MRV Methodology For Energy Efficiency Implementation Measures In Commercial And Public Buildings For Countries Of The Caribbean Region

AUSTRIAN DEVELOPMENT COOPERATION

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Contents

1 Glossary of terms

ACP - African, Caribbean and Pacific
ADA - Austrian Development Agency
BAU – Business as Usual
BEL - Belize Electricity Limited
BUR - Biennial Update Report
CARICOM - Caribbean Community
CCCCC - Caribbean Community Climate Change Centre
CCU - Central Coordinating Unit
CDM - Clean Development Mechanism
CER - Certified Emission Reductions
CMVP - Certified Measurement and Verification Professional
COP - Convention of the Parties
CSC - Commonwealth Science Council
DFC - Development Finance Corporation
DNA - Designated National Authority
ECM - Energy Conservation Measure
ECPA - Energy and Climate partnership of The Americas
EDF - European Development Fund
EE - Energy Efficiency
EEC - Energy Efficiency Certificate
ESCO - Energy Service Company
EU - European Union
GEF - Global Environment Facility
GHG - Green House Gases
ICA - International Consultation Analysis
IDRC - International Development Research Centre
INDC - Intended Nationally Determined Contributions
IPMVP - International Performance Measurement and Verification Protocol
LDC - Least Developed Countries
M&V - Measurement and Verification
MPSEPU - Ministry of the Public Service, Energy and Public Utilities
MRV - Measurement, Report and Verification.
NAMA - Nationally Appropriate Mitigation Action
NC - National Communications
NEP - National Energy Policy
OAS - Organization of American States
OCT - Overseas Countries and Territories
OLADE - Organización Latinoamericana de Energía
PAHO - Pan American Health Organization
PALCEE - Programa para América Latina y el Caribe de Eficiencia Energética
PUC - Public Utilities Commission
RE - Renewable Energy
SIDS - Small Island Developing States
UNEP - United Nations Environment Program
UNFCCC - United Nations Framework Convention on Climate Change
WTA - Walk Through Audit

2 Executive summary

The Latin American Energy Organization (OLADE) with support from the Austrian Development Cooperation seeks to strengthen the energy efficiency institutional framework in the Members Countries of the Organization. This is seen as an appropriate means to achieve regional sustainability.

As a result, OLADE and ADA, developed the Latin America and The Caribbean Energy Efficiency Program (PALCEE), whose propose is to achieve the strengthening of the institutional framework through the reinforcement of the institution in charge of guiding and directing energy efficiency programs nationally, including its structure and organization, as well as, the legislation and regulations which lead to the establishment of national plans, from the conception phase to evaluation, and ultimately to the conclusion and presentation of the results.

Additionally, the Program considers different demand-side energy efficiency programs to be developed as the means to initiate the activities of the institution in charge of managing the energy efficiency in the country; and includes inter alia, the training of the staff that will manage the mentioned institution, as well as the professionals in charge of the implementation of the actions contained in the programs. Concomitantly, the local finance sector will be trained to enhance their capacity in the financial aspects of the operations, but specifically as it relates to the implementation of energy efficiency measures.

To create the intended impact and to assure long term sustainability, the contemplated programs for implementation are: energy savings in public and commercial buildings, efficient lighting in the lowest income sectors, and energy efficiency in industry and services sectors.

Moreover, in accordance to the effective development of energy efficiency, it has been identified that as a complement of PALCEE implementation, is necessary to rely on a mechanism for monitoring the state of the energy efficiency in the countries, reason why is proposed in manner of technical support to develop a Monitoring, Reporting and Verification Proposal (MRV) for energy efficiency implementation measures for commercial and public buildings.

OLADE has contracted "SEG Ingeniería" to develop, in the first instance, an MRV proposal for energy efficiency implementation measures for commercial and public buildings in Belize **and to develop a replicable MRV methodology for the countries of the Caribbean Region**. This document is the fourth of four products and refers to the replicable MRV methodology.

3 Important definitions

NAMA - Nationally Appropriate Mitigation Action. Are a set of feasible activities defined in a sovereign manner by a country and which lead to reducing emissions in a measurable, reportable and verifiable manner. In general, it is understood that NAMAs would be actions proposed by developing countries, which would lead to reducing greenhouse gas emissions below the level that would result from doing things as they have been done up to now (BAU scenario). NAMA's are part of the structure generated by the UNFCCC and the Kyoto Protocol and emerge from the need to shorten the emission gap that is originated between current Kyoto commitments and future emissions projections. The execution of a NAMA will make it possible to access the financial, technological and technical assistance resources that are necessary for the realization of these actions and that should be provided by the developed countries. Those actions need to be appropriate to the actual circumstances of the developing country.

In chapter 5, there is an extended explanation of the meaning and the different types of NAMAs.

MRV - (Measurement, Reporting and Verification) is a technical instrument to confirm GHG emission and GHG emission reduction objectively. An MRV can be used to define the Climate Finance. An idea of the definition of Climate Finance is "Any finance which support the investment cost of GHG emission reduction project and activities and its reduction is confirmed objectively by MRV.

INDCs - (Intended nationally determined contributions) The Conference of the Parties (COP), by its decisions 1/CP.19 and 1/CP.20, invited all Parties to communicate to the secretariat their INDCs well in advance of COP 21 (by the first quarter of 2015 by those Parties ready to do so) in a manner that facilitates the clarity, transparency and understanding of the INDCs. The Paris Agreement requires all Parties to put forward their best efforts through nationally determined contributions (NDCs) and to strengthen these efforts in the years ahead. This includes requirements that all Parties report regularly on their emissions and on their implementation efforts.

Paris Agreement[1] - The Paris Agreement builds upon the Convention and for the first time brings all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects, with enhanced support to assist developing countries to do so. As such, it charts a new course in the global climate effort.

The Paris Agreement central aim is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius. Additionally, the agreement aims to strengthen the ability of countries to deal with the impacts of climate change. To reach these ambitious goals, appropriate financial flows, a new technology framework and an enhanced capacity building framework will be put in place, thus supporting action by developing countries and the most vulnerable countries, in line with their own national objectives. The Agreement also provides for enhanced transparency of action and support through a more robust transparency framework.

Stakeholders - All those who are affected by, or who could affect (positively or negatively) the project's results".

1 https://unfccc.int/

Level 1 Walk-Through Analysis/Preliminary Audit definition (1)

The Level 1 audit alternatively is called a "simple audit", "screening audit" or "walk-through audit" and is the basic starting point for building energy optimization. It involves brief interviews with site operating personnel, a review of the facility's utility bills and other operating data, and an abbreviated walk-through of the building. The audit should result in a preliminary, high-level, energy-use analysis for the entire facility, and a short report detailing the findings, which may include identifying a variety of recognizable efficiency opportunities.
Usually this report does not provide detailed recommendations, except for very visible projects or operational faults.

The Level-1 audit is intended to help the energy team understand where the building performs relative to its peers; establish a baseline for measuring improvements; deciding whether further evaluation is warranted; and if so, where and how to focus that effort.

Level 2 Energy Survey and Analysis definition (1)

The Level-2 project starts with the findings of the Level-1 audit, and evaluates the building energy systems in detail to define a variety of potential energy-efficiency improvements. This should include the Building Envelope, Lighting, Heating, Ventilation, and Air Conditioning (HVAC), Domestic Hot Water (DHW), Plug Loads, and Compressed Air and Process Uses (for manufacturing, service, or processing facilities). This study starts with a detailed analysis of energy consumption to quantify base loads, seasonal variation, and effective energy costs.

From there, the study should include an evaluation of lighting, air quality, temperature, ventilation, humidity, and other conditions that may affect energy performance and occupant comfort. The process also includes detailed discussions with the building Ownership, Management, and Occupants to explore potential problem areas, and clarify financial and nonfinancial goals of the program.

The Level-2 audit should result in a clear and concise report and briefing with the Owner and Management Team describing a variety of Energy Efficiency Measures (EEMs) including null and low-cost measures, modifications to system controls and building automation, operational changes, and potential capital upgrades. The findings should include general costs and performance metrics, as well as a way for the Owner to evaluate the EEMs and decide how to proceed with implementation.

Level 3 Detailed Analysis of Capital Intensive definition (1)

Some of the system upgrades or retrofits revealed by the Level-2 audit may require significant investments of capital, personnel, and other limited resources. Before making this level of investment, the owner will want to have a much more thorough and detailed understanding of the benefits, costs, and performance expectations. There may be only a few capital-intensive EEMs exposed by the Level-2 audit, or there may be dozens for larger facilities. Investment levels can range from tens of thousands to tens of millions of dollars. In most cases, since this cannot be clearly determined or accurately estimated in advance, the recommendation and scope definition for a Level-3 audit usually is an outcome of the Level-2 process.

4 Framework[2]

4.1 The State of the Caribbean Energy Sector Supply of energy. (2)

Caribbean countries have very high access to electricity (excepting Haiti), but use expensive off-grid supply to compensate for deficiencies in utilities. According to World Bank indicators, Caribbean countries have, on average, above 90 percent electrification rates. However, off-grid self-generation is commonly used by large hotels and some commercial establishments, given low reliability of utilities and frequent power outages. Supply deficiencies are similar across most of the region. Although each country has unique energy sector conditions, most face the same supply constraints. These include limited generation capacity, outdated power systems, isolated grids and lack of technical expertise that, together with episodes of high and volatile oil prices, have resulted in high average electricity costs. Electricity tariffs increased by almost 80 percent over 2002-2012, exceeding 0.30 US$/kWh for most countries in 2012.

The single most important cost problem is the region's heavy dependence on expensive imported fossil fuels. As in the U.S., the cost of using petroleum to produce electricity is several times higher than alternative fuels. Except for Trinidad and Tobago, the only net exporter of oil and natural gas, all other Caribbean countries are net oil importers. For importers other than Suriname, around 87 percent of primary energy consumed is in the form of imported petroleum products. Mostly diesel fuel for electricity generation is imported, gasoline for transportation and liquefied petroleum gas (LPG) used as cooking gas in households. Among the net-oil importing countries, only Barbados has installed capacity that uses natural gas for electricity generation, which has partly contributed to its higher efficiency rates. Hydroelectric power, harnessed through facilities in Suriname, Belize, Dominica and St. Vincent and the Grenadines, supplies about 6 percent of regional electric energy consumption. Excluding Haiti, biomass represents around 11 percent of Caribbean energy supply, mostly concentrated in Jamaica.

An important burden on cost is that Caribbean power systems suffer from notable inefficiency and high system losses. For most countries, electricity generation relies heavily on medium-speed/low-speed generators running on diesel or heavy fuel oil, the efficiency of which is constrained by their age and old generation technology. The bulk of the power grids are also old and not adequately maintained, leading to significant technical and transmission losses. Commercial losses, resulting from illegal connections to the grid, are a significant problem[3].

A second constraint is that the power market structure is undiversified and under regulated. The Caribbean electricity market is served by a mix of state-owned and private utility companies (Figure 2). For the most part, electric utilities are vertically integrated monopolies that hold exclusive licenses for generation, transmission, distribution and sale of electricity. Some of these monopolies are unable to finance necessary investments in generation capacity and the national grid, leaving consumers without access to reliable and affordable energy. The absence of adequately-staffed and independent national energy regulators in many countries leaves regulatory gaps unbridged.

2 This chapter is based upon the paper *Caribbean Energy: Macro-Related Challenges* (2)

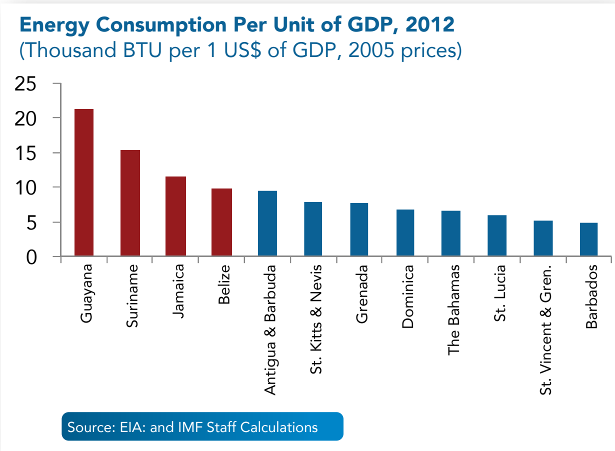
3 Commercial losses reach as high as 20 percent of net generation in Guyana and 16 percent in Jamaica, while Antigua and Barbuda and St. Kitts and Nevis suffer from significant operational inefficiency, with the highest rate of system losses in the ECCU.

Country	Power Utilities	Ownership
Antigua and Barbuda	Antigua Public Utilities Authority (APUA)	State-Owned
Bahamas	Bahamas Electricity Corporation (BEC)	State-Owned
	Grand Bahama Power Company (GBPC)	Privately-Owned
Barbados	Barbados Power & Light-(P&L)	Privately-Owned
Belize	Belize Electricity Limited	State-Owned
Dominica	Dominica Electricity Services Ltd. (DOMLEC)	Privately-Owned
Grenada	Grenada Electricity Services Ltd. (GRENLEC)	Privately-Owned
Guyana	Guyana Power & Light Inc.-State-(P&L)	State-Owned
Jamaica	Jamaica Public Service Company (JPSCo)	Privately-Owned
St. Kitts and Nevis	St. Kitts Electricity Department (SKELEC)	State-Owned
	Nevis Electricity Company Ltd. (NEVLEC)	State-Owned
St. Lucia	St. Lucia Electricity Services Ltd. (LUCELEC)	Private/Public entity
St. Vincent and the Grenadines	St. Vincent Electricity Services Ltd. (VINLEC)	State-Owned
Suriname	Energy Companies of Suriname	
Trinidad & Tobago	Trinidad & Tobago Electricity Commission	State-Owned
	PowerGen	Private/Public enterprise

Table 1 - Electric Utility Companies in the Caribbean region (2)

Countries' energy intensity depends on their economic structure[4].

Guyana appears to be the most energy-intensive country among commodity exporters, while Barbados is the most energy-efficient country, consuming the least energy per unit of GDP. Antigua and Barbuda is the least efficient country in the ECCU and in tourism-dependent economies. On a per capita basis, tourism-dependent Caribbean economies appear more energy intensive than commodity-exporting countries like Belize, Guyana, Jamaica and Suriname; this is largely explained by how much larger the tourist population is in tourism-dependent economies relative to their small indigenous population.



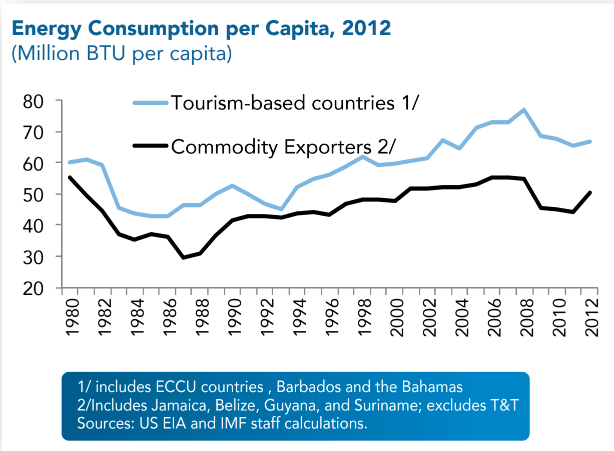


Figure 1 – Energy intensity in Caribbean countries (2)

4 Tourism-dependent countries include ECCU countries, the Bahamas, and Barbados. Commodity exporters are those countries where at least 20 percent of total exports in 2008–2012 were natural resources, including agricultural commodities, and these include Belize, Guyana, Jamaica, and Suriname.

The most energy intensive users include hotels in tourism-based economies, and the industrial sector in other Caribbean states.

In tourism-based economies, commercial consumers, namely hotels and tourist establishments, are the most intensive energy users, absorbing around 41 percent of ex-transportation primary energy, with air conditioning accounting for almost half of consumption. Residential consumers are the second largest users. In commodity-exporting countries—where the productive base is larger—the industrial sector is the largest energy consumer with a share of about 57 percent of total primary energy consumed in the region, around 36 percent is for transportation.

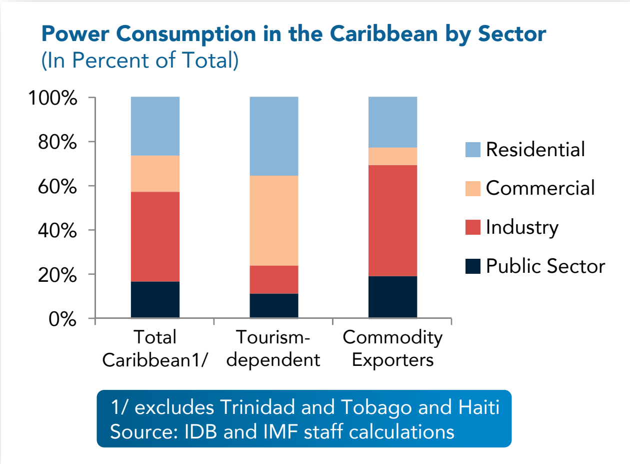


Figure 2 - Power consumption in the Caribbean by Sector (2)

Mitigating the negative impact of oil prices on growth and external competitiveness can be achieved through efforts to reduce oil dependency and lower the energy bill. While countries have no control over oil price movements, they can save over the longer run by diversifying their energy mix and improving the efficiency of energy consumption to reduce fuel imports and thereby limit the impact of price shocks.

Improvements in energy efficiency as well as investment in the energy sector both have a positive impact on long-run GDP. It was estimated by the paper's authors (2) that an improvement of 1 percent in energy efficiency would be accompanied by an increase in GDP per capita by 0.2 percent in the long run. An increase in 1 percent of gross capital formation per capita is associated with a 0.15 percent increase in long-run GDP per capita.21 In sum, staff results indicate that improving energy efficiency, including through diversification of the generation mix with cheaper and more efficient alternative energy sources and the adoption of energy efficient technologies, will have a significant impact on GDP in the long run.

Improving Energy Efficiency

Energy efficiency measures are a focus in most country strategies and are likely to be the most feasible short-and-medium-term way to reduce energy costs. Energy efficiency can be improved on both the energy generation side and the consumption side. On the generation side, countries should strive to reduce technical losses, by replacing old and inefficient power plants and transmission/distribution lines, which cause major technical losses for the grid. On the consumption side, it is important to improve the energy consumption patterns of heavy energy users. In small tourism-dependent countries, improving the energy efficiency of hotels can significantly reduce the national energy bill. Based on a study carried out in Barbados, air conditioning alone accounts for 48 percent of total electric consumption by hotels. The adoption of energy-efficient technologies, like the use of smart window technology, can have a tangible impact on reducing overall energy consumption and improve tourism competitiveness by directly lowering hotels' overhead costs. Meanwhile, limiting commercial losses in the form of unmetered electricity consumption would help enforce proper price signaling for all consumers and reduce energy intensity in the economy.

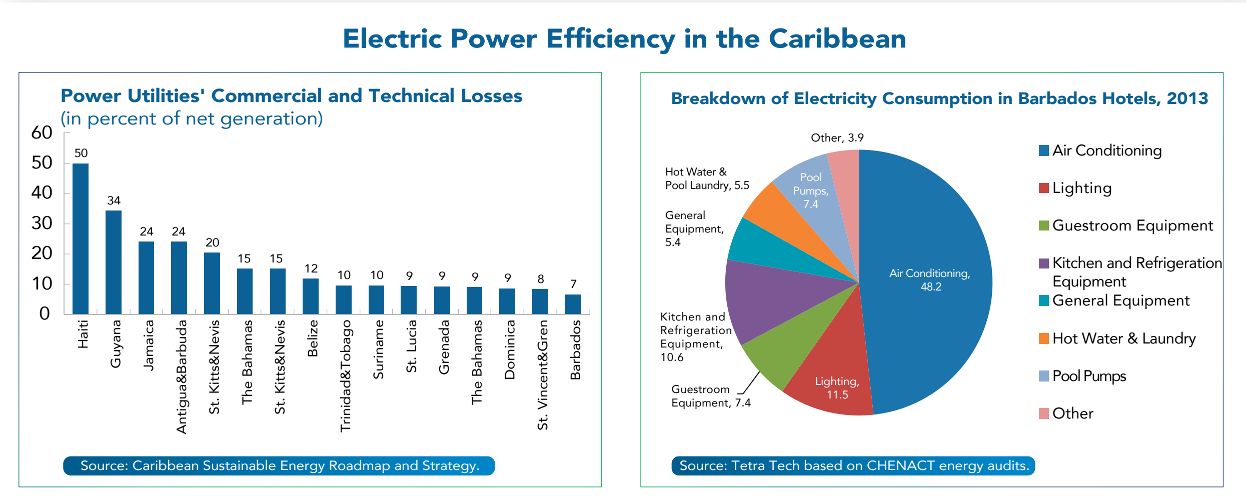


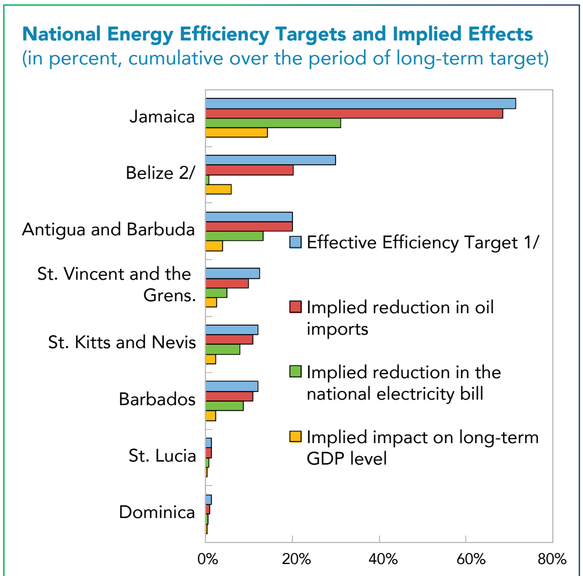
Figure 3 - Electric Power efficiency in the Caribbean (2)

Some CARICOM states have set energy efficiency targets that, if achieved, would have a positive macroeconomic impact. Figure 4 shows the long-term targets and estimated macro-economic effects of reaching them, namely, important savings in fuel imports and the national electricity bill. For instance, if Antigua and Barbuda meets its target of improving overall energy efficiency in the economy by 20 percent (including the transport sector), estimated impacts are: an equivalent 20 percent drop in oil imports; a 13 percent decline in the national energy bill; and a long-run cumulative increase of 4 percent in the level of GDP over the long-run. The right-hand panel of Figure 4 shows that most CARICOM states that have specified energy efficiency targets would reap significant benefits from reaching them.

National Energy Efficiency Targets and Implied Effects

Overview of National Energy Efficiency Targets in CARICOM Member States

Country	Energy Efficiency
Antigua and Barbuda	Improve energy efficiency 20% by 2020
The Bahamas	None
Barbados	Reduce electricity consumption 22% compared to business- as-usual by 2029
Belize	Improve energy efficiency and conservation by at least 30% by 2033 (suggested)
Dominica	Reduce public sector electricity consumption 20% by 2020
Grenada	None
Guyana	Remove duties and taxes on energy-efficient CFLs and LED lights
Haiti	Achieve 36% of households using improved cooking stoves by 2015
Jamaica	Reduce energy intensity from 22 million to 6.3 million joules per USD of GDP by 2030
Montserrat	None
St. Lucia	Reduce public sector electricity consumption 20% by 2020
St. Kitts and Nevis	Reduce projected electricity demand 20% by 2015 (resulting in peak demand of 45.7 MW)
St. Vincent and the Grenadines	Reduce projected increase in peak demand 5% by 2015 and 10% by 2020 Reduce power losses 7% by 2015 and 5% by 2020 Reduce electricity generation 15% by 2020
Suriname	None
Trinidad and Tobago	No target currently exists; however, a 150% tax allowance is granted to commercial and industrial enterprises that achieve a target % of energy efficiency improvement (target currently being determined)



1/ Announced targets shown on the left are normalized to the same base to reflect the targeted improvement in energy consumption in the entire economy, including the transport sector.
2/The impact on the national electricity bill from achieving the target reflects the smaller savings from energy efficiency technologies in Belize, where the electricity tariff rate is relatively low.

Sources: Caribbean Sustainable Energy Roadmap and Strategy (C-SERMS), Castalia Reports, IDB, WEO, and IMF staff estimates.

Figure 4 - National Energy Efficiency Targets and Implied Effects. (2)

4.2 Energy efficiency in Commercial and public buildings in Caribbean countries. Gathered efforts and projects.

As many Caribbean countries share the same concerns about sustainable development, members of multilateral institution such as CARICOM gathered efforts in this regard. The first barrier to confront was the lack of organized and centralized energy information, so in 1989 the Caribbean Energy Information System (CEIS) was created with the focus on information flows of the smaller countries in terms of energy technology development and implementation as well as hard numerical data on energy activities from a Caribbean perspective.

The network became operational in 1989 with technical and financial support from the Commonwealth Science Council (CSC), the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the International Development Research Centre (IDRC). Nowadays, the network is being funded primarily by Caribbean governments.

Further progress were the multi-lateral agreements, for instance, the Caribbean Planning for Adaptation to Climate Change (CPACC) Project that began in 1997, implemented by the World Bank, executed by the OAS, and overseen by a Project Advisory Committee chaired by CARICOM, as a response of the United Nations Framework Convention on Climate Change (UNFCCC).

The idea of a Climate Change Centre (CCC) was conceived at the level of the Project Advisory Committee of CPACC, when it was realized that a piecemeal project-by-project approach would not provide the same impact as a long-term strategic approach. This idea received the full support of Committee members, the World Bank, and CARICOM countries.

The proposal to establish such as Centre was approved by CARICOM's Council for Trade and Economic Development in January 2001. Nowadays, Caribbean Community Climate Change Centre is a regional entity headquartered in Belize created in 2002 and since then it has been supporting many project in different levels such as: "GEF-UNEP Project: Energy for Sustainable Development in Caribbean Buildings" through which are being made energy audits in public buildings (Still ongoing project since it started in 2012).

Furthermore, by 2004 the Caribbean Renewable Energy Development Program (CREDP) was fully implemented. The main objectives were to dismantle identified barriers to the increased use of renewable energy in the region in areas of: Policy, Finance, Capacity and Information/awareness. To date CREDP has had some successes, but the barriers have largely remained. It is considered that inter-alia, the more comprehensive framework of the CARICOM energy program, will continue to build on these successes. The project was developed as two parallel components; one referred to as CREDP/UNDP with a GEF budget of USD 3.726 million and the other funded by the German government through its development agency GTZ.

OLADE-PALCEE

Austrian Development Cooperation (ADA) & OLADE carried out the PALCEE Project (Latin American and The Caribbean Energy Efficiency Program) in 2013, which has the primary objective of strengthening the institutional framework for the development of energy efficiency and gathering and organizing the efforts that various institutions make in a specific country. Its goal is to incorporate energy efficiency in national plans and convert the programs into long-term efforts, providing them sustainability that has been absent from the efforts made by the majority of Latin American and The Caribbean countries.

There's an ongoing project in Belize that consists of training in energy efficiency, energy audits in 3 buildings and implementation of measures, and the development of a demonstration project of efficient lighting in residential low-income households. The training consisted of a 2-week course in energy efficiency for professionals of the Energy Unit of the Ministry of Energy, Science & Technology and Public Utilities (MPSEPU), and members of other public and private institutions.

In the next figure there is a diagram with the different aspects of the PALCEE project.

Figure 5 - PALCEE project organization (3)

GEF-UNEP Energy for Sustainable Development (ESD) in Caribbean Buildings Project

UN Environment-GEF project, which began in 2013, had an intended completion plan for 2017. The project's overall development goal was to reduce greenhouse gas emissions and promote energy efficient technologies and practices in appliances and buildings in five Caribbean countries (Antigua and Barbuda, Belize, Grenada, St Lucia and St Vincent and the Grenadines).

Project Implementation: Structure and Partners.

UN Environment is the Implementing Agency, and the project is situated in the Climate Change Mitigation Unit of the Energy Branch within the Economy Division. The Executing Agency (EA) is the Caribbean Community (CARICOM) Climate Change Centre (CCCCC or 5Cs).

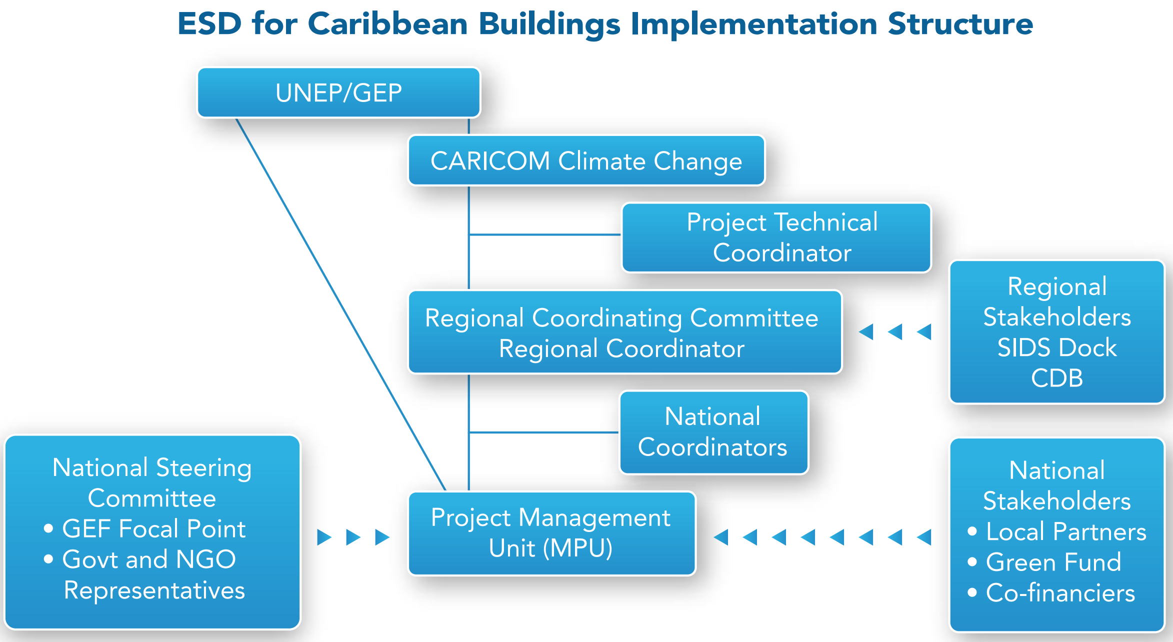


Figure 6 - ESD for Caribbean Buildings Implementation Structure (4)

A full analysis of the outcomes of the projects is found in "Mid Term Evaluation of the UN Environment Project Energy for Sustainable Development in Caribbean Buildings- March 2018"

C. 11th European Development Fund (EDF-11)

The EDF funds cooperation activities in the fields of economic development, social and human development as well as regional cooperation and integration.

It is financed by direct contributions from EU Member States according to a contribution key and is covered by its own financial rules. Although the 11th EDF remains outside of the EU budget, the negotiations in the Council of Ministers on the different elements of the 11th EDF have taken place in parallel with the negotiations of the external Instruments financed under the budget, to ensure consistency. The total financial resources of the 11th EDF amount to €30.5 billion for the period 2014-2020.

In the field of the external actions of the EU, the applicable legislation is composed in particular by the international agreement of Cotonou for the aid financed from the EDF, by the basic regulations related to the different cooperation programs adopted by the Council and the European Parliament, and by the financial regulations.

The 11th EDF was created by an intergovernmental agreement signed in June 2013 – as it is not part of the EU Budget – and entered into force on the 1st March 2015, after ratification by all Member States. In order to ensure continuity of funding for cooperation with ACPs and OCTs, a 'Bridging Facility' was set-up to cover the period between the end of the 10th EDF (December 2013) and the start of the 11th EDF (March 2015). This 'Bridging Facility' seized to exist when the 11th EDF entered into force.

EU cooperation 2014-2020

Under the 11th EDF (2014-2020) the financial allocation for Belize is €27 million. The EU financial support to the national development strategy is built around three focal sectors, namely r**enewable and sustainable energy**, health and public finance management. Further, Belize is a signatory of the EU-Central America Association Agreement, a comprehensive free trade agreement with a strong focus on development cooperation. In this context, Belize can benefit from the EU Central America regional program (€120 million).

PAHO Smart Hospitals

PAHO has been providing technical assistance to Caribbean countries for the development of the pilot project and implementation of the initiative of the Smart Hospital - SMART hospital in phases 1 and 2 (2012-2014 and 2015-2020). The SMART Hospital is based on the Safe Hospital Initiative and focuses on improving hospitals resilience, strengthening structural and operational aspects and providing green technologies. Smart hospitals receive interventions to improve energy efficiency, as well as collecting and storing rainwater. The energy improvement consists of solar panels installations, electric storage batteries and low-consumption electrical systems, which, in addition to reducing energy consumption, reduce health sector carbon footprint in the environment and provide the hospital with energy autonomy, allowing it to continue running during storms without need for a generator.

Smart hospitals have already shown their strength to storms and cost-benefit. In St. Vincent and the Grenadines, Georgetown Hospital (benefiting from the intervention of a smart hospital) was the only one that remained functional after a severe storm affected 39 clinics and the reference hospital (Milton Cato Hospital). In addition, this hospital became a water supply center for the community after the storm, using rainwater reserves.

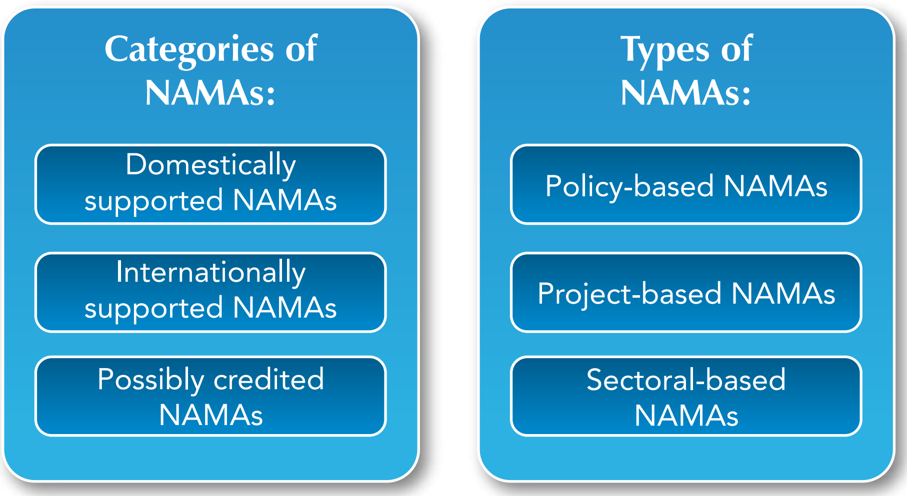
Although the smart hospital concept has not been implemented in South America, countries of the region are aware of the Safe Hospital initiative, as well as the Hospital Safety Index, which is widely disseminated in the region. The smart hospital initiative is complemented by the safe hospital initiative and will allow countries to be better prepared for new challenges.

5 Introduction

MRV is a concept introduced by the United Nations Framework Convention on Climate Change with the aim to develop a structured approach to measurement, reporting and, after COP 13 in Bali (2007), also verification of the greenhouse gas (GHG) emissions by sources and removals by sinks, as well as on the actions that Parties are taking to mitigate and adapt to climate change and to implement the Convention.

"The Bali Action Plan introduced the principle of measurement, reporting and verification (MRV) for both developed and developing country Parties in the context of enhancing action at the international and national level to mitigate climate change." (5)

The MRV is the structure to evaluate whether the aims of a NAMA are being accomplished. A National Appropriate Mitigation Action (NAMA), is a concept also introduced by UNFCCC and it consists on a group of measures adopted by a developing country that has the aim of reducing GHG directly or indirectly. Such actions could be undertaken by a country on its own with domestic resources (domestically supported NAMAs), or with international support, including capacity-building, finance or technology (internationally supported NAMAs). NAMAs can take various forms, ranging from policy or regulatory interventions at the national or sectoral level (e.g. emissions trading schemes, feed-in-tariffs), to project-based NAMAs targeting specific investments or technology (e.g. development of a waste treatment facility).



The first stage of a roadmap to develop an MRV is to define and characterize the NAMA. For instance, "New policy that promote the use of LED lighting in residential sector" (policy based NAMA) or "Energy efficiency in public and commercial buildings" (Sectorial based NAMA), etc.

Government could decide for instance, to register a NAMA in UNFCCC as a "NAMA seeking international support" to facilitate the matching of finance, technology and capacity-building support. Participation in the registry is voluntary (www.unfccc.int/8184.php). Or it could be applied for instance at the Clean Development Mechanism (CDM) in order to have a possibly credited NAMA[5] . Having a credited NAMA implies the earning of Certified Emission Reductions (CERs) to be sold in the international carbon market, but this approach requires a much lengthier bureaucratic road. There are many

5 There are other voluntary credit initiatives that do not follow the Clean Development Mechanism of UNFCCC.

Carbon Markets one of the most important is the European Union Emission Trading System, in the next figure it is shown the history prices of the CERs in that market. Nowadays, the price is set on 15 €/tCO_2 eq recovering the value they had before the 2012 crisis.

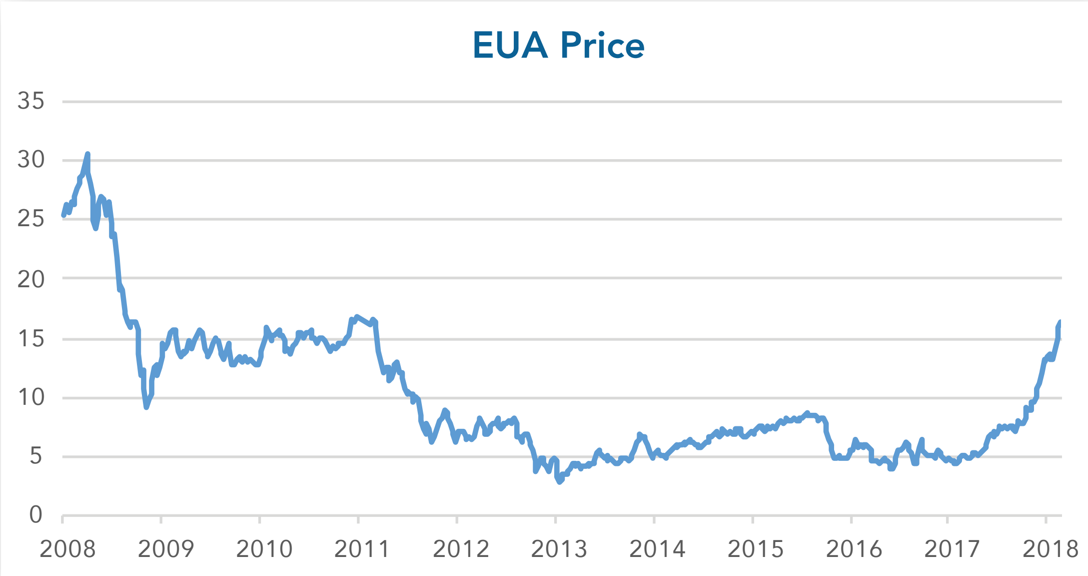


Figure 7 – EU Emissions Trading System (EU ETS). €/tCO_2 eq

The registration of the domestically supported NAMAs is not a requirement to develop an MRV, but could reinforce measurement, reporting and verification of the aims planned. In any case, establishing an achievable quantitative goal regarding energy savings or GHG reductions from a BAU scenario is the key to succeed.

Every internationally supported NAMA has reporting obligations, UNFCCC establishes a mechanism of biennial update reports (BURs) in order to inform the Parties that provide financial and technical support. Furthermore, a process for international consultation and analysis (ICA) of BURs has been established.

The frequency of the ICA will depend on the frequency of the BURs, which is normally every two years, with special flexibility for SIDs and LDCs, which may undergo ICA at their discretion.

Biennials Update Reports (BURs) for internationally supported NAMA

BURs are reports to be submitted by non-Annex I Parties[6], containing updates of national Greenhouse Gas (GHG) inventories, including a national inventory report and information on mitigation actions, needs and support received. Such reports provide updates on actions undertaken by a Party to implement the Convention, including the status of its GHG emissions and removals by sinks, as well as on the actions to reduce emissions or enhance sinks. In the next figure there is a summary of the key elements of a Biennial Update Report.

Key elements of the Biennial Update Reports (BURs)

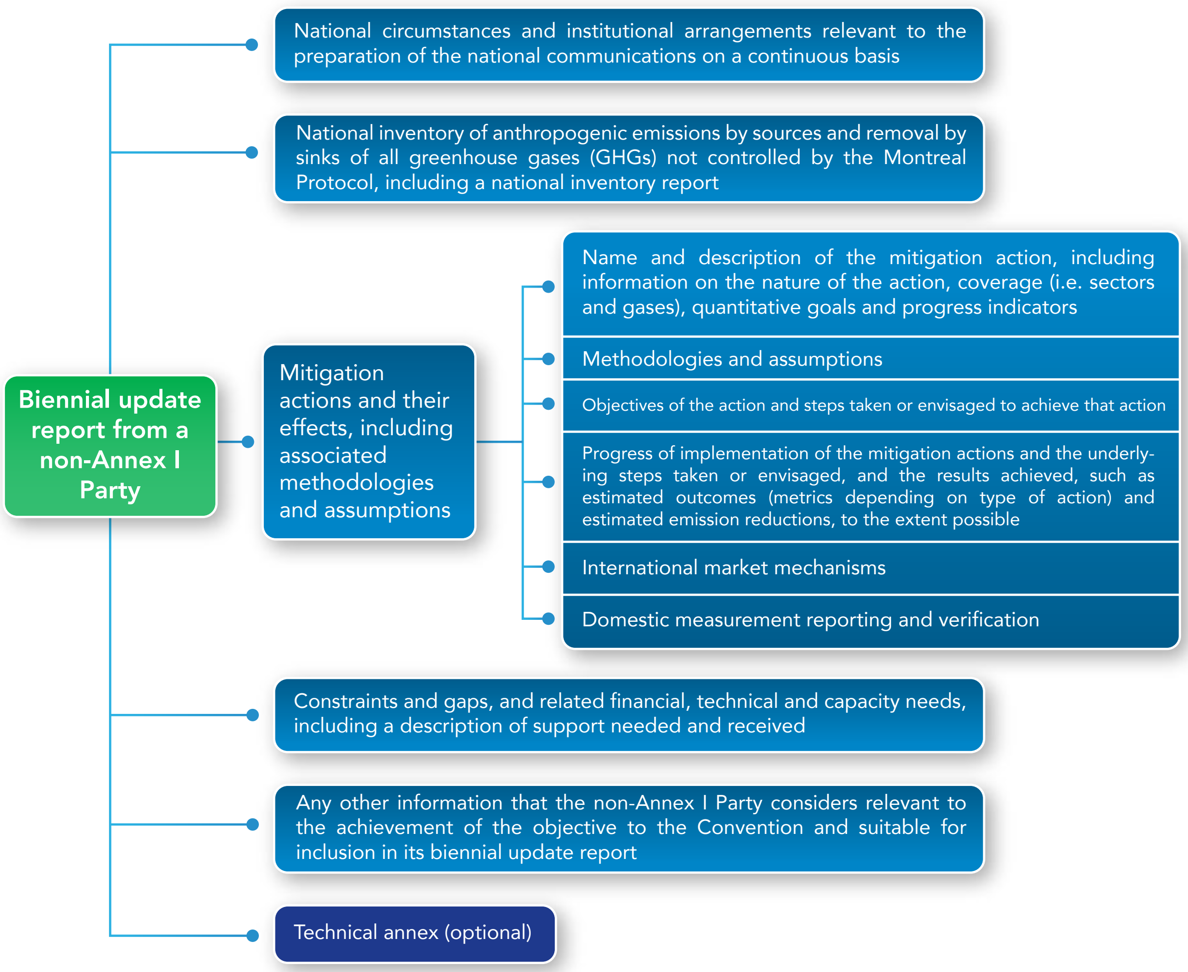


Figura 8 - Elementos clave de BUR. (5)

6 Principalmente países en desarrollo.

International Consultation Analysis (ICA)

An ICA consist on two steps: the technical analysis of BURs by a team of experts; and a facilitative sharing of views, in the form of workshops convened at regular intervals under the Subsidiary Body for Implementation (SBI).

As formerly said, there is a difference between international and domestic NAMAs, regarding the requirements, so as the MRV that support that NAMA. In next picture it is clearly shown the different types of MRV that UNFCCC recognize and its key elements. As the resolution 21/CP.19 of the COP, UNFCCC gives guidelines for domestic MRV, the accession is completely voluntary.

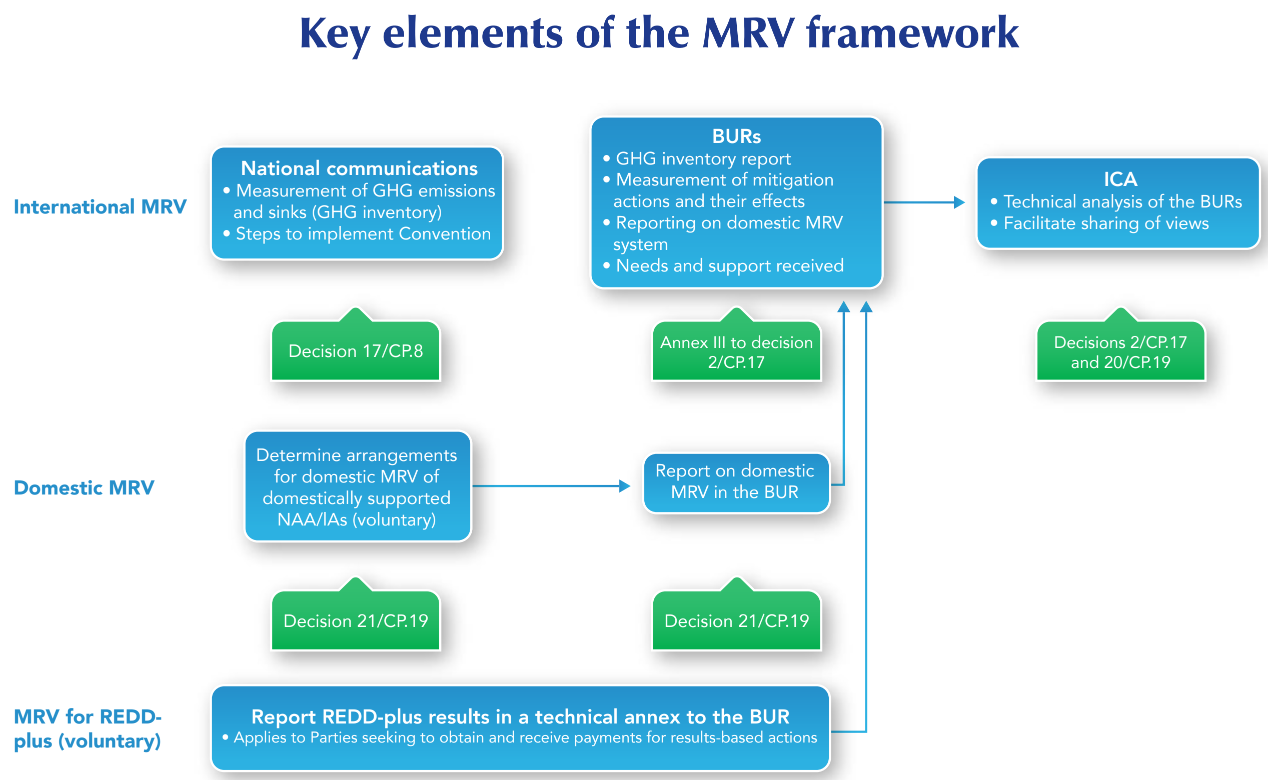


Figure 9 - Key elements of the MRV framework (5)

The MRV for REDD-plus apply for activities relating to reducing emissions from deforestation and forest degradation, and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries.

In this document there is a suggested roadmap to develop **a domestic MRV that supports a sectoral-based NAMA** "Energy efficiency in public and commercial buildings". The suggestion of considering a domestic MRV relays on the fact that maintaining an internationally supported NAMA requires more effort and infrastructure, especially if there is no previous MRV experience in the country.

The Decision 21/CP.19 of Conference of Parties refers to domestic MRV and express the following:

"Recognizing that the general guidelines for domestic measurement, reporting and verification of domestically supported nationally appropriate mitigation actions by developing country Parties are to be voluntary, ***pragmatic, non-prescriptive and nonintrusive, take into account national circumstances and national priorities, respect the diversity of nationally appropriate mitigation actions, build on existing domestic systems and capacities, recognize existing domestic measurement, reporting and verification systems and promote a cost-effective approach****,*

- Adopts the general guidelines for domestic measurement, reporting and verification of domestically supported nationally appropriate mitigation actions by developing country Parties;

- Invites developing country Parties to use the guidelines contained in the annex on a voluntary basis;"

"Recognizing, using and reporting on the domestic measurement and verification of nationally appropriate mitigation actions

- Developing country Parties are encouraged to utilize existing domestic processes, arrangements or systems, including domestically available information, methodologies, experts and other aspects, for domestic measurement, reporting and verification. Otherwise, developing country Parties may wish to voluntarily establish domestic processes, arrangements or systems for the domestic measurement, reporting and verification of domestically supported NAMAs.

- Developing country Parties may, taking into account national circumstances, capacities and national priorities, indicate the general approach adopted:

(a) To establish, when appropriate, and/or recognize, where relevant, inter alia, the institutions, entities, arrangements and systems involved in the domestic measurement, reporting and verification of NAMAs;

(b) To measure domestically supported NAMAs, including the collection and management of relevant and available information and the documentation of methodologies;

(c) To verify domestically supported NAMAs, including the use of domestic experts using domestically developed processes, thereby enhancing the cost-effectiveness of the verification process." (6)

6 Domestic MRV key elements

6.1 Measurement

Measurement is applied in both to efforts to address climate change as well as to the impacts of these efforts, including the level of GHG emissions by sources and removals by sinks, emission reductions and other co-benefits. In a particular NAMA: "Energy efficiency in public and commercial buildings", it will be necessary to measure energy related savings that impact on the electricity consumption baseline. To calculate the GHG saved it is necessary to apply the current emission factor[7] , that is the amount of CO_2e that implies the electricity generation and distribution considering the losses. Such measurement occurs at the national level and within the scope defined by the NAMA.

The electric energy is the focus of the present MRV since is the main energy source for this particular sector in Belize based on previous consultancies (7). It will be assumed that in the rest of Caribbean countries this situation is replicable. This does not mean that the energy audits develop in the future should avoid studying other energy resources, however, for the first stage of MRV development other energy sources are out of the scope of the MRV due to the complexity that this could add versus the benefit obtained.

In case that an additional energy source needs to be added, the methodology is similar to the exposed in this document. The main difference lies in the construction of an additional baseline, one for each energy source that needs to be taken into account.

The methodologies for measurement are not defined by the Convention; therefore, in undertaking measurement, Parties rely on methodologies developed internally and according to the national circumstances. However, where possible, the COP identifies and endorses the methodologies that Parties should use, at a minimum, unless no financing counterparty imposes a methodology. Good practices regarding the measurement of implemented ECMs are presented in this document.

Generally, measurement is a prerequisite for verification. A measurable unit is required in order to identify the records that will be available for verification through reporting systems.
There are two main categories of metrics for NAMAs: quantitative and qualitative. In addition, metrics can be categorized as inputs acting towards GHG mitigation or the outputs of mitigation activities in terms of real measurable GHG reductions.

For example, input metrics might include a certain number of established activities, implemented programs or units constructed in an effort to reduce greenhouse gas emissions, while output metrics would include, for instance, the electric energy savings in a building, from which it is possible to calculate the GHG emission reductions.

The range of metrics applied to a NAMA could, and in many instances should, include quantitative and qualitative, input and output metric types.

7 In CDM there is a tool to calculate the emission factor for an electricity system called "Dispatch data" –
More information: https://cdm.unfccc.int/

6.1.1 Quantitative Financial Metrics

Financial metrics include the financial flows from donor institutions to recipient institutions or organizations, and from those institutions to funded activities and operations.

Their usefulness in respect of NAMAs is primarily to ensure the efficacy of funds in conjunction with one or more supplemental metrics. Financial metrics therefore on their own will be unlikely to demonstrate real reductions in emissions but will form part of a mix of metrics useful for assessing the performance of supported NAMAs. In particular, these metrics will allow for the assessment of the cost effectiveness of NAMA activities. Funding through the prospective Global Green Fund or the Global Environment Facility is likely to be much easily accounted for at the international level, while funding provided through less straightforward channels may be more difficult to measure and verify. Funding institutions may choose to carry out their own auditing of funding flows and there may be an opportunity to rely upon some of the new climate fund standards that have been developed such as the Climate Bond Standard by the Climate Bond Initiative. The outcomes of third party MRV related to those standards could potentially be incorporated at the broader international level. (8)

In case that no donor institutions are financing the NAMA other than the government, it would be useful to define quantitative financial metrics to give the authorities the feedback to monitor the execution of the national plans included in the NAMA's objective and to correct the execution if necessary.

Measurement of financial metrics is relatively straightforward. Data systems and record keeping arrangements for investment flows are usually already in place. The key element is to ensure that procedures are in place to secure that funds are allocated to activities and projects which are included in the particular NAMA.

6.1.2 Quantitative Process Metrics

Quantitative process metrics include activities which are procedural in nature and can be measured in terms of numbers of activities completed. Quantitative process metrics are relatively simple to document, record and report, provided that appropriate administrative practices are established to ensure that thorough documentation is kept. Quantitative process metrics are unlikely to require significant capacity building and do not demand sophisticated data management systems. They are therefore relatively easy to implement. However, like quantitative financial metrics, quantitative process metrics are input metrics and do not provide any indication on their own of NAMA effectiveness or GHG emissions mitigation quantification. They are primarily used to guarantee the efficacy of processes and programs in conjunction with one or more additional metrics, and to demonstrate that a NAMA is functionally operating as planned. Examples of quantitative process metrics include documenting and reporting on the creation of new institutions or working groups, meetings held or progress in educational programs. (8)

For instance, is recommended to develop a Gantt chart or a milestone Calendar with the main activities of the program to keep track of the progress and the achieved goals. It is particularly important to use one of these tools when many programs are being held at the same time with the same focus in energy savings in commercial and public buildings.

6.1.3 Quantitative Technical Metrics

Quantitative technical metrics may be input or output based. *Input technical metrics* are, for example the number of inverter air conditioners or LED tubes installed as a retrofit of an inefficient equipment. *Output technical metrics* are the GHG emissions reduction measured at an installation (directly and indirectly). The MRV frameworks for CDM are quantitative output technical metrics and are well elaborated following UNFCCC procedures. Technical metrics are the most challenging to document, record and report. Quantitative technical metrics may require significant capacity building and would usually require sophisticated data management systems.

Technical metrics may be either input or output metrics; however, output metrics have the capacity to provide the clearest evidence of GHG reductions. On the other hand, they can be the costliest to measure and verify. They may also exhibit the characteristics of uncertainty, error and poor accuracy. (8)

The savings need to be computed following a very well described procedure, in the next chapters a suggestion is presented, one appropriate for a first stage approach and a complete one for a second and mature stage of the MRV implementation.

In a mature stage of the MRV implementation, it is recommended the application of an objective way of measuring energy savings in buildings based on an international guide or protocol. However, the application of any protocol requires the certification of professionals from the organization in charge of data gathering, i.e. reviewing the M&V reports and validating them. Also, the country will need professionals certified in the protocol to design the M&V plan and elaborate the reports. This capacity will take time to implement, therefore it's recommended to consider it in a second stage of the MRV, and for the first stage the protocol can be used as a guide. To compute any kind of savings (with or without an M&V protocol) it is necessary to assess the evidence of the implementation and savings.

There are a few protocols available and not all of them have a global scope. The ones with a global coverage are:

- IPMVP
- CDM Methodology AMS-II.C and AMS-II.L
- ISO 50001 Energy Management Standard (EnMS)
- The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard

PROTOCOL	APPLICATION	KEY FEATURES	COMMENTS
International Performance Measurement and Verification Protocol (IPMVP) Volume I.	IPMVP is an international M&V protocol describing different methods to determine water and energy savings of energy efficiency projects. It presents a framework for transparent, reliable, and consistent reporting a project's saving, which can be used to develop M&V plan for projects.	IPMVP presents four M&V options to evaluate a project's savings: Option A: Retrofit isolation—key parameter measurement Option B: Retrofit isolation—measurement of all parameters Option C: Whole facility Option D: Calibrated simulation IPMVP is available in more than 11 languages.	IPMVP is one of the most comprehensive frameworks for M&V. It is used extensively and has become the de facto M&V standard in many countries.
CDM MethodologyAMS-II.C and AMS-II.L	The AMS-II.C methodology is for demand-side energy efficiency activities for specific technologies such as lamps, ballasts, refrigerators, motors, fans, air conditioners, pumping systems, and chillers. The AMS-II.L methodology is for demand-side energy efficiency activities for efficient outdoor and street lighting technologies.	These documents provide the user with necessary instructions to develop and implement M&V plan as per the CDM criteria so as to qualify for emission reduction certificates. The main contents of the methodology documents are scope and applicability, normative references, definitions, baseline methodologies, and monitoring methodologies.	The methodologies AMS.II.C and AMS.II.L are very comprehensive documents. They provide definitions and calculation methods for baseline development along with monitoring techniques. Project proponents need to follow these guidelines in carrying out the M&V of energy efficiency projects to qualify for emission reduction certificates under the CDM.
ISO 50001 Energy Management Standard (EnMS)	ISO 50001 EnMS is a framework developed for industrial facilities, commercial facilities, and organizations to manage energy, which includes energy procurement and use. The EnMS institutes a structure and discipline to implement technical and managerial strategies to cut energy consumption and GHG emissions.	The standard addresses: Energy use and consumption Measurement, documentation, and reporting of energy use and consumption Design and procurement practices for energy-using equipment, systems, and processes. All variables affecting energy performance that can be monitored and influenced by the organization.	ISO 50001 is a voluntary international standard developed by the International Organization for Standardization (ISO) to manage and improve energy performance. Certification by an independent auditor of conformity of the user's energy management system to ISO 50001 is not a requirement of the standard itself. To certify or not is a decision to be taken by the ISO 50001 user, unless imposed by regulation. Alternatives to independent (third-party) certification are to invite the organization's customers to verify its implementation of ISO 50001 in conformity with the standard (second-party verification), or to self-declare its conformity.
The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard	The protocol sets global standards for how to measure, manage, and report GHG emissions.	The protocol sets out standard and/or guidance on the following: GHG accounting and reporting principle, business goals and inventory design, setting organizational boundaries, setting operational boundaries, tracking emissions, calculating GHG emissions, managing inventory quality, accounting GHG reduction, reporting GHG emissions, verifying GHG emissions, setting GHG targets.	It serves as the basis for nearly every GHG standard and program in the world—from the International Standards Organization to The Climate Registry—as well as hundreds of GHG inventories prepared by individual companies.

Table 2 - Description of available M&V protocols (9)

From the list of possible protocols, the consultants recommend the IPMVP (currently only Jamaica counts with at least one registered CMVP professional in the Caribbean region). The International Performance Measurement Verification Protocol (IPMVP) of the Efficiency Evaluation Organization is a free access protocol and widely used all over the world.

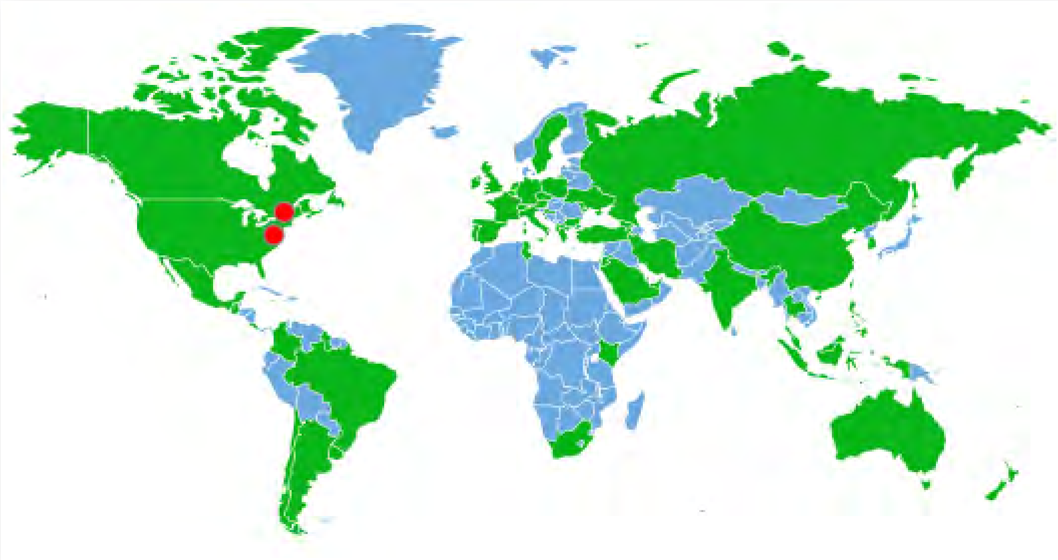


Figure 10 – In green, countries that have adhered to the IMPVP. www.evo-world.org

6.1.3.1 First stage *Certified ECM savings*

The key element to construct the quantitative technical metrics is to compute energy, economic and GHG savings due to the implementation of the ECMs. In that regard there needs to be a set of defined input data that need to be registered on the first stage of the MRV implementation, to track the ECM into the data base. Such database would need to register several parameters on each ECM to be able to obtain the desired metrics such as GHG savings and to unequivocally identify each one. What follows is a possible list of data inputs.

- Total building annual energy demand (kWh/year)
- Annual consumption of other sources of energy (define source and units)
- ECM name
- Date of implementation
- Lifetime of ECM
- Area of implementation: lighting, HVAC, ventilation, pumping, refrigeration, direct heat, compressed air, etc.
- Baseline Annual energy demand of the building (kWh/year)
- Average energy price (USD/kWh), inform tariff
- Annual baseline CO2e emissions (ton CO2/year)
- Investment (amount un USD)
- ECM Annual energy demand (kWh/year)
- ECM CO2e emissions (ton CO2/year)
- Annual saved energy (kWh/year)
- Annual saved CO2e emissions (ton CO2/year)
- Annual savings (USD/year)
- Savings calculation method

The methods to collect this information from the NAMA target sector is discussed in chapter 6.1.5. Afterward, this information is assessed by the Monitoring responsible unit, which should be a part of the Ministry in charge of energy, and who is the final responsible to compute the ECM certified savings that will be reported.

These inputs will need to be supported by an Energy Audit report. Here two possibilities emerge; a level 2 or level 3 audit can be demanded. It's recommended to differentiate the requirement based on the capital investment of the project. As a recommendation, any project with an investment above USD 50,000 would require a level 3 energy audit, for the rest a level 2 energy audit report would be required. It's suggested that as a first stage, a theoretical approach to the savings calculation is accepted.

Often, there's an appreciable difference between the energy audit report and the project's implementation results. Therefore, submitting an implementation report is a good practice to enforce.

Other supportive information to be asked are invoices, installer bills, pictures, and other forms of evidence. It's recommended to also require a sworn statement by the facility's representative stating that all the presented information is true. This will serve as way to make sure of all the aspects of the ECM that can't be verified by evidences. For instance, in the case of lighting, providing evidence of the equipment purchase, the power demand of the new lamps can be established, but the replaced lamp power and the hours of operation won't be demonstrable with evidence.

6.1.3.2 Second stage Certified ECM savings

In a possible second stage, the quantitative metrics to be measured will be determined by the protocol for savings greater than 150 USD/month[8]. If the government decides to adopt the IPMVP to validate energy, economic and GHG savings, the NAMA should include capacity building for the application of the protocol. It would be necessary to train CMVP who could certify the ECM. It is a good practice that the Ministry in charge of the energy sector, to keep an open record of the whole CMVP with capacity to certify ECM in the country, so as a list of ESCO companies and energy professionals with proven capacity to carry out level 2 or 3 energy audits. The implementation of a record promotes ESCO companies and energy professionals providing trust, and ultimately promoting energy efficiency actions.

Procedure:

1. For savings below 150 USD/month the consultants suggest not to use the protocol due to cost effectiveness, instead it's recommended to use input technical metrics. As part of the quality assurance of the verification, it's necessary to present evidence of the implementation, for example, the invoice of efficient equipment that has been installed. The requested information is similar to the first stage input requirements.

2. For savings greater than 150 USD/month, the IPMVP is recommended as it brings more transparent and confident results for the savings calculations. Nevertheless, typically average annual M&V costs should be less than 10% of the annual savings being assessed. In annex 2 "IPMVP application" is an example developed for ECM usually found in commercial and public buildings.

8 Suggestion based on consultant experience. It should be evaluated for each case. And it depends on the % error is going to be assumed.

A- Savings <300 *BZD/month

- Savings calculation based on *input technical metrics*. Ex: Annual energy savings = N° of LED tubes installed x estimated usage hours x (Power_before - Power_after). Responsables to compute savings need to have an evidence of how many tubes (and which type) have been changed, the rest of the parameters are estimated.

B- Savings >300 *BZD/month

- Savings calculation based on IPMVP (*output technical metrics*). The savings could be determined using 4 options that are decribed in table 5 and 6 of annex 1. In all cases, annual M&V costs should be less than 10% of the average annual savings being assessed.

Figure 11 - Certified ECM savings

6.1.3.3 GHG calculation methodology

Project emissions from consumption of electricity from the grid are calculated based on the energy consumed by the project activity and the emission factor of the grid, adjusted for transmission losses, using the following formula:

$$PE_y = ES_y \times GEF_y \times (1 + TL_y)$$

Where:

PE_y: Project Emissions savings in year y ($tonCO_2$)

ES_y: Energy Saved by the project in year y (MWh)

GEF_y: Grid Emission Factor in year y ($tonCO_2/MWh$)

TL_y: are the average technical losses in the grid in year y (%)

6.1.4 Qualitative Process Metrics

Qualitative process metrics include assessments of the efficacy of activities undertaken and are procedural by nature. Although qualitative process metrics are more difficult to document, record and report, they are not likely to require significant capacity building and do not demand sophisticated data management systems. Qualitative process metrics will still be relatively simple to establish and implement. However, qualitative process metrics will require significant local review and audit processes as part of the MRV development process. Like quantitative process metrics, qualitative process metrics are input metrics and do not provide any indication on their own of NAMA effectiveness or GHG emission mitigation quantification. They are primarily used to ensure the efficacy of processes and programs in conjunction with one or more other metrics, and to demonstrate that a NAMA is functionally operating as planned.

Examples of qualitative process metrics include documenting and reporting on the progress and outcomes of new institutions or working groups, actions implemented as a result from meetings held, and measurable competency improvements as a result of progress in educational programs. (8)

In the next table some metrics have been assembled as an example for this project.

NAMA: "Improve energy efficiency in public and commercial buildings"

Quantitative Financial metrics	Quantitative Process metrics	Quantitative Technical metrics	Qualitative Process metric
- Loans given to commercial sector in a differential rate for energy efficiency projects vs Expected - Public Funds spent in energy audits vs N° of energy audit completed. - Public funds spent in retrofitting public buildings vs Funds available for retrofit in public sector - Cost of retrofitting office building per square meter. - Fiscal benefits given to the commercial sector for ECM implemented.	- N° of efficient equipment installed in public sector vs. Expected - N° of efficient equipment installed in commercial sector vs. Expected - N° of energy audits completed and documented by public and private sector - N° of ECM proposed vs. ECM implemented effectively - N° of Certified Measurement & Verification Professional in Country.	- kWh*/yr saved in public and commercial buildings through ECM implemented and verified vs. Expected - USD/yr saved in public and commercial buildings through ECM implemented and verified vs Expected - GHG/yr saved in public and commercial buildings through ECM implemented and verified vs. Expected - Investment vs. GHG saved - Baseline follow up	- Assessment of behavior-based energy management outcomes following training.

Table 3 - Metrics for NAMA. * As it has been shown in previous documents, most of the energy consumption in public and commercial building is the electric energy. (5)

6.1.5 Data gathering mechanism

Since the government is the responsible for implementing the NAMA, it must define several points regarding the mechanism of data collecting for computing the savings that will be informed afterwards: *how, who and when.*

The first step is to define the total number of commercial and public buildings (the target). In general, is recommended to define the target as a customer category of the power utility, to easily track the target. This is especially useful to set a baseline and to perform the different baseline adjustment throughout the NAMA duration.

Systematize the collection of the energy savings evidence is a critical step to assure the success of the MRV that support this NAMA. This should be solved considering the available resources. Here it is presented some feasible possibilities to accomplish the data collection objectives.

A. Prepare a group of inspectors to check in a regular basis any energy efficient measure, oriented towards getting the evidence of the implementation. This mechanism could be more applicable to the public sector (some restrictions could exist in accessing information from the commercial sector). Therefore, its recommended that the inspector's coordination be in contact with the DNA to be aware of the internationally and domestically supported programs implementing ECMs, and contact ESCO company and other known energy professionals in order to inspect only buildings where energy audits have been performed. If not already available, the legal framework would need to be developed to obligate building owners and/or occupants to provide the information the inspectors will need.

B. Encourage the commercial sector to voluntarily present the evidence of implemented ECMs, for instance by giving fiscal discounts or some other incentives. In this case the Ministry in charge of implementing the NAMA should count on a group of technicians that could evaluate the ECM's savings presented. As an example, the government can incentivize the presentation of ECM projects in private and public sectors by a mechanism in which funds are awarded in relation to the amount of saved energy and the type of project, location, sector or other parameters. These benefits are not only oriented to gather this information in different sectors (industry, residential, transport, public office, etc.), but to promote investment in energy efficiency (an example in Uruguay of this mechanism is the EEC[9] : Energy Efficiency Certificates). Other similar mechanism would be to organize a national contest for the best energy efficiency projects in different areas.

C. Other alternative to get the information about savings is to persuade the energy professionals, as responsible for the ECM proposal and/or implementation, to voluntarily present evidence of ECM savings in order to be recognized by the Ministry as a Certified Professional if the ECMs are proven to be valid. This is a low-cost way of gathering data, since just an updated list of professionals who successfully presented ECMs savings needs to be published (in the Ministry's web site for instance). But, as the incentive is less attractive than option B it could be less effective.

It's necessary to consider the development of a legal framework for the correct functioning of these mechanisms. For instance, in case of the implementation of EEC tool to gather data, it is needed regulate the creation of non-refundable funds and the conditions to use it.

9 http://www.eficienciaenergetica.gub.uy/visualizar-contenido/-/asset_publisher/fnOFJTPAaHM7/content/tercera-convocatoria-de-los-certificados-de-eficiencia-energetica

6.1.6 Quality control

The responsible of monitoring in charge of assessing the ECMs and computing certified savings, should establish a mechanism to check the information received. This can consist on a random sampling of ECMs presented to evaluate the consistency of the savings vs. the total consumption of the building, or prepare an in-situ inspection, etc.

6.1.7 Baseline

Energy or GHG savings cannot be directly measured, because savings represent the absence of energy consumption. Instead, savings are determined by comparing measured consumption before and after the implementation of a program. The comparison of before and after energy consumption should be made on a consistent basis, using the following general M&V equation:

Savings = (Baseline Period Energy – Reporting Period Energy) ± Adjustments

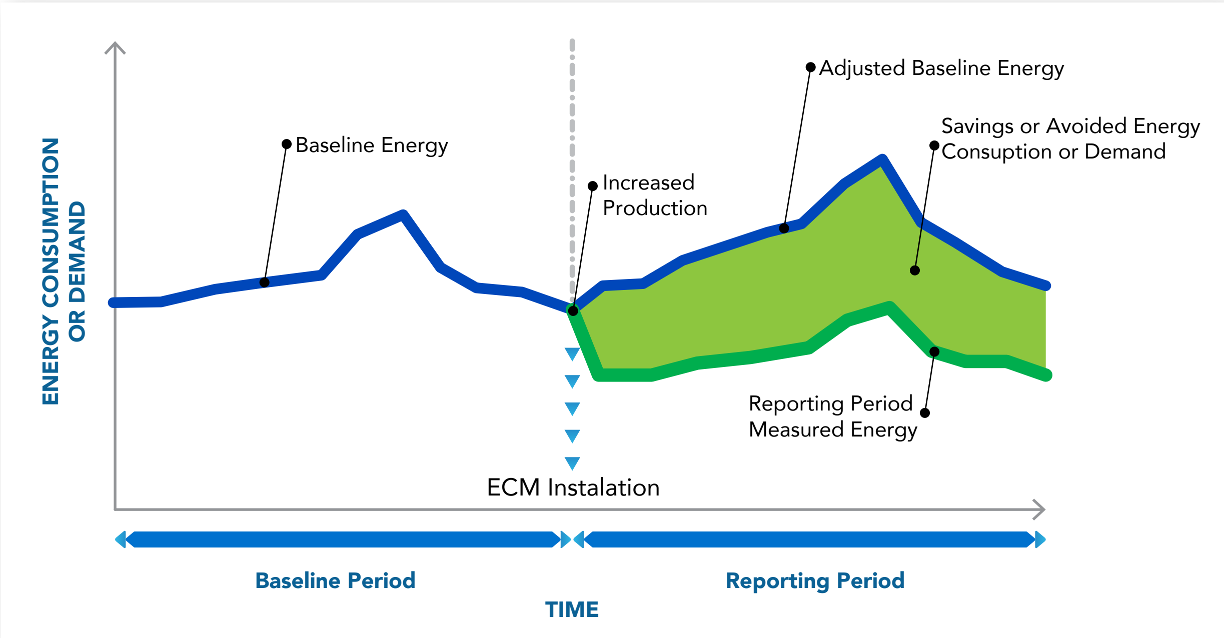


Figure 12 - https://evo-world.org/

When referred to measuring a specific metric, it is needed to establish a comparison pattern. The first step it to define the scope (the target).

The energy baseline is defined with the information from the initial energy baseline assessment and with the data that has been collected in an appropriate period of time. All changes to the energy-related performance must be measured and assessed on this basis. GHG baseline is easily calculated from the energy consumption baseline using the official grid emission factor of the country.

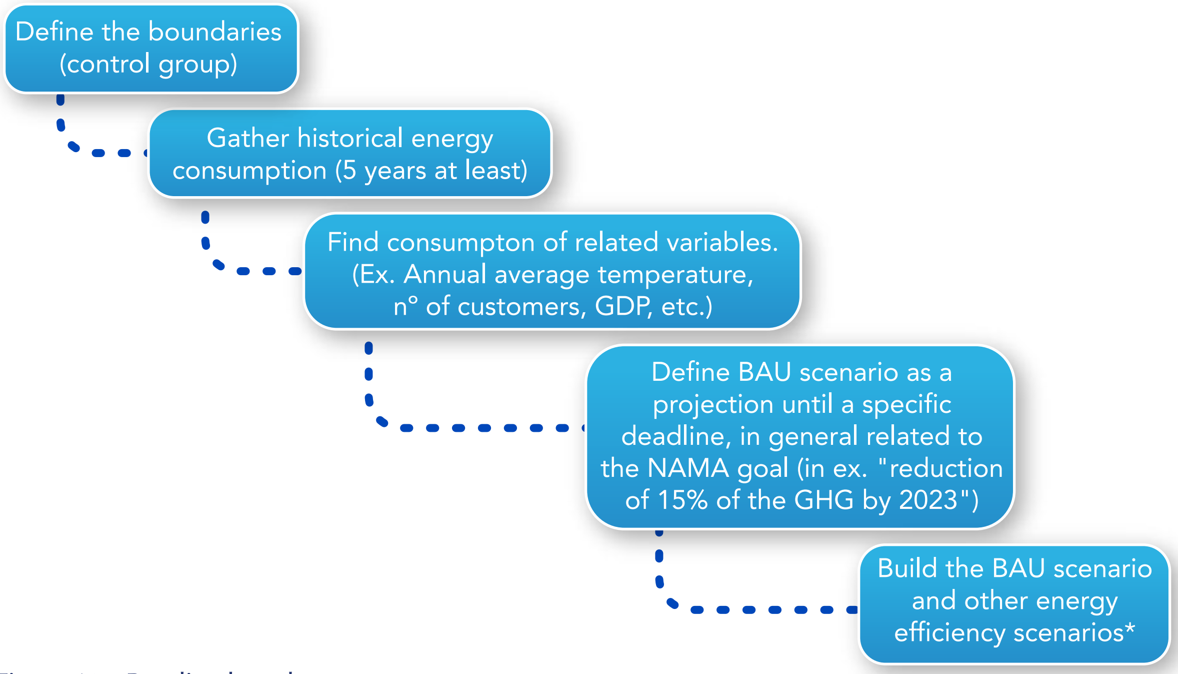


Figure 13 - Baseline key elements

*Other scenarios could be estimated based on the potential for energy savings for each sector.

With this data updated to the beginning year of the NAMA “year 0” is possible to generate the projection of the different BAU and EE scenarios (with different levels of ECM potential penetration). This is particularly useful to compare the total energy savings certified with the global consumption of the sector, and it could be seen as a quality control of the GHG savings that will be informed in the BURs.

In the next figure there is an example of Baseline in different scenarios (models), as shown is necessary the definition of a starting date, define a projection that should take into account the variables that affect the energy consumption of the sector (GDP, annual degree days, n° of customers within this categories) as a parametric adjustment. Is necessary to define a final date to establish the aim. The projection of the different EE scenarios predicts a gradual penetration until reaching the goal by the final year.

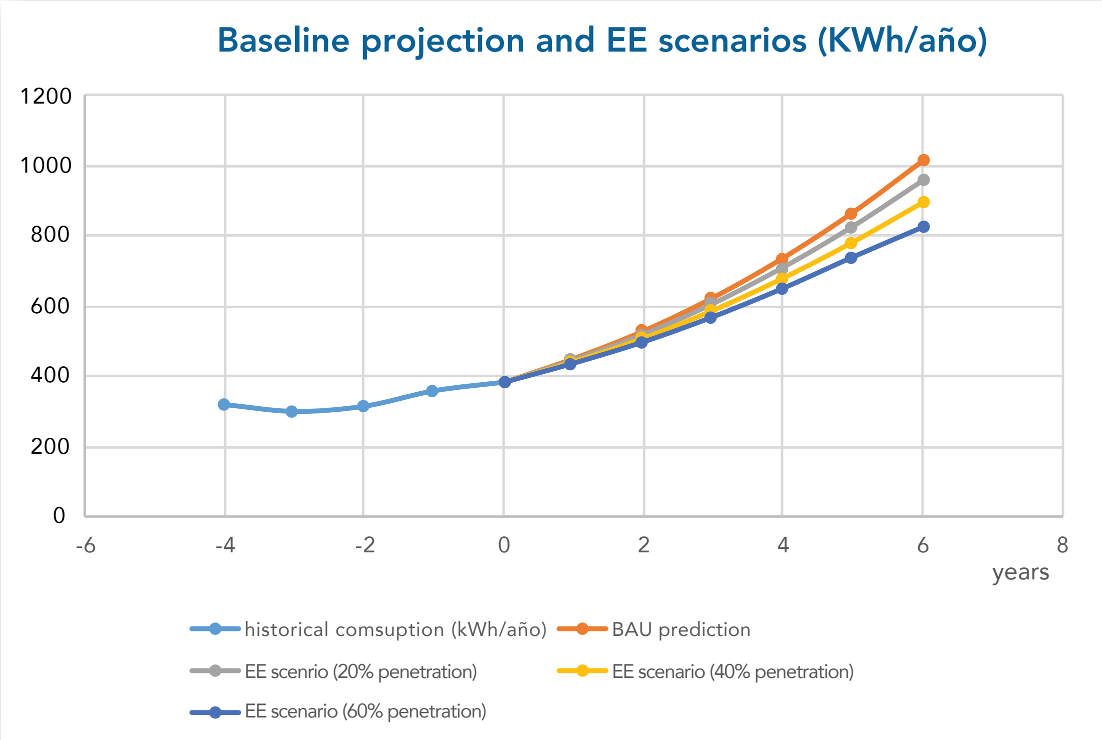


Figure 14 - Baseline projection example

6.1.7.1 Baseline update

On one hand, due to the *Gathering data mechanism* formerly exposed, the unit in charge of processing that information (*monitoring responsible*) would obtain the energy, GHG and cost savings of the documented ECMs implementation. On the other hand, developing a baseline and monitoring the global consumption of the complete public and commercial buildings is not an easy task but is quite useful as quality control to compare the certified ECMs savings. It's essential that the power *utility* plays a key role in this regard, as is the source of electrical consumption of the target sectors.

In the following years of the starting date of the NAMA, the *power utility* should inform the electric energy consumption of the target sectors as a whole. That consumption is going to be compared with the expected model year by year:

$$\Delta E_i \ (kWh/yr) = Real\ consumtion_i - (BAU_{(ex\text{-}post\ i)} - Certified\ savings_i)$$

Being:

Real consumption$_i$: The annual consumption of the target sector from *power utility* database in year *i*.

$BAU_{(ex\text{-}post\ i)}$: Is the result of updating the BAU model with the parameters of year *i*.

BAU= f(yr, GDP, annual degree days, n° of customers in the category). This function should be determined using historical data of energy consumption, assessing the correlation with the parameters mentioned. In case no correlation can be found, then the equation that best describes the behavior of the demand can be used.

Certified savings$_i$: The computing of energy savings resulting from the assessment of the ECMs results that come out from the *gathering data mechanism*.

Δ*E*: This "error" includes the model uncertainty and *saving leakages* or uncertified savings that could be obtained by the natural penetration of the new efficient technologies within the sector.

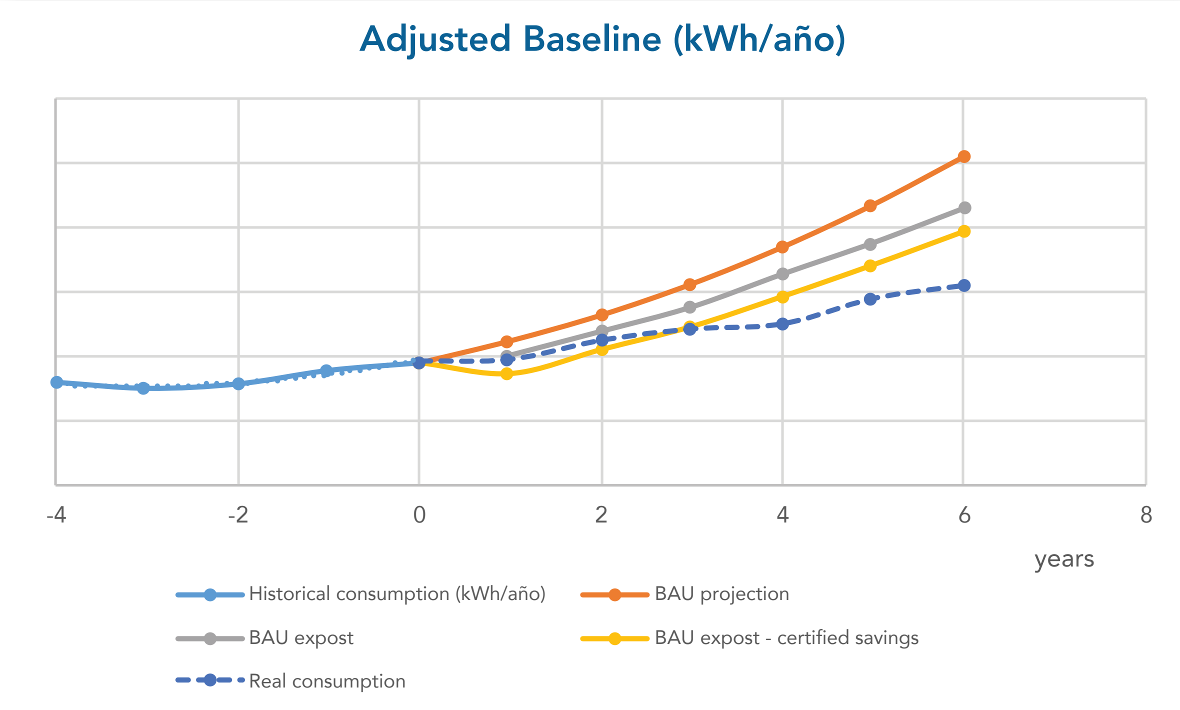


Figure 15 - Year by year evaluation of the baseline compared with the real consumption

6.2 Reporting

The first stage of the reporting process begins after gathering data is complete for the first year. The unit in charge of gathering, assessing and computing energy savings (monitoring responsible) should oversee elaborate the primary report with the qualitative and quantitative metrics compared with the expected value in each case. In this primary report the baseline update should be included.

This primary report has two main purposes, the first is to inform the verification responsible of the NAMA who is in charge of evaluating whether the NAMA aims are been accomplished or not and taking the decisions to correct it. Secondly, is the input to elaborate the BURs, or the second part of the reporting process that include GHG savings calculated by using the updated grid emission factor. The reporting responsible is in charge of elaborating the BUR that is presented to the DNA.

Countries that ratified the Paris agreement are required to report on their actions to address climate change in their National Communications (NC), which include information on the GHG inventories at a national level, adaptation, whole mitigation actions and their effects, constraints and gaps, support needed and received, and other information considered relevant to the achievement of the objective of the Convention. National Communications are to be submitted every four years (except for SIDs and LDCs) and prepared following the guidance contained in the revised guidelines for the preparation of national communications from non-Annex I Parties.

As it is shown in Figure 9, it's not mandatory to report domestic NAMA outcomes in the NC which implies for example, a GHG inventory for the target sector. Just BURs are required to be submitted to the Parties. In any case, this BUR can be considered as an input to the next NC if the country decided to include this category.

Figure 16 presents the information on domestic MRV of domestically supported NAMAs that needs to be **reported in the BUR** as laid out in the guidelines. When reporting on their domestic MRV in the BURs, non-Annex I Parties are encouraged to provide information on three key elements, including:

1. A description of the overall **institutional arrangements**, whether based on existing or new processes and systems;

- This includes information on the key domestic MRV processes, systems and arrangements, including institutional structures, legal and administrative framework, relevant information, methodologies and experts to be engaged. Where necessary, developing country Parties may choose to voluntarily set up new arrangements and processes for domestic MRV;

2. **A description of the approach used to measure domestically supported NAMA**.

This should include information on the systems for collection and management of relevant data and on how methodologies are being documented;

It should include:

- Detail of all energy audits done in the sector

- List the whole ECM proposed

- List of ECM effectively implemented and its corresponding savings (kWh/yr, GHG/yr and USD/yr) →ECM proposed vs ECM implemented,

- Other NAMA results (other quantitative and qualitative metrics)

- Describe the institutional arrangements in place to collect information and manage quality assurance (QA) and quality control (QC) through documentation of the methodologies and data sources used;

3. Finally, it should describe the approach used to conduct **domestic verification** of the information, including a description of experts engaged in the verification and the mechanisms of verification;

- This may include information on how the experts involved in the independent evaluation of information/verification are being selected and appointed (e.g. is there an accreditation process involved, and if so, what does it entail). (5)

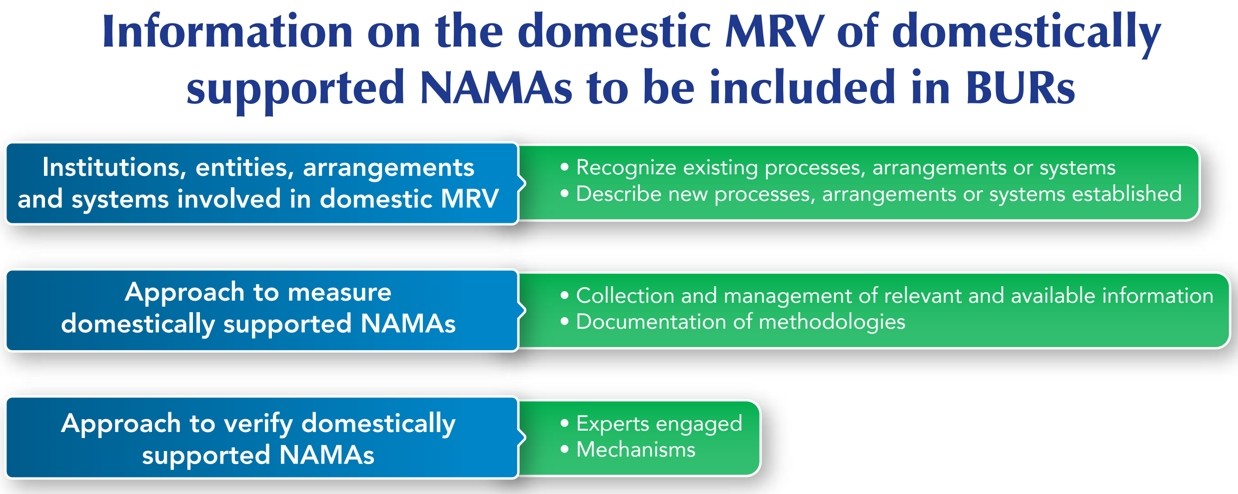


Figure 16 – Biennial Update Report for domestic MRV (5)

6.2.1 NDC Linkages

Another reporting action is the NDC (Nationally Determined Contribution) to the Climate Change secretariat. NDCs are submitted every five years to the UNFCCC secretariat, with the next round of NDCs (new or updated) being submitted by 2020. NDCs are recorded in the NDC registry which is publicly available and maintained by the secretariat. Modalities and procedures for the operation and use of this public registry are currently being negotiated under the Subsidiary Body for Implementation (SBI). The MRV outcomes of this specific NAMA should be reflected in these documents.

The Paris Agreement mentions only general principles and objectives for each of its chapters. Therefore, in the next COP that will take place in Poland (COP24), Parties are going to negotiate the implementation of a rulebook, which consist on a set of applicable and detailed rules based on these principles to explain who does what, when and how, in order to:

- Harmonize the content and timing of NDCs, for example on accounting for GHG emissions from agriculture and forestry
- Organize the global five-year stock take of GHG emission reduction efforts
- Establish the transparency framework
- Structure international cooperation mechanisms, in terms of financing with the mobilization of USD 100 billion, technology transfers and capacity building between developed and developing countries.

6.3 NAMA Linkages

NAMAs will rarely be stand-alone activities. Emerging from a more strategic planning process they will most likely represent concerted actions that include several **mitigation activities** and many **different sources of funding**, and all must document their effect. It is essential that these linkages are not lost in the registration and reporting on each single NAMA. In many cases such concerted actions involve more than one governing institution which will lead to activities that involve a range of different stakeholders. The delay or overachievement of one NAMA may directly affect the implementation of another. Keeping track of activities, with a view to coordinating these activities and optimizing their impact, requires transparent reporting systems. For this reason, is it recommended to designate a Designated National Authority (DNA) or a Central Coordinating Unit (CCU), which is in charge of centralizing the information about different NAMAs with the same or similar goals.

The designated DNA or CCU needs to have the capacity to take the following responsibilities and capacities:

»» It must incorporate reporting from all line ministries and their regulatory bodies and keep a constantly updated registry of relevant policies and projects.

»» It must possess the capacity, in collaboration with the line ministries, to record the effects of regulatory initiatives (policy NAMAs that are actions in themselves) compared to a baseline scenario.

»» It must have sufficient knowledge to oversee the application of relevant methodologies for assessments of emissions reduction from concrete project activities and sufficient capacity to support national and international verification teams.

»» It must be able to devise, and employ, principles for distribution of reduction effects of related NAMAs (8).

For instance, OLADE-PALCEE, GEF-UNEP Energy for Sustainable Development (ESD) in Caribbean Buildings Project, 11th European Development Fund (EDF-11), PAHO Smart Hospitals, among others, are ongoing projects that have and will finance energy audits and ECM implementations in public and commercial buildings in Caribbean countries. The reporting responsible of the MRV who ideally is the already exiting DNA, should assess the whole contribution to the specific NAMA aims.

6.4 Verification

At the national level, verification is implemented through domestic MRV mechanisms to be established by non-Annex I Parties, general guidelines for which were adopted at COP 19 in 2013. Provisions for verification at the domestic level that are part of the domestic MRV framework are to be reported in the BURs. In international MRV the verification is addresses through ICA of BURs.

Typically, the competent authority addresses this process, and it would be in charge of evaluating the progress made on reaching the aims of the NAMAs. In the case of quantitative NAMAs the progress can be evaluated as a percentage. Qualitative NAMAs are also evaluated but instead through metrics that can show the efficacy of undertaken activities. Verification in the case of domestically supported MRV, implies the evaluation of actions taken to correct and redirect efforts.

Accreditation is a critical part of any MRV system as it outlines not only who is responsible for the verification of the Monitoring Reports but also defines the competence of the personnel and/or system. Under the existing schemes MRV systems have relied on the accreditation of third party auditors. However, other types of accreditation can be applied. For example, an accreditation module that relies on either first party or second party auditors. Even assigning a government body to perform the verification constitutes a level of accreditation, although third party verification is generally regarded as more reliable, not least because more direct competency requirements can be imposed.

After a verification process of the exiting NAMA there are some possible steps to be taken:

- Correct through clear directives given by authority in the scope of public sector
- Consequences of failing to meet the requirements, i.e. penalties or withdraw financial support, avoiding taxes benefits, etc.

In the case of international supported NAMAs the failing to meet the requirement may lead to a finance support withdraw from international institutions providing funds.

The mechanism of an MRV results similar to the Deming cycle or the wheel of continuous improvement. As it needs to correct the deviation from the proposed objectives. The frequency, the responsibilities, the material resources must be defended as part of the MRV, in order to let it function properly. The specific context of the country needs to be taken into account to develop an effective system.

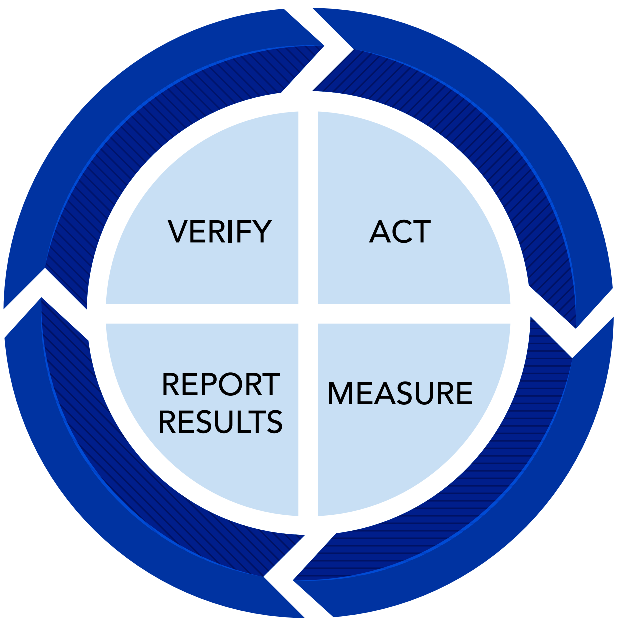


Figure 17 - Deming Cycle

7 Stakeholders

If applied to NAMAs development, it is suggested that the ultimate responsibility for implementation and control of NAMA will lay with the Host Country, assigning clearly defined authorization and responsibilities to the institutions working within the scheme. This is particularly important under the assumption that NAMAs will generally be spread over a number of different ministries within the host country.

Stakeholders form an integral part of the Project by performing various roles, ranging from implementing partners to supporting trade associations, and all of whom are expected to contribute to achieving outcomes and meeting the goals of the project. These stakeholders could include the key partners like governmental actors, regional institutions, private sector entities, external parties such the Associations of Engineers and Architects, and suppliers of energy-efficient appliances and equipment. Stakeholders are identified as playing a critical role in the project. These included the following:

- Ministries responsible for the Environment
- Ministry responsible for Energy
- Designated authority
- Ministry of Finance
- Major equipment suppliers
- Association of Professional Engineers and Architects
- Educational institutions
- Electrical utilities
- Energy Service Companies and energy professionals
- National Development Banks
- External financial and technical supporters (CCCCC, UNEP, GEF, OLADE)
- DNA or CCU
- The public and private buildings occupants (target in this NAMA)

The role of each of the major stakeholders need to be clearly identified in the project, including, as expected, governmental ministries entrusted with responsibilities for the development of policy directives and providing the overarching intra-governance structure to ensure consistency in the development of the NAMA and the MRV that support it. The DNA is involved in the elaboration of the two National Communications to the UN through the GHG inventory team. For that reason, is expected that this entity already has the technical capacity to develop BURs or to coordinate a team to develop it.

As was formerly said, the grid emission factor is an input to elaborate the BUR and need to be updated. In general, updating the grid emission factor relies in the orbit of the Environment Ministries.

The Ministry responsible for Energy must designate a permanent working group and be designated as *monitoring responsible* for the MRV. This unit must be in charge of gathering, assessing the ECMs documentation, computing the energy savings and elaborating the *primary reporting*. The human resources need to be in accordance with the responsibilities, it's therefore necessary to evaluate the expansion of human resources and/or the hiring of external consultants to properly meet the requirements. Improving capacity building should also be taken into account.

It is expected that the *designated authority* be the ultimate responsible for NAMA success and the *verification*, and is also in charge of designate the monitoring and reporting responsible, create the working groups, evaluate the required resources, etc.

Ministries of Finance have a critical role to play in ensuring the success of the project not just for providing in-kind support, but also for the development of new policies which would make financing of EE/RE initiatives more attractive. For instance, evaluating the resources to implement an Energy Audits funding programme, or to create a non-refundable fund to enable the possibility of implementing an EEC as formerly exposed. Also, is the best suited organization to monitor the resources coming from international funds, what can be used as financial metrics.

The **ESCO and energy professionals** identified were also expected to play critical roles in helping with the development of energy audits and ECM proposals. In that regard, the issue of training, knowledge transfer and public awareness-raising initiatives require the involvement of these **professional groups, educational institutions** and electrical utilities, throughout the region, working in close partnership with the implementing agencies.

The Electric utility plays a key role, being the source of inputs to elaborate the baseline and subsequent baseline updates.

External financial and technical supporters like CCCCC, UNEP, GEF, OLADE, etc. are taking an important role by financing and monitoring many programs already described in "NAMA Linkages" that impulse energy audits performance, improve capacity building of local staff and professionals, etc.

In figure 18 there is a flow chart of the activities of the MRV and the suggested responsible for each one. Taking into consideration, the circumstances and barriers that can affect the project, a more conservative approach to reach to NAMA and MRV success is to focus on the first stage at the beginning (marked in the figure) and develop the second stage just after the correct functioning of the first stage is assured.

In table 4 there is a suggestion of the responsibilities assignation which should be check with the implicated.

Responsibility	Stakeholder
Designated Authority	Ministry responsible for Energy
MRV operational implementation team	External consultants and internal technicians
Auditors	ESCO, energy professionals, external consultants, etc.
Monitoring responsible	Ministry responsible for Energy
Verification responsible	Government authority
Reporting BUR responsible	DNA

Table 4 - Stakeholder denomination

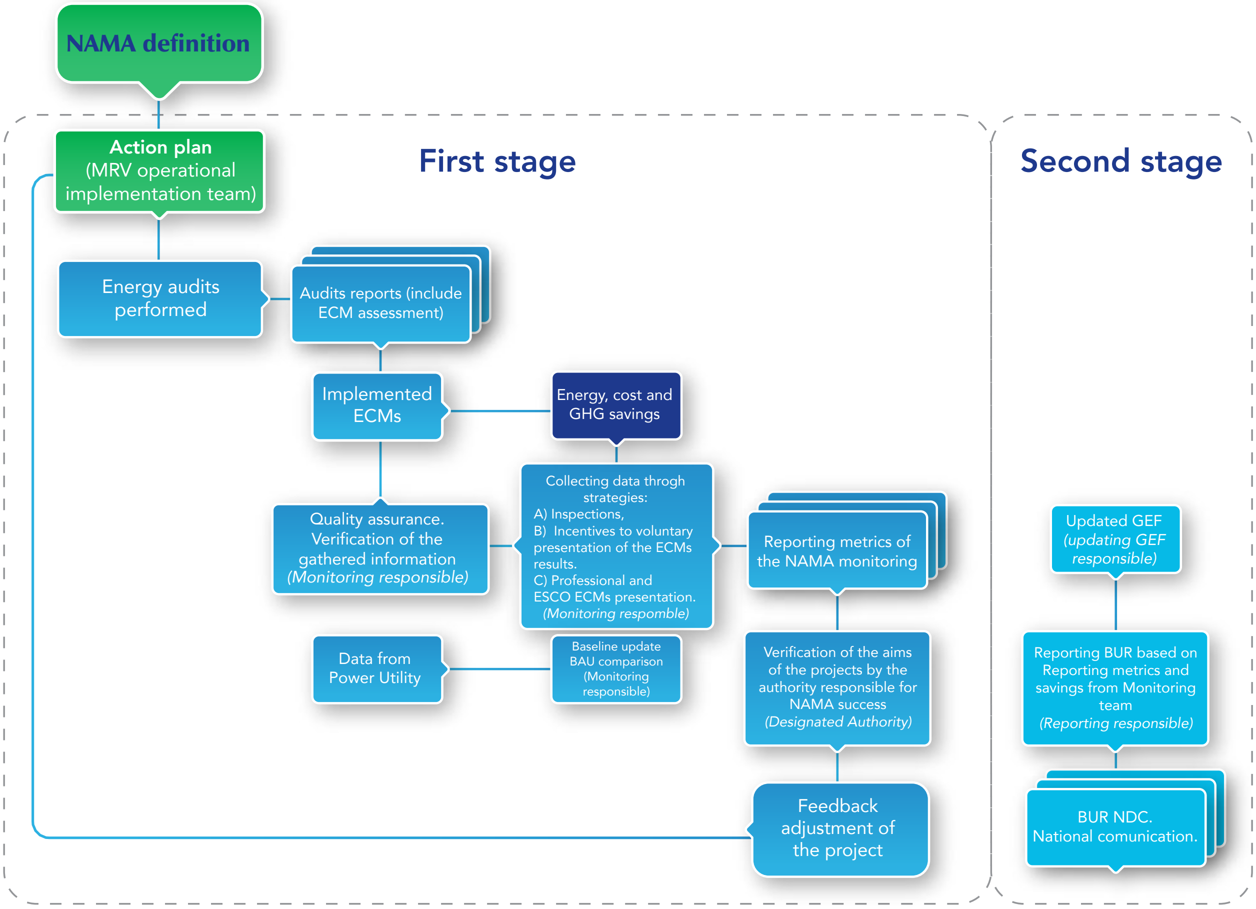


Figure 18 - MRV flow chart

8 Possible barriers

Below there is a list of possible barriers detected in the formulation of the MRV methodology in the Caribbean countries, none of which is insurmountable.

- **If there are no MRV already implemented in the country**
  There is no previous experience with the implementation of an MRV process to rely on, and therefore no internal source of consultation.

- **No previous experience in BURs or NC presentation**
  With BURs already presented there would be existing domestic processes, arrangements and systems in place to base the MRV or utilize some of the same.

- **Additional work demand on the Government structure**
  Many of the tasks that will be necessary for the implementation of the MRV will rely on personal of the Ministry responsible for energy. It will be necessary to count with technical staff to review and approve the energy audits and the information regarding the ECM.

- **Lack of incentives for the private and public sectors to report on implemented ECM**
  If there is no framework and/or incentives for implementers and building owners to report the energy efficiency implementations, these will need to be developed.

- **Capacity for data management**
  Data base management requires a proper structure, this could be a bottleneck if the capacity is not developed.

- **Lack of a record of ESCO companies and energy professionals**
  Not having an open record of professionals recognized by the Ministry makes more difficult the connection of facility owners (party interested in having an energy audit or implementing an ECM) with an energy professional. Also, the implementation of a record promotes ESCO companies and energy professionals providing trust, and ultimately promoting energy efficiency actions.

- **Lack of an annual update methodology for the grid emission factor**
  It would be convenient that the country annually update its grid emission factor to provide more accuracy in GHG emissions calculations. This information should be published of open access to facilitate the calculation for energy professionals.

- **Lack of a grid technical losses publication**
  The technical losses of the grid are needed to calculate the amount of energy saved at the generation level, this will be added to the energy saved at the demand level (reported) to calculate the GHG emissions reductions. For the distributor it is relatively easy to obtain the distribution losses, these are a combination of the technical and non-technical losses. The difficulty is to obtain the non-technical losses.

- **No professionals certified in M&V protocols**
  In the second stage, if the application of a protocol is decided then the country would need to start a campaign to certify professionals from the government and private sector.

Besides the barriers presented above, there are also the barriers for the implementation of ECMs, needed as an input for the MRV.

A number of possible barriers prevent the realization of energy efficiency measures. These barriers can be summarized as (7):

- Agency barriers—when the person who decides what equipment a property should use is not the same person who pays for operating expenses.
- Information barriers—people are not familiar with the energy efficiency equipment they could be using, or they mistrust the information that they have received about that equipment.
- Regulatory barriers—in some cases regulations, may inadvertently incentivize inefficient behavior.
- Market barriers—some efficiency equipment may be difficult to find or may be too expensive.
- Financial barriers—energy consumers may not be able to obtain financing on acceptable terms to invest in energy efficiency equipment.
- Skills barriers—service providers may not have the skills necessary to provide the professional services required to allow efficiency investments to happen.
- Register the auditory results and follow the progress of the implementation in a systematic way.

Potential financial constraints and gaps may, among others, include:

- Difficulties in mobilizing, accessing and delivering financial resources (e.g. understanding the different reporting requirements by donors such as in project proposals and financial reporting; fragmentation of and lack of harmonization of donor landscape);
- Difficulties in collecting information on financial resources available to implement activities that have multiple uses or climate change co-benefits;
- Technical constraints on how to collect and store data on climate change finance;
- Institutional challenges relating to the coordination of climate change finance.

Technical and technological barriers and challenges may include:

- Difficulties encountered in accessing and mobilizing technical assistance;
- Constraints related to the collection, classification, documentation and archiving of information on technical assistance available to implement activities that have multiple uses or climate change co-benefits;

- Institutional challenges relating to the coordination of technical support;
- Difficulties in accessing low-carbon technology;
- Lack of local skills to operate and service a technology. Capacity-building related barriers, challenges and bottlenecks may include:

Difficulties encountered in accessing and mobilizing capacity-building support related to:

- The availability of trainers and demand-driven capacity-building;
- The scope and depth of the training.

Constraints related to the collection, collation, classification, documentation and archiving of information on capacity-building support available to implement activities, measures and programmes that have multiple uses or climate change co-benefits:

- The availability of information on capacity building support in a disaggregated manner;
- Institutional challenges relating to the coordination of capacity-building support;
- Challenges relating to enhancing and retaining capacity built. (5)

9 Financial support

The implementation of the MRV in the buildings sector requires financial resources for several activities. What follows is a description of the activities that may need financing:

- **MRV operational implementation team**

  The final version of the MRV methodology to be implemented will require substantial work for the determination of all the aspects. These aspects include: defining the legal framework, the necessary financial resources, the financial support acquisition and the technical definitions. These activities require a multidisciplinary team to be formed from members of the government and potentially with external consultants.

- **Resource expansion**

  The *monitoring responsible* will need to expand its resources in order to take over the tasks of the MRV. This means additional human resources and additional expenses.

- **Capacity building of the monitoring team**

  Technical training for the members of the monitoring team to acquire the capacities to evaluate energy audit reports, implementation measures and data handling.

- **Data management capacity**

  The data management methods will require design including the database.

- **MRV presentation workshop and promotion**

  The MRV methodology will require communication activities such as a workshop between all parties, manuals preparations and distributions, etc.

- **External consultants**

  Some activities may be more appropriate if they were outsourced to consultants. Some of these activities could be, for instance, the annual baseline update, annual grid emission factor update, reporting activities.

- **M&V protocol certifications**

  In the case of adopting an M&V protocol, then professionals from the responsible organizations and from the private sector will need to be certified in it. Potentially the government can subsidize the cost of certification for the private professionals as a way to promote the adoption of the protocol.

- **EEC fund creation and management**

  In the case of adoption of this mechanism to incentivize the reporting of implemented ECM, a non-returnable fund will need to be created and annually funded. These funds will be used to award an amount in relation to the energy savings of the reported ECM. This mechanism is used to incentivize the private sector.

Financing of other activities to promote the adoption of the MRV.

- **Energy Audits project funding**

  If an MRV is implemented, then it will need a constant flow of ECM to be reported. As a way of incentivizing the generation of energy audits, and by that also training professionals of the public and private sectors, is that such a programs can be used. The program's main objective could be the generation of energy audits in a certain number of buildings, and as a result, the generation of several ECMs. Energy professional would be paid a fix amount to do level 2 energy audits in selected buildings and present reports. The monitoring responsible would evaluate the reports according to requirements to be established. This is a non-returnable fund.

- **ECM implementation promotion fund**

  A different fund can be used to promote the implementation of ECM and therefore generate the energy, costs and GHG savings. This fund can be used to provide loans for the implementation of the ECM generated in the Energy Audits program. The loans would be repaid using the savings generated by the implementation of the ECM. This program can guarantee the flow of ECM reported to the monitoring responsible of the MRV. The program can be used as a training program for all parties and can be discontinued once enough ECM implementation and reporting capacities are developed.

10 Roadmap

In the next flowchart, basic steps to develop an MRV for the **first stage** are described. All these suggestions are justified in this document in the corresponding chapters.

Define the NAMA aim

- Define which type of NAMA. Whether the NAMA will be a domestic one, an international suported NAMA or a possibly credit NAMA.
- Requirement: define an achievable quantitative goal. Ex.: Savings goals in a defined period of time.
- Decide whether the aim is to evaluate the already existing plans or to implement new policies to improve energy eficiency in public and commercial buildings. (Ex. Energy audits programme, ECM implementation promotion programme) or both.

Define the MRV target

- As formerly discuss is it necessary to define whether the target is defined by power utility current customers categories or other ways.

Define the MRV operational team

- Hire or designate external consultants and internal experts to develop the operational ACTION plan to develop the MRV and be in charge of monitoring the whole process, be in touch with the principal stakeholders.
- Output: ACTION plan draft for each activity of the MRV.

Assess NAMA linkages

- Assess the specific contribution of the already existing programmes. This is a key step if the resulting NAMA is a project or a political based NAMA.

Define metrics & project performance indicators

- Quantitative and qualitatives metrics. This is a continuous improving process since metrics can be changed, adapted, improved or removed if they result useless.

Define datagather mechanism

- Evaluate costs, financial requirements, national circumstances, legal framework

Define capacity buildings needs

- To perform energy audits
- To assess ECM and compute savings
- To update baseline
- To report savings
- To develop a BUR

Define responsibilities allocations and HR expansions

- Define the responsibilities, and the dedication time needed, human resources needed, etc.

Workshop to present the ACTION PLAN draft to main stakeholders

- Should be organized by the MRV operational implementation team.
- The ACTION plan should include a very detailed procedure for each MRV structural block and what is needed to be done by the different actors. Indentify the posible bottlenecks, how it's expected to overcome them.
- Outcomes: Milestones and timelines proposal

Approve ACTION PLAN & Gantt Chart

- After the Workshop there is an instance of action plan correction and the operational team elaborate a final version that needs to be approved by the main stakeholders

Baseline creation

- It is needed that the power utility informed at least five years of electric energy consumption of the objetive defined.
- Define HR needed to elaborate the Baseline
- Create baseline model (define significant variables), BAU scenario, EE scenarios.

Database creation

- Once a data gathering mechanism is defined, and the action plan is approved, it is necessary to define a database in order to register ECMs related data.

Evaluation

- After 1 year of MRV implementation, it is recommendable that the *operational team* evaluate the process and recomend changes if necessary.

11 Conclusion

This MRV proposal is oriented to energy efficiency implementation measures for commercial and public buildings in the Caribbean countries. Nevertheless, some general ideas can be used in any kind of MRV.

MRV is a quite new concept, so as BURs communications, and is possible that no previous experience exist in the country, therefore it was recommended to take an approach of two stages for the implementation of the MRV. The first stage contains the domestic activities that need to be implemented; all the processes, arrangements and systems will be new. After this stage, the MRV will be ready for the inclusion of an M&V protocol and for the inclusion of the MRV in the BURs and NDCs. Therefore, it was decided on an approach on a Domestic MRV at the beginning.

In any case, the NAMA definition is a critical aspect before an MRV implementation. These two concepts are closely related, an MRV always support a NAMA and the aims and the target must be clearly defined.

Besides the definitions, the implementation would need to overcome some barriers such as expanding human resources and building capacity, assure the generation of implemented ECM, incentivize buildings to report on the implementations, increase capacity for data management, among others.
The MRV is an important tool devised by the parties to communicate one another of the mitigation actions they have taken on the fight against climate change. Moreover, the implementation of a MRV in energy efficiency it would be an important action forward, and its outcomes can reflect the effort regarding this matter in the country Nationally Determined Contribution.

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Anexo 1: IPMVP[10]

- Purpose and scope

Since 1997, Efficiency Valuation Organization (EVO) develops, maintains, improves and publishes the International Performance Measurement and Verification Protocol (IPMVP). The IPMVP was originally developed to help increase investment in energy and water efficiency, demand management and renewable energy projects around the world.

The IPMVP promotes efficiency investments by the following activities.

IPMVP documents common terms and methods to evaluate performance of efficiency projects for buyers, sellers and financiers. Some of these terms and methods may be used in project agreements, though IPMVP does not offer contractual language.

IPMVP provides methods, with different levels of cost and accuracy, for determining savings either for the whole facility or for individual energy conservation measures (ECM).

- Contents

IPMVP Volume I defines M&V in Chapter 2, presents the fundamental principles of M&V in Chapter 3, and describes a framework for a detailed M&V Plan in Chapter 4. The details of an M&V Plan and savings report are listed in Chapters 5 and 6, respectively. The requirements for specifying use of IPMVP or claiming adherence with IPMVP are shown in Chapter 7. Volume I also contains a summary of common M&V design issues, Chapter 8, and lists other M&V resources. Twelve example projects are described in Appendix A and basic uncertainty analysis methods are summarized in Appendix B. Region-specific materials are in Appendix C. Specific guidance for different types of users is in Appendix D. IPMVP Volume II provides a comprehensive approach to evaluating building indoor environmental-quality issues that are related to ECM design, implementation and maintenance. Volume II suggests measurements of indoor conditions to identify changes from conditions of the baseline period. IPMVP Volume III provides greater detail on M&V methods associated with new building construction, and with renewable energy systems added to existing facilities. IPMVP Volumes I and III are a living suite of documents, with the latest modifications available on EVO's website (www.evo-world.org). Volume II is now found in the archives of the EVO website.

IPMVP specifies the contents of a Measurement and Verification Plan (M&V Plan). This M&V **Plan adheres to widely accepted fundamental principles of M&V and should produce verifiable savings reports**. An M&V Plan must be developed for each project by a qualified professional.

IPMVP applies to a wide variety of facilities including existing and new buildings and industrial processes.

10 https://evo-world.org/

- Principles of M&V reports

Good M&V practice is based on six fundamental principles as described below.

Accurate

M&V reports should be as accurate as the M&V budget will allow. **M&V costs should normally be small relative to the monetary value of the savings being evaluated**. M&V expenditures should also be consistent with the financial implications of over- or under-reporting of a project's performance. Accuracy tradeoffs should be accompanied by increased conservativeness in any estimates and judgments.

Complete

The reporting of energy savings should consider all effects of a project. M&V activities should use measurements to quantify the significant effects, while estimating all others.

Conservative

Where judgments are made about uncertain quantities, M&V procedures should be designed to under-estimate savings.

Consistent

The reporting of a project's energy effectiveness should be consistent between:

- different types of energy efficiency projects;
- different energy management professionals for any one project;
- different periods of time for the same project; and energy efficiency projects and new energy supply projects.

'Consistent' does not mean 'identical,' since it is recognized that any empirically derived report involves judgments which may not be made identically by all reporters. By identifying key areas of judgment, IPMVP helps to avoid inconsistencies arising from lack of consideration of important dimensions.

Relevant

The determination of savings should measure the performance parameters of concern, or least well known, while other less critical or predictable parameters may be estimated.

Transparent

All M&V activities should be clearly and fully disclosed. Full disclosure should include presentation of all the elements. It is important to determine which evidence is going to be asked as mandatory to assure the correct verification of the ECM, as a result of a cost/benefit evaluation. For instance:

- Inspection of second or third parties
- Pictures of the new installation
- Efficient equipment invoice
- Measurement of instantaneous power consumption and other variables
- Measurement of short- or Long-term power consumption and other variables

The key element of the application of this protocol is the need of measurements to validate the savings, and for this the protocol offers 4 options to choose from. Different requirements are asked depending on which option it is decided to use, and that depends on the characteristics of the ECM to be evaluated. In the next table each option is described.

IPMVP Option	How Savings Are Calculated	Typical Applications
A. Retrofit Isolation: Key Parameter Measurement Savings are determined by field measurement of the key performance parameter(s) which define the energy use of the *ECM's* affected system(s) and/or the success of the project. Measurement frequency ranges from short-term to continuous, depending on the expected variations in the measured parameter, and the length of the *reporting period*. Parameters not selected for field measurement are estimated. *Estimates* can based on historical data, manufacturer's specifications, or engineering judgment. Documentation of the source or justification of the *estimated* parameter is required. The plausible *savings* error arising from *estimation* rather than measurement is evaluated.	Engineering calculation of *baseline* and *reporting period energy* from: • short-term or continuous measurements of key operating parameter(s); and • *estimated values.* *Routine* and *nonroutine adjustments* as required.	A lighting retrofit where power draw is the key performance parameter that is measured periodically. Estimate operating hours of the lights based on facility schedules and occupant behavior.
B. Retrofit Isolation: All Parameter Measurement *Savings* are determined by field measurement of the energy use of the *ECM*-affected system. Measurement frequency ranges from short-term to continuous, depending on the expected variations in the *savings* and the length of the *reporting period.*	Short-term or continuous measurements of *baseline* and *reporting-period energy, and/or engineering* computations using measurements of proxies of *energy use.* Routine and nonroutine adjustments as required.	Application of a variable- speed drive and controls to a motor to adjust pump flow. Measure electric power with a kW meter installed on the electrical supply to the motor, which reads the power every minute. In the *baseline period* this meter is in place for a week to verify constant loading. The meter is in place throughout the *reporting period* to track variations in power use.

Table 5 - IPMVP Options A and B (https://evo-world.org/)

IPMVP Option	How Savings Are Calculated	Typical Applications
C. Whole Facility Savings are determined by measuring energy use at the whole facility or sub-facility level. Continuous measurements of the entire facility's energy use are taken throughout the reporting period.	Analysis of whole facility baseline and reporting period (utility) meter data. Routine adjustments as required, using techniques such as simple comparison or regression analysis. Non-routine adjustments as required.	Multifaceted energy management program affecting many systems in a facility. Measure energy use with the gas and electric utility meters for a twelve month baseline period and throughout the reporting period.
D. Calibrated Simulation Savings are determined through simulation of the energy use of the whole facility, or of a sub-facility. Simulation routines are demonstrated to adequately model actual energy performance measured in the facility. This Option usually requires considerable skill in calibrated simulation.	Energy use simulation, calibrated with hourly or monthly utility billing data. (Energy end use metering may be used to help refine input data.)	Multifaceted energy management program affecting many systems in a facility but where no meter existed in the baseline period. Energy use measurements, after installation of gas and electric meters, are used to calibrate a simulation. Baseline energy use, determined using the calibrated simulation, is compared to a simulation of reporting period energy use.

Table 6 - IPMVP Options C and D (https://evo-world.org/)

- Certified Measurement & Verification Professional (CMVP) Program

The Efficiency Valuation Organization (EVO) is the exclusive global training body for the Certified Measurement & Verification Professional® (CMVP). In conjunction with the Association of Energy Engineers (AEE), the CMVP program was established with the dual purpose of recognizing the most qualified professionals in this growing and critical area of the energy industry, and to raise the overall professional standards within the measurement and verification (M&V) field.

The right to use the CMVP title is granted to those who demonstrate proficiency in the M&V field by passing a four-hour written exam and having the required academic and professional qualifications. EVO's certification level training must be taken to prepare for the exam and as a review of basic principles for experts.

Annex 2: Example of a Plan for Measurement and Verification

Plan for Measurement and Verification

Client's name

Energy efficiency in lighting, replacement of lamps for LED

Protocol option chosen: A

Opción A

Date:	July 2018

IPMVP version: IPMVP Volume I EVO 10000-1:2010[11]

FACILITIES WHERE THE MEASURE IS IMPLEMENTED:

M&V PLAN DEVELOPER:

International Performance Measurement and Verification Protocol

This model makes explicit reference to performance measurement and the International Performance Verification Protocol (IPMVP) 10000-1: 2010, published by the EVO Organization (Efficiency Valuation Organization), and is available at www.evo-world.org.

OPTION A:

The measurement of key parameters. The energy quantities can be derived from a calculation using a combination of the measurements of certain parameters and the evaluations or estimates of the others. These evaluations should only be used when the combined uncertainty of all these evaluations will not significantly affect the reported savings.

OPTION B:

The measurement of all parameters, which excludes any estimate. As a result, it is required to measure the energy quantities and parameters needed to calculate the energy consumption.

OPTION C:

Use counters from the energy supplier or sub-meters to assess the energy efficiency of the entire site.

OPTION D:

Calibrated simulation. It involves the use of a computer simulation program to predict the consumption of the installation in one or both terms of the equation.
Next, the document with the Measurement and Verification Plan of the savings to be developed is presented.

1. Energy efficiency project's objectives

The advancement of technology in LED lighting has reached a point where it is possible to achieve significant energy savings with reliable luminaires, making possible the profitability of energy efficiency projects by replacing lamps. In turn, LED technology offers other benefits such as a longer service life and lower depreciation of the luminous flux.

The objective of the project is to replace the current lamps so that the quality characteristics of the current lighting are maintained using less energy. The following changes are described below:

Nº	Type	Power (W)	Replacement	Power (W)
L1	Lamp type 1	L1	LED lamp type 1	18
L2	Lamp type 2	L2	LED lamp type 2	9
L3	Lamp type 3	L3	LED lamp type 3	4
L4	Lamp type 4	L4	LED lamp type 4	7
L5	Lamp type 5	L5	LED lamp type 5	26
L6	Lamp type 6	L6	LED lamp type 6	40
L7	Lamp type 7	L7	LED lamp type 7	7
L8	Lamp type 8	L8	LED lamp type 8	11
L9	Lamp type 9	L9	LED lamp type 9	6
L10	Lamp type 10	L10	LED lamp type 10	8,5
L11	Lamp type 11	L11	LED lamp type 11	26
L12	Lamp type 12	L12	LED lamp type 12	160

Table 7 - Lamp types contemplated and its replacements

2. IPMVP selected option and boundaries:

Option justification

IPMVP version: IPMVP Volume I EVO 10000-1:2010.

We have chosen to use option A of the protocol: Measurement of the key parameter.

This option is the one that best adapts to the characteristics of the project. Option D (perform simulations) is not allowed by the protocol because this is an existing installation. On the other hand, using the facility's general energy meter to calculate the savings would be difficult due to the high variability of all the loads, included and excluded from the current project, so it is not possible to use option C of the protocol. Option B would involve the measurement of all parameters, in this case all hours of use should be measured. This option would involve a prohibitive cost in terms of the number of meters that should be installed, and therefore is discarded.

The remaining option is A, the key parameter of the installation is the active and reactive power demanded by the luminaires to be replaced. The parameter to be estimated are the hours of use. The estimation of hours of use arises from surveys at the facility and is in common agreement between the facility and the consultant.

On the other hand, in this type of installation, it can be considered acceptable that the power of the luminaires has a value that can be considered constant over time. This allows that the verification of the power consumed can be verified by making instant measurements of a specimen by type of lamp to be changed.

Limits of the Energy Efficiency Measure

The limit of the measurement in this case is reduced to the lighting fixture itself. There is a cross effect outside the measurement limit related to the savings in thermal conditioning, due to the thermal contribution of the lamps that is being avoided in the future scenario, it produces a decrease in the energy need for cooling. However, this effect is counteracted during the winter months, where the areas are heated. It is considered that both effects are counteracted so that the final effect is zero.

3. Reference: period and energy

a) Reference period identification

The reference period corresponds to the duration of the measurement of the key parameter of the luminaires in the baseline scenario. The duration of the measurement will be 30 seconds per luminary, period in which it must be verified that the reading of the measurement remains stable.

b) Reference conditions

The lighting levels in certain areas of the facility are established as a reference for the measure. It will be required that the illumination levels (illuminance measured in lux) do not decrease from the baseline value. For this, sites will be chosen to measure the baseline and post-measure situation, which include area 1, area 2, area 3, 2 offices and 2 corridors. A virtual measurement grid will be created through which the points to be measured will be established from defined distances of elements of the environment (doors, walls, columns, etc).

The grid and the measurement sites will be agreed and validated by the facility.

Record of the obtained values will be saved, for comparison. A routine annual comparison of the results is established, and it is foreseen that at the request of the facility, additional measurement campaigns may be carried out in the event of any doubt.

The project will not be considered to have worsened the lighting conditions if the average of the lighting levels of all the measured points is not less than 90% of the baseline value.

c) Energy demand and consumption reference

Key parameter measurement:

A test bench will be assembled at the facility to perform the measurement of the active and reactive power of lamps / tubes (including all their auxiliary equipment) of each type currently installed (baseline) and to be installed. At least 3 units will be measured to determine the initial variance of the results. The sample size will be obtained using the procedure established in the protocol, in which an initial sample size is determined and modified according to the variance of the results. The final power value will be the average of the concordant measures for each type. These measurements will be used to calculate the reference consumption and the demonstration period of savings.

Estimation of parameters: Hours of use

The hours of use were determined during audits and its results were approved by the facility.

	Type	Annual hours
L1	Lamp type 1	3.919
L2	Lamp type 2	1.642
L3	Lamp type 3	1.350
L4	Lamp type 4	3.862
L5	Lamp type 5	4.347
L6	Lamp type 6	1.453
L7	Lamp type 7	3.952
L8	Lamp type 8	4.438
L9	Lamp type 9	3.170
L10	Lamp type 10	3.709
L11	Lamp type 11	1.440
L12	Lamp type 12	1.440

Table 8 – Summary of hours of use audit

No independent variables are detected that may influence the energy consumption of lighting. The monthly hours will remain unchanged throughout the demonstration period of savings, regardless of the variability in the facility.

Reference energy is then determined according to the equation:

$$\text{Energy (kWh/year)}_{\text{before}} = \text{Power (kW)}_{\text{before}} \times \text{annual hours}$$

$\text{Power(kW)}_{\text{before}} \rightarrow$ measured in the test *Key parameter measurement*

Annual hours $\rightarrow$ Estimated in table 8.

4. Demonstration period of savings:

The demonstrative period of savings is considered associated with the measurements that will be made in the test bench with the new lamps and tubes that will be placed. This singular test will be repeated annually. This consumption value obtained in each measure will be used to determine the overall monthly monetary saving of the project, during the period that is necessary to complete the repayment of the total investment.

5. Base for adjustments:

The savings will be adjusted by the active and reactive power values resulting from the annual measurements made. The hours of use remain unchanged throughout the demonstration period of savings.

6. Analysis procedure:

Equation for the calculation of annual average of avoided energy:

Energy savings calculations

Active energy saved by lamp calculation

$$EA_{saved}\,(kWh) = (P_{before}\,(kW) - P_{after}\,(kW)) \times h$$

Where:

EA: active energy

h: hours of use

P_{before}: Power demand before substitution in kW.

P_{after}: Power demand after substitution in kW.

7. Energy prices

The calculation of the monetary saving varies according to the tariff. BEL's tariffs have different values according to the amount of energy consumption and is divided into 3 groups. The lowest group is the cheapest, the middle group and the highest group with the most expensive cost BZD/kWh. Monetary savings will be calculated using the most expensive cost being charged to the building.

8. Measurement specifications

Measurement device characteristics

Include accuracy and precision.

9. Responsibilities

Responsible	Responsibility
Facility	Deliver samples of current lamps and provide test bench.
Certifier	Responsible for measurements
	Responsible for reports elaboration

Table 9

10. Expected precision

According to measurement device

11. Budget

Certifier's fee

12. M&V plan report format

Location and date

Facility's name

Baseline

Nº	Type	Power (W)	Quantities	Hours of use	Active energy (kWh)
L1	Lamp type 1				
L2	Lamp type 2				
L3	Lamp type 3				
L4	Lamp type 4				
L5	Lamp type 5				
L6	Lamp type 6				
L7	Lamp type 7				
L8	Lamp type 8				
L9	Lamp type 9				
L10	Lamp type 10				
L11	Lamp type 11				
L12	Lamp type 12				

Table 10 - Baseline calculation

After implementation

Nº	Replacement	Power (W)	Quantity	Hours of use	Active energy (kWh)
L1	Lamp type 1				
L2	Lamp type 2				
L3	Lamp type 3				
L4	Lamp type 4				
L5	Lamp type 5				
L6	Lamp type 6				
L7	Lamp type 7				
L8	Lamp type 8				
L9	Lamp type 9				
L10	Lamp type 10				
L11	Lamp type 11				
L12	Lamp type 12				

Table 11 - After implementation

Nº	Sector	Baseline (lux)	After implementation (lux)	Result (accepted or not)

Table 12 - Result of illuminance measurements

13. Quality assurance

As a way of guaranteeing the calculation of the savings and the agreement of both parties, it is proposed the participation of the interested parties in the realization of the tests for the determination of the key parameter. For the determination of the hours of operation, Table 8 of this protocol, which is endorsed by both interested parties, will be taken as valid.
The available technical data sheets of the equipment will be attached in order to support the parameters used to calculate the savings.

The calculations and the presentation of the report with the results will be carried out by an authorized EVO certifier.

ANNEX 3: Measurement record

location, date

NAME:

BRAND: NOMINAL POWER:

MODEL: AUXILIAR GEAR:

Measurements

Nº	Voltaje (V)	Current (A)	Power (W)	Power Factor
1				
2				
3				
4				
5				

Certifier Facility

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