in the region, concerning the generation of green energy. Only 43 per cent of its generated energy comes from oil products, while almost all the rest is produced by hydro and biomass sources. More than 80 per cent of the energy supply is consumed by the residential and the commercial sector. Despite the good results in producing green energy, Belize has some weaknesses in its system; 12 per cent of its population still has no electricity access.

Cayman Islands have one of the best living standards of the Caribbean. According to the CIA World Factbook,[25] the Cayman Islands have the 33rd best living standard of the world. However, its energy supply still depends mainly from oil products, which has a negative impact on its environment.

Dominica has the third greenest energy matrix in the Caribbean region. This is possible due to its large hydroelectric generation system. The remainder of its energy supply comes from diesel. Energy in Dominica is consumed mostly by the residential sector.

Almost all the energy in **Grenada** comes from oil products. However, a change in the energy matrix in this country might be plausible, since the whole population has access to electricity and the transmission losses are relatively small. Half of its energy supply is consumed by the commercial sector, while households consume around one third of the total share.

[25] https://www.cia.gov/library/publications/the-world-factbook/rankorder/2004rank.html

Guyana main energy source are oil products. However, it produces energy from biomass and has a considerable potential for hydroelectric power generation. According to its government, there are 67 potential spots for this purpose.[26]

Ninety-four per cent of the energy in **Jamaica** is produced from oil products. However, Jamaica has other major problems in its energy sector. Almost one out of ten citizens has no access to electricity, and one quarter of the energy is lost in the transmission process.

Saint Lucia has potential for generating solar, wind and geothermal energy. However, these sources have not been exploited yet. Saint Lucia's energy production is generated almost exclusively by oil products. This country is not an oil producer, and this leads to higher energy prices. According to the National Renewable Energy Laboratory, the electricity rates in Saint Lucia are three times higher than the United States average.

After Dominica, **Saint Vincent and the Grenadines** is the second biggest hydroelectric energy producer in the region (22 per cent). However, the majority of its supply still comes from fossil fuels. According to the NREL[27] wind and solar potential are estimated to be high. However, the country still does not produce energy from those sources.

Saint Kitts and Nevis is one of the five countries in the Caribbean that produce wind energy. However, the great majority of its energy supply comes from fossil fuels. Around of one fifth of the generated energy is lost in the transmission process.

Suriname's energy supply depends mostly from oil products. However, there is a small amount of hydroelectric energy being generated. Energy losses are around 10 per cent while the commercial and the residential sector consume 35 per cent of the supply.

The energy in **Trinidad and Tobago** depends mainly from natural gas (99 per cent); the remaining supply comes from oil products. This is one of the five countries in the region with no share of renewable energies. Mostly of the generated energy is consumed by the commercial sector (65 per cent).

Like Trinidad and Tobago, **Turks and Caicos Islands** use natural gas as its main energy source. However, it has a little share of solar energy (0.4 per cent). Despite the need for producing green energy, this country has practically no programs or policies about it.[28] The industrial sector consumes almost a third of the energy supply, reaching a similar consumption level as the households.

The **Virgin Islands** energy matrix is really similar to Suriname's. However, the country is fostering policies to increase the renewable energy generation (e.g. feed-in tariffs, net metering, renewables quota and interconnection standards).

[26] http://gea.gov.gy/energy-development/hydropower
[27] www.nrel.gov/docs/fy15osti/64127.pdf
[28] www.nrel.gov/docs/fy15osti/62698.pdf

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