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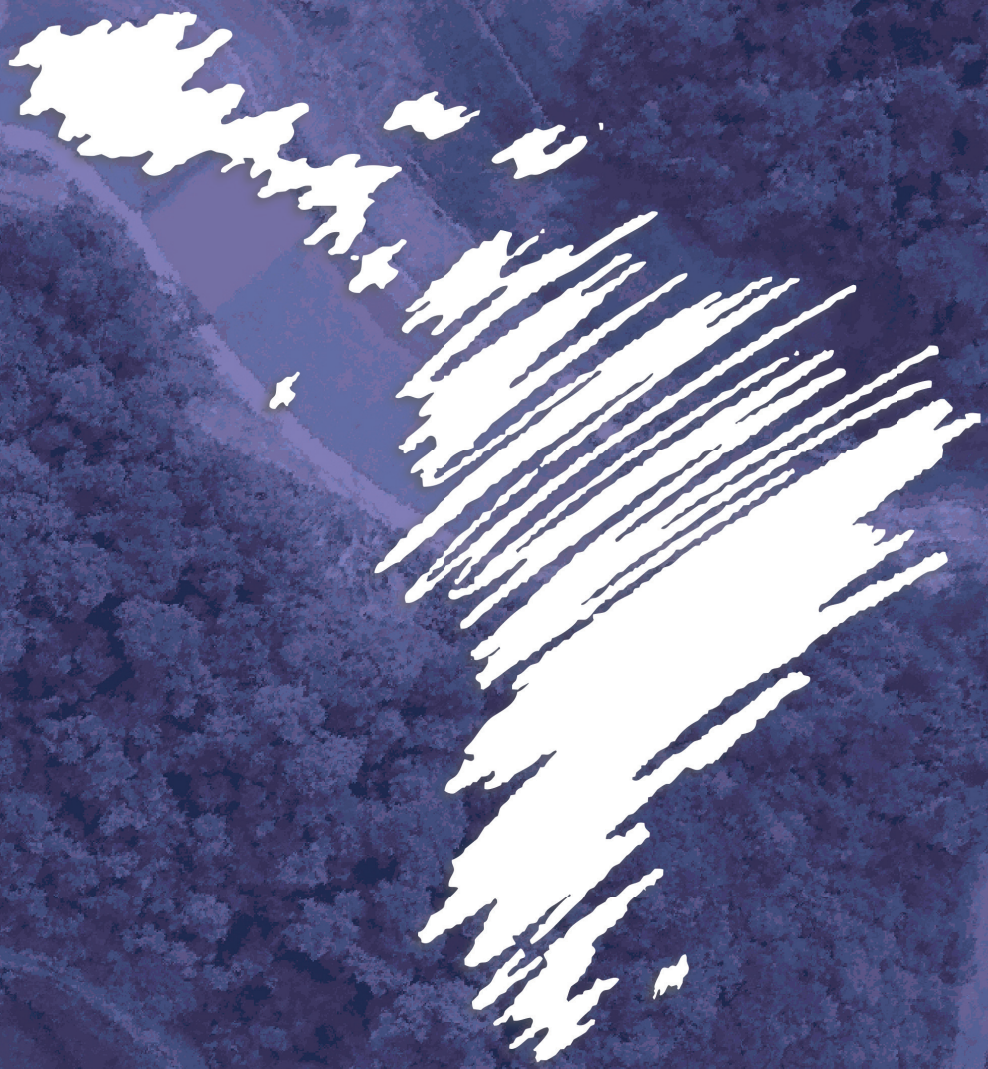

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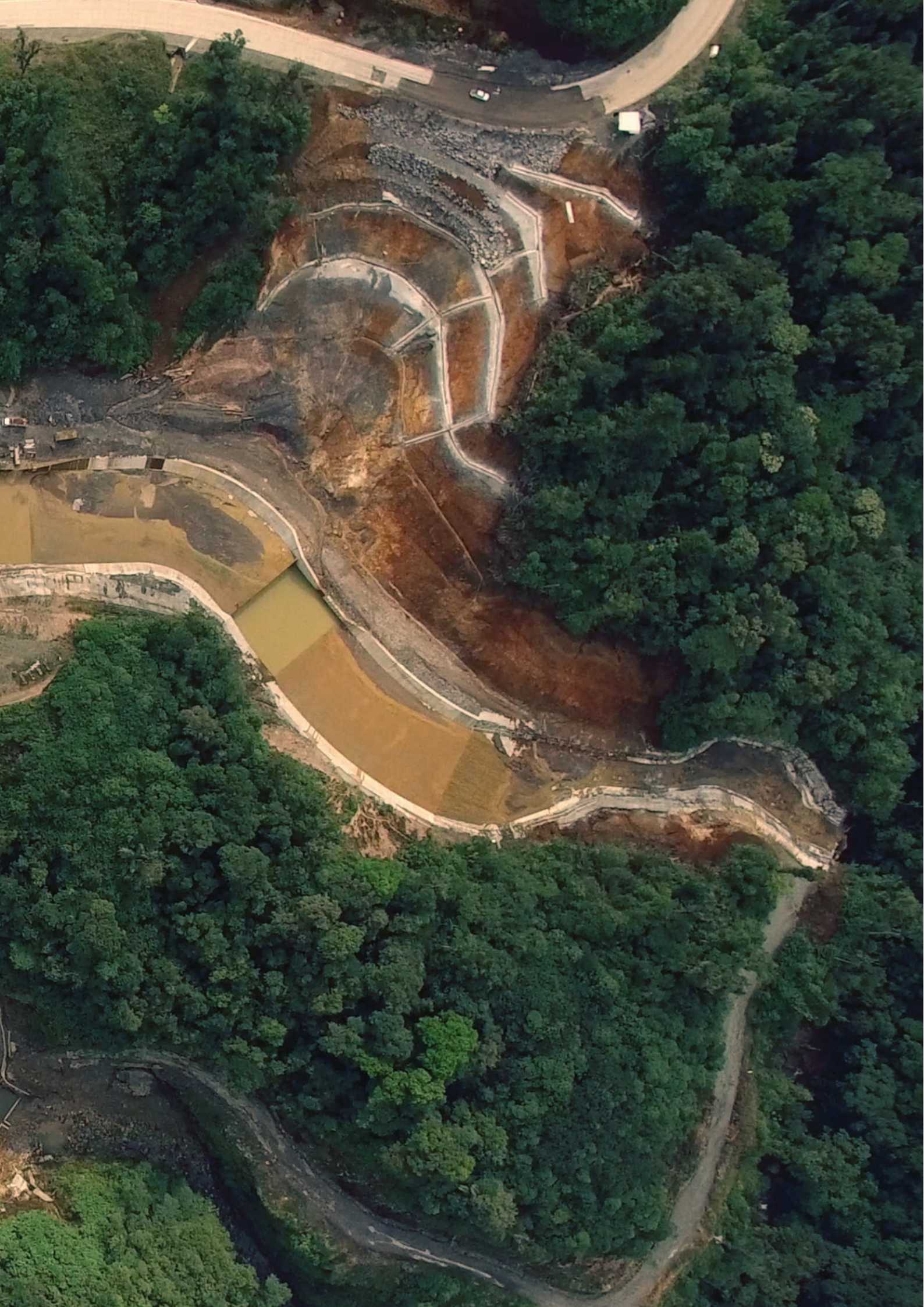

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NATIONALLY APPROPRIATE MITIGATION ACTION (NAMA) CONCEPT IN RESIDENTIAL ENERGY EFFICIENT LIGHTING IN GRENADA

Executive summary made by OLADE of the consulting work carried out by
Per Wretlind and Federico Canu of UNEP DTU Partnership

Luis Guerra

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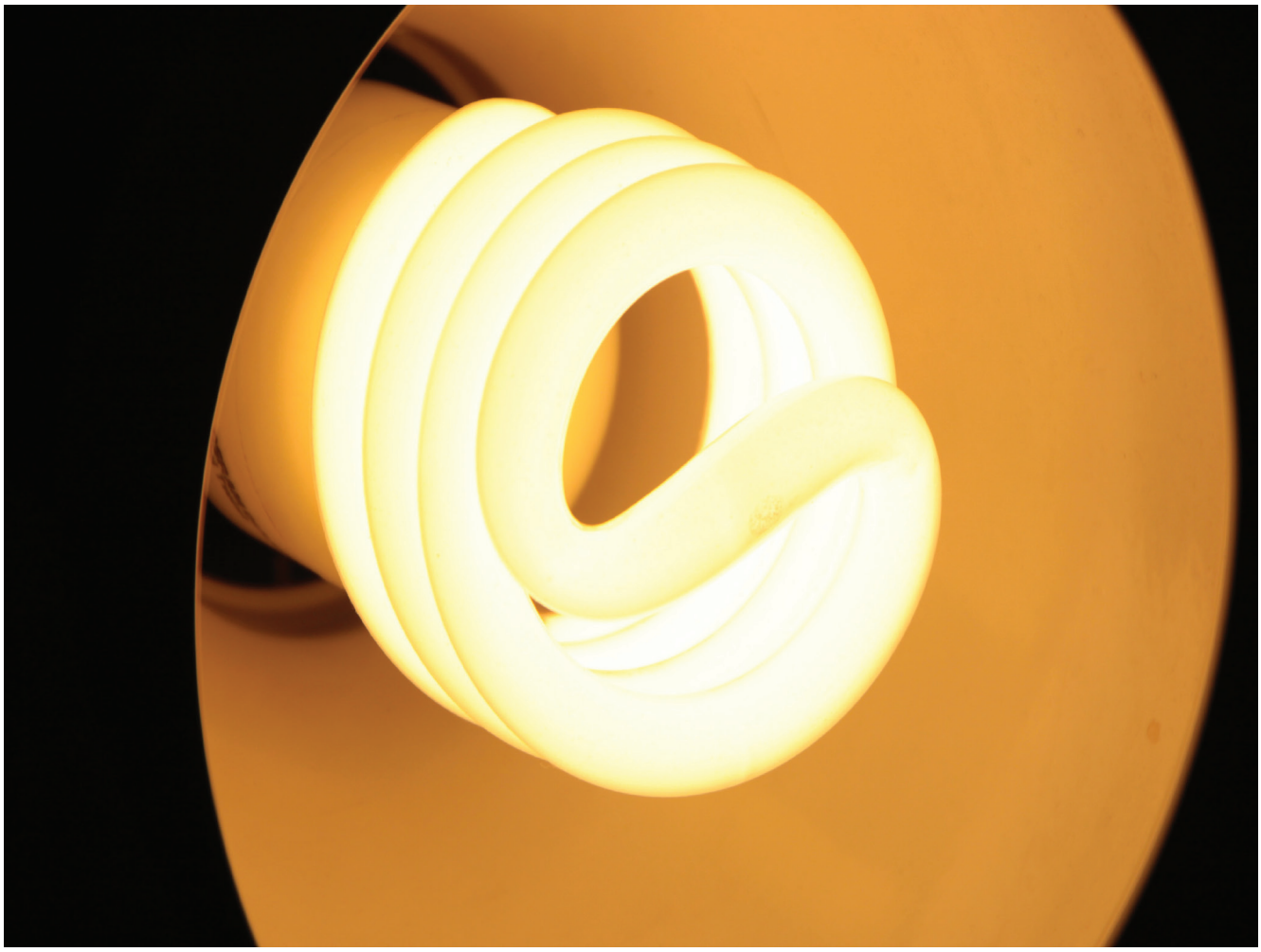


Luis Guerra is an Environmental Engineer with a M. Sc. in Renewable Energy Management. He is currently working as a consultant for the Latin American Energy Organization (OLADE) on projects related to mitigation and adaptation to climate change. luis.guerra@olade.org

ABSTRACT

Grenada joined ranks with the world's nations and signed the Paris Agreement in New York in April 2016. The NDC includes energy efficiency as this has large potential development and mitigation benefits. For this a NAMA Concept is proposed with the objective of achieving energy savings and GHG emission reductions through increased accessibility to energy efficient lighting technologies in the residential sector. Two different scenarios were forecasted for this NAMA, where both scenarios result in decreases in electricity use and GHG emissions, but of varying degree. Scenario 1 results in a GHG reduction of 16,883 tCO_2 emissions, while Scenario 2 reaches a reduction of 29,976 tCO_2 emissions. Furthermore, an identification of barriers was followed by the proposal of a NAMA action plan, for which the total estimated cost is 120,000 USD, that would serve to overcome the identified barriers, including the economic and financial.

Keywords: Climate Change, Efficient Lighting, Nationally Determined Contributions, National Appropriate Mitigation Action, Grenada.

RESUMEN

Granada se unió a la iniciativa que ya fue apoyada por de las naciones del mundo y firmó el Acuerdo de París en Nueva York en abril de 2016. El NDC incluye la eficiencia energética, ya que tiene un gran potencial de desarrollo y beneficios de mitigación. Para ello se propone un concepto de NAMA con el objetivo de lograr el ahorro de energía y la reducción de las emisiones de GEI a través de una mayor accesibilidad a las tecnologías de iluminación energéticamente eficiente en el sector residencial. Se pronosticaron dos escenarios diferentes para este NAMA, donde ambos escenarios resultan en disminuciones en el uso de electricidad y emisiones de GEI, pero en diferentes grados. El Escenario 1 da como resultado una reducción de GEI de 16.883 tCO_2, mientras que el Escenario 2 alcanza una reducción de 29.976 tCO_2. Además, a la identificación de los obstáculos siguió la propuesta de un plan de acción sobre el acceso a los mercados para los productos no agrícolas, cuyo costo total se estima en 120.000 dólares de los EE.UU., que serviría para superar los obstáculos identificados, incluidos los económicos y financieros.

Palabras Clave: *Cambio Climático, Iluminación Eficiente, Contribuciones Determinadas a Nivel Nacional, Acciones Nacionales de Mitigación Apropiadas, Granada.*

INTRODUCTION

Grenada joined ranks with the world's nations and signed the Paris Agreement in New York in April 2016. The action of signing the agreement signified that Grenada had ratified it, and the Intended National Determined Contribution (INDC) of Grenada thus became the National Determined Contribution (NDC). The focus is thus on implementation.

The NDC includes energy efficiency as this has large potential development and mitigation benefits. One study made by United for Efficiency (U4E), a UN Environment initiative, states that if policies are implemented to promote energy efficiency broadly in Grenada, the construction of 20 MW generation capacities can be avoided until 2030. Electricity consumption would be reduced by 14.2 GWh by 2030, whereof a considerable part would be due to efficiency gains in lighting (En.lighten & U4E, 2015).

The development of this proposal for a National Appropriate Mitigation Actions (NAMAs) should be seen in the light of the implementation of Grenada's NDC. The focus on energy efficiency

lighting within the residential sector will not be sufficient for Grenada to meet its commitments, but it is a good start. Furthermore, the experience gained of formulating and discussing a NAMA builds the capacity of Grenada, enabling further mitigation actions.

This document presents the NAMA proposal in the following way. First, the focus area of energy efficient lighting in the residential sector alignment with Grenada's development and climate change plans is presented. This is followed by a brief run-through of the existing and previous projects in Grenada, to ensure that this builds on what they have uncovered. A technological analysis follows, determining which technological options Grenada has to choose from. This is followed by the start of the development of the NAMA, introducing an institutional structure, the objectives and targets, and the baseline and NAMA scenarios. Upon this, the barrier analysis and the proposed NAMA Action Plan is presented.

ALIGNMENT WITH GRENADA'S DEVELOPMENT, SECTORAL AND CLIMATE CHANGE POLICY AND REGULATIONS

A NAMA is an action that brings both sustainable development and mitigates GHG emissions. In advancing sustainable development, the direction of this is decided by the country's government. As these priorities are already existent, the NAMA needs to align with the plans and regulations concerning climate change, relevant sectors and development in general. This section aligns the NAMA with the existing plans and regulations concerning climate change, relevant sectors, and development.

Climate Change Regulation

The climate change regulation of Grenada consists of a number of policies and action plans. The main focus is on adaptation measures, since Grenada is one of the countries in the world most vulnerable to climate change (see e.g. Kreft, Eckstein, & Melchior, 2017). Grenada has submitted a National Determined Contribution (NDC), as well as developed a 'National Climate Change Policy and Action Plan' which provides a roadmap for various mitigation actions.

National Communications and Biennial Update Report

In 2000, Grenada submitted its First National Communication to the UNFCCC[1]. The document describes the framework for environmental management as fragmented, and proposes a more systematic approach towards mitigation policies, therein measures to promote energy efficiency. The First National Communication calls for the introduction of Compact Fluorescent Bulbs (CFLs), the adoption of standards for certification of electrical appliances, as well as public awareness campaigns for energy efficient equipment. One of the measures to increase energy efficiency within the public sector is to retrofit buildings, as well as the procurement of energy efficient lamps for public offices.

The development of this proposal for a National Appropriate Mitigation Actions (NAMAs) should be seen in the light of the implementation of Grenada's NDC. The focus on energy efficiency lighting within the residential sector will not be sufficient for Grenada to meet its commitments, but it is a good start.

1 Grenada is currently working on its Second National Communication. As a small island developing state, Grenada can submit a biennial update report (BUR) at its own discretion. Up to this point, Grenada has not submitted a BUR.

National Climate Change Policy and Action Plan (2007-2011)

In 2007, the GoG launched the National Climate Change Policy and Action Plan (2007-2011). The plan introduces eight strategies to address climate change, with a focus on adaptation measures. In relation to improving energy efficiency, the plan does not focus on energy efficient lighting specifically but rather on comprehensive incentive packages to promote energy efficiency. This plan suggests using benchmarks for electricity generation equipment, reducing import duties and taxes on energy efficient appliances, and stipulating higher standards for the imported goods. This is to be coupled with, inter alia, public education on reducing energy consumption. In addition, the plan emphasises the importance of regional coordination within the Organisation of Eastern Caribbean States (OECS) and the Caribbean Community (CARICOM) in implementing energy efficiency measures (GoG, 2007).

There has been a reduction of import duties and the value added tax (VAT) on energy efficient light bulbs. Currently, the general VAT stands at 15%. In 2010, 'energy saving bulbs' was added to a list of products exempted from VAT. The list does not define criteria for when a bulb saves energy, making it difficult to apply in practices. Moreover, light bulbs often arrive in fixtures rather than individually, resulting in that this exemption does not apply to many products.

In regards to customs, the coordination work to introduce reduction of the customs service charge has yet to start. As the CARICOM region imposes a common external customs charge, a coordinated approach among the member countries is necessary.

Nationally Determined Contribution

Grenada's INDC was submitted to the UNFCCC in September 2015, and now that the country has ratified the Paris Agreement, which entered into force in November 2016, its objectives have become the official NDC of Grenada. It focuses mainly on adaptation, but also includes mitigation measures. The NDC sets an unconditional target of reducing GHG emissions by 30% compared to 2010, and a conditional target of 40% by 2025. A varied set of policy instruments are proposed to reach the targets, including informative (public awareness campaigns), economic (fiscal incentives) and regulatory (minimum energy performance standards and building codes) measures. For example, within the electricity sector, Grenada envisions two-thirds of emission reductions to stem from improvements in energy efficiency, while the remaining third is to be provided through increased renewable energy generation. The NDC proposes to retrofit all buildings to improve their energy efficiency, establish energy efficient building codes, and support the implementation of energy efficiency pilot projects in hotels.

Sectoral Regulation

The sectoral regulation relevant for this NAMA is primarily regulations for the energy sector, including energy efficiency regulation, as well as the building sector.

National Energy Policy

The National Energy Policy from 2011 has as an overarching goal of decoupling economic growth and energy use. To achieve this, the policy suggests specific measures as well as the institutional set-up of the energy related questions. It also calls for the adoption of energy efficient building codes which should be mandatory for all public sector construction. It suggests providing incentives to financial institutions for them to offer their clients preferential rates for new and retrofitted energy efficient homes. Public information campaigns and education is also echoed as instrumental. All of these measures are suggested to be incorporated into an Energy Efficiency Act (GoG, 2011). The Energy Efficiency Act is currently in the making, and the first draft is to be expected during the spring of 2017.

Targets for renewable energy are not set in the NDC, but in other documents. The National Energy Policy specifies that by 2020, 20% of total electricity and transportation energy should be generated from renewable sources (GoG, 2011). The Grenada Vision 2030 sets a goal that by 2030, 100% of all energy should be renewable (IRENA, 2012).

There are no nationwide energy efficiency targets expressed (Ochs, Konold, Auth, Musolino, & Killeen, 2015). There are a few policies in place to favour energy efficient appliances, including lighting. The government provides an exemption of the 15% Value Added Tax (VAT) for investments in energy efficient technology.

National Building Code

Grenada's building code, which was updated in June 2015, stems from the Organization of Eastern Caribbean States' (OECS) Code from 1992. It is a common code for Grenada, St Vincent & the Grenadines, St Lucia, and Montserrat (OECS, 2015). The main priority is to build structures able to withstand natural disasters such as earthquakes and hurricanes, as with a changing climate, Grenada has become more exposed to especially hurricanes (GoG, 2007). The building code emphasizes natural lighting in the first place to avoid unnecessary energy consumption - all rooms need to have windows and/or skylights. The section regulating artificial lighting, 1105a) requires lighting to be "in accordance with the requirements of the electricity regulation in force" (OECS, 2015, p. 161). It is thus the electricity regulation that takes priority in relation to the scope of this NAMA targeting EE improvements in residential lighting. The current electricity regulation in Grenada does not address energy efficiency, but is to come with the Energy Efficiency Act.

TECHNOLOGY ANALYSIS

This section introduces the technological options that exist for lighting in Grenada as well as a cost-benefit analysis of the different technologies.

Introduction of Technology Options

Within residential lighting, there are three relevant technological options to be considered in the analysis in the Grenadian context. These are incandescent lightbulbs (ICLs), compact fluorescent lightbulbs (CFLs) and light emitting diodes (LEDs). The three chosen technologies emit approximately the same number of lumens. The three chosen products are also among the most commonly sold within the respective technologies. The technological specifications are shown in the table below.

Table 1. Technological specifications of the three types of technologies for residential lighting

Technical assumptions per lamp type	ICL	CFL	LED
Watts	60	18	6
Lifetime (hours)	1500	8000	40000
Use per day (hours)	3.5	3.5	3.5
Purchasing price per lamp (XCD)	0.8	4.3	29

Source: Own elaboration.

The technical specifications are taken from a report by the U.S. Department of Energy, where it conducts a life-cycle analysis on LED lights compared to CFLs and ICLs (U.S. Department of Energy, 2012). The comparison in this publication is between lamps that carry out the same function. The average use time per day is based on the Clean Development Mechanism (CDM) methodology

on residential energy efficient lighting (UNFCCC, 2016b). The purchasing price of the lamps was estimated to this by the participants in the workshop. Attempts have been made to verify it with local suppliers, though without success.

The experience gained of formulating and discussing this NAMA supports capacity building in Grenada, which enables further mitigation actions.

Cost-Benefit Analysis of Technologies

The different technologies have different purchasing prices, maintenance costs, and lifespans, resulting in different replacement rates and operational costs. This allows for a payback period to be calculated. The formulas for each calculation are specified below:

• Replacement rate [lamp/year]:

$$\frac{\textit{Lamp use per day} \times \textit{days in year}}{\textit{Lifetime in hours}}$$

• Annual operational cost (XCD/year):

$$\textit{Replacement rate} \times \textit{price per lamp} + \frac{(\textit{Watts} \times \textit{lamp use per day} \times \textit{days in a year})}{1000} \times \textit{price of electricity}$$

• Payback period (years):

$$\frac{\textit{Annual operational costs}}{\textit{Annual operational costs (ICLs)}}$$

Table 2. Cost-Benefit Analysis of Technological Options

	Units	ICLs	CFLs	LEDs
Replacement rate	Lamps/year	0.9	0.2	0.03
Annual operational cost	XCD/year	26.8	7.2	3.5
Payback period	Years	NA	0.3	0.1
Annual operational cost, excluding purchasing price	XCD/year	26.1	6.5	2.6
Payback period, purchasing price not accrued	Years	NA	0.4	1.2

Source: Own elaboration.

The cost-benefit analysis shows that ICLs have the highest annual operational cost of the three technologies, with CFLs having an operational cost of less than a 1/3, and LEDs slightly more than a 1/9 of that of ICLs. If we look at the payback period of buying a CFL or LED lightbulb instead of an ICL, a CFL pays back after 0.3 years, thus roughly four months; the LED bulb is paid back already after a bit more than a month. If the entire purchasing price is incurred in the first year, the payback period does increase, especially for the LED as it is considerably more expensive than the ICL. However, it only increases to 1.2 years, indicating that it is still a desirable investment to make.

INSTITUTIONAL ARRANGEMENTS

Appropriate institutional arrangements are key to make the NAMA successful. The institutional arrangements delineate the different roles and responsibilities of the key stakeholders in the design and implementation of the NAMA, and establishes decision-making hierarchies and communication channels. Having clear institutional structures in place facilitates the implementation of the NAMA activities greatly.

NAMA Steering Committee

The NAMA Steering Committee's task is to coordinate the relevant stakeholders and make overall decisions regarding the NAMA and ensures that the NAMA is being implemented. The following stakeholders are proposed to take part in the NAMA Steering Committee:

Association of Electrical Engineers
Bureau of Standards Grenada
Chamber of Industry and Commerce
Grenada Customs & Excise Division
Department of the Environment
Economical and Technical Cooperation
Energy Division
GRENLEC
Inland Revenue Department
Ministry of Education
Ministry of Legal Affairs
Ministry of Trade
Ministry of Works (Electric Department)
Physical Planning Unit
Social Development and Housing
Solid Waste Management Authority
Statistics Division

Their selection is based on the suggestions that came out of the NAMA Managing Entity (Energy Division), and through a consultation process in a national workshop with the relevant stakeholders (17-18 January 2017).

NAMA OBJECTIVE AND TARGETS

The NAMA Objective and Targets presented below were discussed at the workshop in Grenada with relevant stakeholders, including representatives of what will form the future NAMA Steering Committee[2]. The objective is to set the direction of the NAMA, whereas the targets concretize the direction through setting specific measurable targets.

2 The stakeholders present at the workshop were the following: Representatives from the Policy Unit, Technical Cooperation and Energy Division under the Ministry of Finance. Representatives from the Environment Division under the Ministry of Agriculture Lands, Forestry, Fisheries and the Environment. Representatives from the Grenada Bureau of Standards, Customs & Excise Division, GRENLEC, UNDP Regional Office, GIZ-CIM, the RCC of the UNFCCC, OLADE and UNEP DTU Partnership.

NAMA Scope

The scope of the NAMA is defined both in terms of focus area and geography. The area of focus is lighting within the residential sector of Grenada. The geographical scope is nationwide, encompassing all three islands of Grenada.

NAMA Objective

The objective of the NAMA is as follows: Achieving energy savings and GHG emission reductions through increased accessibility to energy efficient lighting technologies in the residential sector.

NAMA Targets

The overall NAMA objective is accompanied by three targets which specify the objective.

Target 1: Adoption of EE Lighting Technologies in The Residential Sector

• Target 1A: Increase Use of EE Lighting

The first target aims to increase the use of energy efficient lighting in the residential sector by 30% by 2025 compared to the baseline of 2017.

• Target 1B: Phasing Out ICLs

In order to increase the accessibility to energy efficient lighting, it is also important to make the alternative, ICLs, less attractive. This is especially true given the initial price difference between the technologies which constitutes a substantial barrier. The gap cannot only be closed by decreasing the price of the EE technologies, but needs to be coupled with price increases of the inefficient technology as well.

• Target 1b: Phasing out ICLs by 2025
25% less use by 2018
50% less use by 2021
75% less use by 2023
100% less use by 2025
(Base year: 2017)

Target 2: GHG Emission Reductions & Energy Savings

Target two specifies that the emission reduction, as well as energy savings, should be 30% by 2025 compared to the BAU scenario. As there is a linear relationship between the GHG emissions and the energy savings in this particular NAMA, the same development of both parameters can be expected.

Target 3: Financial Savings

Target three specifies that the financial savings should be 25% by 2025 compared to the BAU scenario.

NAMA Baseline and Mitigation Scenarios

The following section presents the NAMA Baseline and Mitigation Scenarios. The Baseline Scenario, also called the Business-as-Usual (BAU) Scenario, is first presented. It builds on the current energy system, and through a historical trend extrapolation approach through which the future technological trends are sketched. The NAMA Mitigation Scenarios are what is projected to happen if the NAMA is implemented. There are two NAMA Mitigation Scenarios, Scenario 1 (S1) and Scenario 2 (S2).

Baseline Scenario

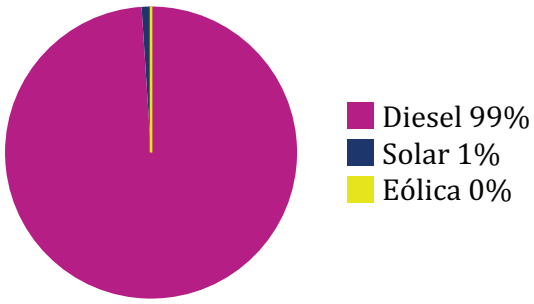
The baseline scenario builds on two components - the present energy system and its projected development, as well as the technological development and adoption rate of lighting technologies. The text below first describes the energy sector with a strong emphasis on electricity. Secondly, a set of key figures and assumptions are presented from which the BAU scenario is drawn.

Energy and Electricity in Grenada

Energy generation in Grenada is, as in most Caribbean island states, heavily dependent on imported diesel (Energy Transition Initiative,

2016; GoG, 2011). This has a direct impact on the price of electricity, as more than 50% of the electricity price depends on the fuel price, making the economy and households sensitive to fuel price fluctuations (GRENLEC, 2016). Moreover, this makes the Grid Emission Factor (tCO_2 emitted per MWh produced) high in an international comparison. The GoG reports to the UNFCCC that its grid emission factor is 0.634 tCO_2/MWh on the island of Grenada, while it is slightly higher on Carriacou (0.675) and considerable higher in the much smaller electricity plant on Petit Martinique (0.890) (UNFCCC, 2016a).

Figure 1. Energy Generation Mix



Source: (Energy Transition Initiative, 2016)

Grenada has one utility company named GRENLEC. It was founded in 1961 as a public company, and was granted the sole and exclusive license to generate, transmit, distribute and sell electricity in Grenada until 2041. In 1994, GRENLEC was privatised by the GoG selling 50% of its shares to a Canadian company (GRENLEC, 2015).

The current installed capacity is 48.6 MW, and the peak load is 30.9 MW, making brownouts rare (GRENLEC, 2015). There is a very high degree of access to energy, as Grenada has a 99.5% national electrification rate. However, the high energy prices limit actual access as it becomes unaffordable for many families (SE4All, 2012).

Figure 1 illustrates that there is currently a small portion of renewable energy sources, mainly solar, followed by wind power. The share of renewables is expected to grow in the future aligned with efforts to diversify the energy matrix, improve energy security and transition towards low carbon development. As was described above, the goal set out in the National Energy Policy is that 20% of electricity and transport energy should come from renewable sources in 2020. In the workshop consultation held in Grenada, it was stated that this goal will not be achieved - the current penetration rate of renewable energy is 1.85%. Given that there is an uncertainty of this development, this NAMA assumes that the Grid Emission Factor will remain the same for this time period.

The second component rests on a number of figures and assumptions which are specified below.

Table 3. Key Figures and Assumptions

	Value	Unit	Comment/Source
Number of households	41400	Number	Assumed to be constant throughout the period. Changes would result in positively correlated changes in energy use, GHG emissions, and financial savings.
Average lightbulbs per household	10	Number	The estimation is derived from discussion with the workshop participants. Needs verification. Changes in this would affect the energy use, GHG emissions, and financial savings.
Lamp use per day [hours]	3.5	Hours	The assumption used in CDM baseline calculations for energy efficient lighting in residential settings (UNFCCC, 2016b).

Days in a year	365	Days	
Grid Emission Factor	0.634	tCO2/MWh	Taken from (UNFCCC, 2016a). The grid emission factor for the island of Grenada is used, as the lion share of the population lives there, and to maintain a conservative approach.
Economic assumptions			
Purchasing Price			The prices of the bulbs are kept constant over the period. The prices matter most for the more energy efficient technology, that also have very long life times. As the time period of the NAMA only is eight years, the impact of the prices is neglectable. Sources: Prices are verified with the workshop participants. The price of electricity is taken from (Energy Transition Initiative, 2016), and the exchange rate from (XE Currency, 2017).
ICLs	0.3	USD/bulb	
CFLs	1.6	USD/bulb	
LEDs	10.75	USD/bulb	
Price of electricity	0.34	USD/kWh	
Exchange rate, XCD to USD	2.7	XCD/USD	

Source: (GRENLEC, 2015), except the USD price/kWh which comes from (Energy Transition Initiative, 2016), and the GDP/capita figure comes from (UN Data, 2017)

According to the BAU, ICLs will be phased out completely by 2028. There is a steady growth of CFL and LED use, with both types growing their share at an equal pace. The technological development results in lower energy use, GHG emission reductions and generates financial savings. Comparing the final year to the base-year, these three parameters have decreased by respectively 69% (for GHG emissions and energy savings) and 68% (for financial spending).

This document presents the NAMA proposal in the following way. First, the focus area of energy efficient lighting in the residential sector alignment with Grenada's development and climate change plans is presented. This is followed by a brief run-through of the existing and previous projects in Grenada, to ensure that this work builds on what they have uncovered. A technological analysis follows, determining which technological options Grenada has to choose from. Finally, this is followed by the start of the development of the NAMA, introducing an institutional structure, the objectives and targets, and the baseline and NAMA scenarios.

Table 4. The Projection of Use of Different Lighting Technologies.

Year	ICLs	CFLs	LED
2009	95	5	0
2017	55	30	15
2018	50	33	17
2019	45	36	19
2020	40	39	21
2021	35	43	22
2022	30	46	24
2023	25	49	26
2024	20	52	28
2025	15	55	30
2026	10	58	32
2027	5	61	34
2028	0	64	36

Source: Own elaboration.

As described in Table 4, the BAU is based on a number of assumptions; these leaves room for further investigations and revisions to increase the accuracy of the BAU scenario, as data is

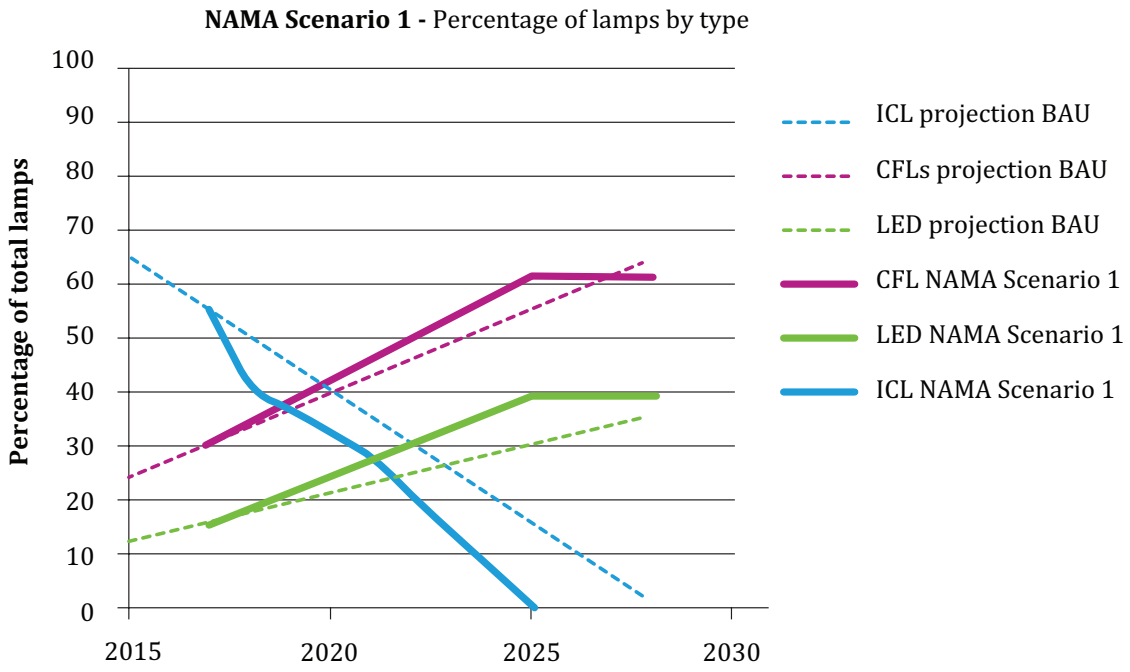
gathered during the NAMA's implementation. An additional implicit assumption has been built into the model, namely that the number of lamps, and the light they produce, is constant. The assumption disregards the risk of a "rebound effect". It has been documented in many different circumstances where financial savings due to improved energy efficiency actually lead to a higher energy consumption by users (see e.g. Greening, Greene, & Difiglio, 2000). Furthermore, a BAU scenario based on two observations transposed from other countries does not constitute a robust basis for scenario creation.

Mitigation Scenario

Based on the targets that are established for the NAMA, two mitigation scenarios are presented below, and compared to the BAU scenario. The two scenarios are created as there are uncertainties of the rate of adoption of the two alternative more efficient technologies. The creation of two scenarios illustrates potential future situations, enabling decision makers to identify which future outcome is more attractive, and devise actions to direct development towards the more attractive end results.

Scenario 1 (see figure 2 below) is a scenario where actions introduced by the NAMA lead to a phase out of ICLs by 2025, leading to a higher adoption of CFLs and LEDs to fill the space of the phased out ICL. A linear growth is assumed, resulting in both reduced energy use for the same provision of light as well as the GHG emissions. This forecasts an increased use of both CFLs and LEDs as a result of the NAMA, and a corresponding decrease of ICLs. The scenario is continued to 2028 for the sake of comparison with the BAU scenario. In 2025, when the ICLs have been phased out, the distribution between CFLs and LEDs is assumed to be constant for the foreseeable future, as the policies introduced will benefit both technologies, even though it is expected that over time, technological development and decreasing LED prices, LEDs will slowly take shares of the CFLs.

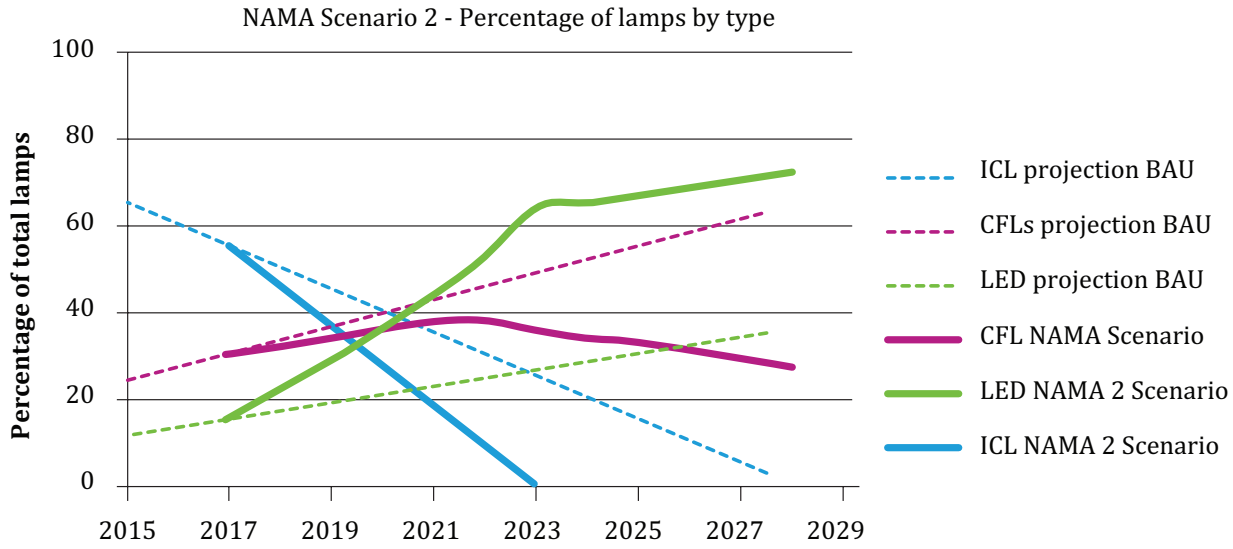
Figure 2. NAMA Scenario 1. Illustration of the development of the shares of the three technologies under the NAMA Scenario 1.



Source: Own elaboration.

Scenario 2 sees a quite different development for all three types of technologies. The introduced measures are tougher on ICLs in order to phase them out faster, and the support provided will be stronger targeted to the most energy efficient technology, which thus excludes CFLs. This results in a faster expansion of LEDs, and a faster decline of ICLs. Furthermore, while the share of CFLs initially continues to grow, the expansion of LEDs soon take shares from CFLs as well.

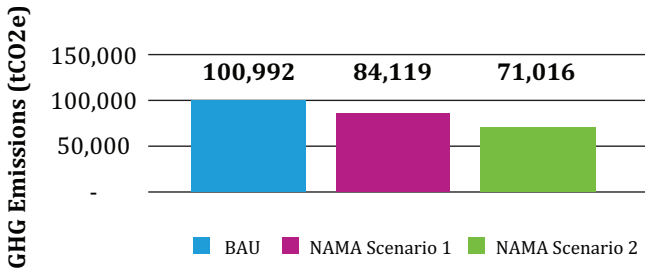
Figure 3. NAMA Scenario 2 - Illustration of the development of the shares of the three technologies under the NAMA Scenario 2.



Source: Own elaboration.

The two NAMA scenarios result in decreases in electricity use and GHG emissions[3], but of varying degree. Figure 3 shows the aggregated GHG emissions in the BAU and two NAMA scenarios. S1 results in a GHG reduction of 16,883 tCO_2, or 16% compared to BAU, while S2 reaches a reduction of 29,976 tCO_2, equivalent to a 30% reduction compared to the BAU.

Figure 4: GHG Emissions by scenario



Source: Own elaboration.

The reduced energy use would also result in financial savings of a similar magnitude. While the electricity cost accounts for the lion's share of the total cost, the cost of the lightbulbs is considered as well. This means that in S1, there is a 15% financial saving while there is a 28% financial saving in S2. Expressed in XCD, this represents a saving of respectively 740 XCD in S1 and almost

3 As the energy use, GHG emissions, and the cost of electricity are linearly correlated in this NAMA, as neither the grid emission factor nor the electricity price changes no matter how much electricity that is consumed, the changes in one of these parameters are reflected 100% in the other.

1400 XCD in S2 per household. It should be mentioned that this way of calculating distributes the purchasing cost of the lamps over its entire life-time, which does not accurately represent the reality faced by households in the lower income strata as it is the high upfront costs which prevent many from making the switch. There has been no accessible data to calculate the decline of the ICLs for either scenario. In general, one can say that the price elasticity of demand of ICLs is a decisive factor, and also the cross-price elasticity of demand to CFLs and LEDs. A brief search for data shows that the price elasticity of demand for lighting is -0.6 (Fouquet & Pearson, 2011), which means that a 1% increase on the price of the light bulb results in a 6% drop in demand.

Summarizing, the two NAMA Scenarios comply with different aspects that the participants in the workshop identified as important. S1 keeps to the time plan of phasing out the ICLs by 2025, as a faster phase-out was perceived as unrealistic from some of the consulted stakeholders, and also as potentially risky as it could result in residents hoarding ICLs. S2 sets a tighter time plan for this, and is in line with potential achievements expressed by other stakeholders, thus achieving a GHG emission and increase in energy efficiency of 30%. The system is intended to have a gradual approach, according to the implementation of the NAMA. Thus, the MRV system can be equally applied to earlier phases of the project and also fully operational ones.

BARRIER ANALYSIS

The following two sections, the Barrier Analysis and the Action Plan, are heavily based on the workshop held in Grenada in January 2017. The Action Plan, in particular, is crucial that it is well-grounded with the stakeholders who are to develop and implement it.

Political Barriers

There are two sub-headings under Political barriers; one concerns the institutional and organizational structures while the other focuses on the framework created by policies and regulations. There are considerable barriers in both groups.

• Institutional and Organizational Barriers

The barriers under this heading fall under two major categories - the danger of missing political commitment and lacking coordination between the ministries. There is a lacking coordination between different ministries. For the purpose of this NAMA, the coordination and cooperation between the Department of Environment (which pertain to the Ministry of Education, Human Resources and The Environment) and the Energy Division (that pertains to the Ministry of Finance and Energy) is especially highlighted as a barrier due to its importance in implementing this NAMA. Moreover, there is a complicated bureaucratic process to approve regulations in Grenada, which burdens the process further.

• Policy and Regulatory Framework

The policy framework constitutes a barrier in so far as that it is mostly lacking to promote energy efficient lighting. There are no taxes providing incentives for the energy efficient options, nor any dis-incentivizing conventional lighting. This underlines what has been mentioned above regarding the current VAT exemption for energy efficient lightbulbs - that it is not sufficiently specific. There is also a lack of quality assurance of the products that currently enter the market. Furthermore, there is a general lack of enforcement of the existing regulation which would constitute a challenge for new regulation as well. There is lacking capacity within the Ministries. This is both in regards to drafting new laws, as well as enforcing existing ones. This also risks creating a so-called positive feedback loop where the lacking ability to develop coherent regulation makes it difficult to enforce them properly, which further strains resources, making implementing new regulation even more difficult.

Economic Barriers

The subsections of the economic barriers are economic, financial and market conditions. A similar pattern to the situation emerges here as well, where its rather the lack of elements that constitute a barrier than the opposite.

• Economic Barriers

The barrier identified is high upfront costs for the technology. As described above, switching to more energy efficient lighting saves costs as the energy use decreases considerably, but these come in increments over time. The purchasing of the lightbulb, on the other hand, occurs at one time. As the price of a more efficient light bulb is substantially higher than for an ICL, and both satisfy the same immediate need (providing light), many consumers opt for the ICL in the purchasing moment.

• Financial Barriers

The participants perceive a lack of interest from financial institutions regarding this issue, which results in a lack of finance to solve it; this is especially true in relation to the upfront cost mentioned above. There is currently only one financial institution that offers a product that includes financing for energy efficient lighting, and that is the Grenadian Development Bank (GDB) which provides loans for energy efficient renovation of houses, within which lighting can be a component. It is discussed if the lacking interest is due to the very small scale of each investment, and whether it can be bundled so as to achieve larger volumes.

• Market Conditions

There are several barriers nested within the market conditions as well, many of which are related to the barriers mentioned above. The price of light bulbs is a central barrier, which is described above. Moreover, the lack of standards mentioned under the "Policy and Regulatory Framework" also creates issues on the market, as it becomes difficult to know with certainty that the products uphold a certain standard. A related issue is that the labelling of the products sometimes are in languages that are spoken by few in Grenada. This further decreases the information that the consumer can access in the purchasing moment.

Capacity Barriers

Capacity barriers are divided into two categories - "Human" and "Data and information". Similar to the barriers identified above, they most often consist in the lack of capacity or systems.

• Human Capacities

The workshop participants identify that there are lacking human capacities in many different aspects of the Grenadian society in relation to EE lighting. This stretches from a lack of training of technicians to install CFLs and LEDs instead of ICLs, to the personal in stores where lighting is being sold as they are not aware of the benefits of EE lighting for the customers. There is also a lack of capacity within state institutions such as the Customs and Excise Division to monitor imported products. There is also a lack of knowledge within the Ministries to advice the political decision makers. This adds to the issue raised above with a potential unwillingness to champion this politically. If there is lacking knowledge of the merits of these measures, it is even less likely that it will be championed. The lacking human capacity is not limited to lacking knowledge, but also to having sufficient staff resources.

• Data and Information

There is a general lack of data which makes the justification as well as monitoring and evaluation of measures difficult. This is related to lacking human and institutional capacities in terms of establishing data collection routines and reporting routes for the data.

Social Barriers

The social barriers are within two categories: "cultural" and "public awareness". In general, there is no focus on energy efficiency within the communities in Grenada; it is not considered to be one of the more important topics. The lacking human capacity identified above goes hand in hand with this, as if it is not seen as a prioritized area, there is no need to build capacity in it. This is coupled with a general negative perception of new (and expensive) technology, as well as that many already have experience with low quality energy efficient light bulbs; these experiences have left traces, as many in the population are skeptical of it. Moreover, the participants describe that there is not a large openness to change in Grenada, especially not if there is not a concrete reason to do so. The negative perception is further fueled by the fact that there are issues surrounding the handling of the disposed bulbs. As CFLs contain harmful chemicals, this is labelled on them. However, as there is a general low level of public awareness surrounding this, the harmful chemicals in CFLs easily become perceived as harmful chemicals in all energy efficient lights.

Prioritization of Barriers

The following step in the workshop was to prioritize the identified barriers (see below).

#	Barrier	Type
1.	High up-front cost	Economic
2.	Lack of adoption/enforcement of standards for import of EE lights	Regulative
3.	Lack public awareness on benefits and costs of EE lighting	Social
4.	Lack of an institutional and organizational coordination	Institutional
5.	Lack of policies and regulation to promote EE lighting	Regulative
6.	Lack of human capacities and equipment and technology to carry out necessary tasks	Capacity
7.	Lack of finance to implement the NAMA	Economic
8.	Lack of capacity in the public and financial institutions	Institutional
9.	Lack of data and data management	Institutional
10.	Lengthy and complicated political processes for decision making	Institutional

If one sees the top barrier, high-up front cost, as a consequence of lacking incentives for EE lighting/dis-incentives for ICLs, then the majority of the most important barriers are due to lacking institutional or regulative measures. This underlines the importance as well as the potential that this NAMA has, as the only actor to can address these barriers is the GoG. The political as well as institutional commitment is decisive for this to happen, and the measures presented below are contingent on this.

NAMA ACTION PLAN

The action plan lists the specific measures proposed to address the prioritized barriers above. The Plan also specifies who is responsible for carrying out the action, and the estimated cost. The total estimated cost is 120,000 USD, the responsibilities, timeline and costs for each measure are listed in table 5.

High upfront costs

The high upfront costs are above identified as the top barrier. In order to overcome these, the introduction of a temporal lowering of the Value Added Tax (VAT) on the energy efficient lightbulbs is proposed. An important distinction between the two scenarios need to be made here, as in S2, the lowering would only apply to LED lights. The time period of the lowering should be announced before-hand, and be between 9 months to 1 year.

The reasoning behind this measure is that a temporal lowering of the VAT would change the price structure to favor the energy efficient lights, but also ensure that the residents make the necessary investment in this time period, rather than wait. There are also other measures that can be taken. These goods can also be exempted from the Customs Service Charge (CSC) of 6%. A longer process includes lowering the Common External Tariff of 20%. However, as this is common for the CARICOM region, it is not the prerogative of the GoG, but a joint decision needs to be taken at the Ministerial Meeting of Trade Ministers.

Lack of adoption/enforcement of standards for imports of EE lights

The representative from the Customs and Excise Division points to that when energy efficient light bulbs are imported into Grenada, they sometimes arrive in fixtures. The current VAT exemption described above does only apply to individual light bulbs - a further differentiation of the categories of imports is needed. This categorization, however, is made on the CARICOM level, and is thus connected to the same time-line that is described above for the exemption of the Common External Tariff.

Lack of Awareness on Benefits and Costs of EE Lighting

Given the lack of public awareness of the benefits and costs of EE lighting, a public awareness campaign needs to be launched. This is to be developed and implemented by the government official.

Institutional and organization structure for coordination

The way forward here is to establish the NAMA Steering Committee, which is described above. The Committee is to oversee the development and implementation of this NAMA, but the structure could also be used for other NAMAs, though with other relevant actors.

Lack of policies and regulation to promote EE lighting

The Energy Efficiency Act that is currently being worked on will be an important tool to promote EE in general - it is within in this act that measures to regulate EE likely will be found. A first draft of the EE act is to be expected this April - if there is a consultation process, actors should suggest to include measures relevant for this NAMA. The gradual decrease would be equal to what is suggested in target 1b.

Lack of Human Capacity and Equipment

There is a general agreement that this is a central issue, and that special training of the personal is necessary. The earlier projects have increased the capacity, but more is needed. This proposal suggests for key personnel within selected ministries to get access to funds and resources, including time, to seek out training in the areas they deem necessary. This should be done according to a pre-determined plan agreed on with the supervisor. The cost to develop a plan could be financed as part of this NAMA.

Lack of Finance to Implement the NAMA

The workshop participants perceived this as a barrier as to how to pay for the technology, and its distribution, especially to low-income households. The issue of this is that no actor responsible for such a coordination - purchasing

of the bulbs, distribution and also finding ways to retrieve payments from the households - was identified. This way forward is thus not examined further in this proposal.

Lack of Capacity in the Public and Financial Sector

The role of the financial institutions is in focus here, and what role they potentially could play. As the investment for lightbulbs does not concern large sums, financing these with bank loans is implausible as the transaction costs simply would be too much. However, a proposal could be to collaborate with micro-credit organizations, which are used to handling loans with small sums. A possibility could be to create an incentive for the micro-credit organizations to add an extra loan on-top of their usual loan for investments in energy efficient lighting.

Lack of Data and Data Management

The solution to this barrier will go hand-in-hand with the MRV system, and will thus be further elaborated there.

Lengthy and Complicated Decision-Making Process

This is an institutional issue that will not be solved easily. Such an approach would require coordination between the different departments, potentially through the Steering Committee.

Table 5. Responsibilities, timelines and costs for the measures to overcome the prioritized barriers

Barrier	Responsibility	Timeline	Cost
High upfront cost.	Ministry of Finance, Inland Revenue Department.	The implementation would ne in two steps: the incentives are to be introduced as soon as possible. The tax increase should first be introduced in 2018.	6000 USD, which includes staff time and 2000 USD for holding one or two consultations. There would be addiotional time allocated in-kind from the government for this.
Lack of adoption / enforcement of standards for imports of EE lights.	Grenada Bureau of Standards, CRSQUE (a CARICOM body).	2019 (24 months).	7000 USD for a consultancy.
Lack of Awareness on Benefits and Costs of EE Lighting.	The Energy Division si responsible for identifying who can develop aand implement such a strategy.	18 months.	100,000 USD as a minimum. Add space TV and other media outlets are expensive. The cost is if one does all of this without any prioritization.
Institutional and organization structure for coordination.	The Energy Division. The establishment of a Steering Committee requires a cabinet decision, but it is the Energy Division which should develop the propossal.	Within the first half year of 2017.	Covered in-kind.

Lack of policies and regulation to promote EE lighting.	Energy Division.	The timeline for the import quotas is to be introduced first in 2018.	Funded mainly through in-kindwork.
Lack of Human Capacity and Equipment.	Ministry of Finance.	1 year to develop a plan, the implementation will be continuos.	5000 USD, part of it is in-kind work as well.

Source: Own elaboration.

MRV ACTION PLAN

The proposed MRV system builds on existing structures, and is aimed to be simple and limited in what it encompasses. There are several benefits of this, primarily that it can become operational fast. Moreover, a simple MRV system does not overburden the NAMA with a bureaucratic system that demands considerable resources to be operational. This is especially important in a NAMA with a smaller scope such as this one.

Monitoring

The essential parameter to monitor is the change of use of light bulbs in the country. As it is not feasible to measure this directly, a proxy is to track the different type of light bulbs which are imported into the country. The Customs and Excise Division already records the import of different goods, meaning that this should not constitute a significant extra expense.

Reporting

The reporting line of the NAMA is simple: it is illustrated in the figure above. The Customs and Excise Division provides the number of imported lightbulbs to the Energy Division. The Energy Division uses this input to calculate which percentage of the households have adopted energy efficient lightbulbs, the progress on phasing out the ICLs, as well as the energy and financial savings and the GHG emission reduction. These calculations build on the expertise and information the Energy Division have. The information flow also adds the opportunity for the Energy Division to overview how the situation develops over time, and, as the main implementing actor, tweak or suggest additional measures if needed. The final reporting step is to the NAMA Focal Point, which is the Permanent Secretary of the Ministry of Environment. The office is responsible for coordinating the reporting to the UNFCCC.

Verifying

The verification process needs to check that the population is actually using the imported energy efficient lightbulbs in their homes. As the Central Statistical Office of Grenada has as an objective "to generate social and environmental indicators for the formulation, pursuit and evaluation of the policies that government can execute" (Central Statistical Office of Grenada, 2017), this lies squarely within their area of competence. When conducting household surveys, it could be possible to include questions regarding the type of lighting they use at home and their average use time.

SUSTAINABLE DEVELOPMENT CO-BENEFITS AND CONCLUSIONS

Increasing the energy efficiency of lighting is not only motivated by the mitigation potential, but also by its sustainable development impact. This goes hand-in-hand with the ambitions of the GoG.

Within the current Growth and Poverty Reduction plan of 2014-2018, increasing energy efficiency is seen as a priority area to develop a sustainable energy system, which in turn is seen as important to reduce poverty and stimulate growth (Antoine, Taylor, & Church, 2014).

Target 3 of the NAMA is to generate 25% financial savings compared to the BAU scenario within residential lighting. This will have an impact on all income segments, but it will likely have a stronger impact in the lower segments. This is for various reasons.

The cost of electricity makes up 3% of the GDP per household. While increasing energy efficiency does not affect the unit cost of, in this case, electricity, it does decrease the overall spending on electricity. This increases the disposable income for all households, but as energy costs form a proportionally larger part of the disposable income for low-income segments, increased energy efficiency has the potential to decrease the vulnerability of these households.

The NAMA will contribute to gender inequality as well, which constitutes another focus in Grenada's Growth and Poverty Reduction Strategy (Antoine, Taylor, & Church, 2014). 44% of female-headed urban households are within the bottom three quintiles, as opposed to 18.6% of the male-headed households. Other sustainable development impacts are within the economic sphere. The National Energy Policy describes high energy costs as threats to the economic growth (GoG, 2011); lowering these would free resources for other consumption and strategic investments. Managed well, an increased economic growth could lead to sustainable development. Another threat mentioned is the high dependency on fossil fuel imports which compromises energy security. Increased energy efficiency reduces the dependency as fewer imports are needed.

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