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Executive Summary

Consultancy on Energy Efficiency measures in Guyana

Elaborated for OLADE

Authors:

Mauricio Zaballa Romero & Vera Franken

Cambiando Paradigmas LLC — Jacinto Benavente Street 2138, Sopocachi, La Paz - Bolivia

T: +591 (2) 2427072 **DD:** +591 698 31605 **E:** mzaballa@cambiando-paradigmas.com / mzaballa@icloud.com

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Acronyms

AC	Air conditioning
BAU	Business As Usual
EE	Energy efficiency
GEA	Guyana Energy Agency
GEAP	Guyana Energy Agency Programme
GHG	Greenhouse Gas
GPL	Guyana Power and Light Inc.
HEC	Hinterland Electrification Company Inc.
MRV	Measure, Report and Verification
PUC	Public Utilities Commission
PV	Photovoltaic
SD	Sustainable Development
SDGs	Sustainable Development Goals
SEER	Seasonal Energy Efficiency Ratio
UN	United Nations

Introduction

The consultancy assessed the energy audits as well as the implementation of Energy Efficiency (EE) measures in public buildings in Guyana. The assessment of the consultancy regards four mayor impacts of the implementation of such measures. Each of the following four aspects were presented in the form of reports:

1. Assessment of the energy audits that were conducted in public buildings in Guyana under the Energy Efficiency Programme of the Guyana Energy Agency (GEA);
2. Assessment of the impact on energy savings on the GHG emissions scenarios for Guyana;
3. Contribution of the implementation of EE measures to sustainable development;
4. Assessment of the institutional framework and proposal of an MRV system for the implementation of the EE measures.

In this short summary of the consultancy, the reports and their main findings along with main recommendations are presented below.

Objective of the consultancy

The main objective of the consultancy was to suggest a Measure, Report and Verification (MRV) system for the Energy Efficiency measures to be implemented and currently under implementation in public buildings in Guyana. In addition, it was requested to define a roadmap in order to establish the suggested MRV system in Guyana.

In order to reach this objective, it was necessary to assess the conducted energy audits in public buildings in Guyana and further assess the energy efficiency measures recommended by those audits. Furthermore, a research of the impact of energy efficiency measures on future energy demand until 2035 and on the GHG emissions stemming from this demand was required. In addition, the sustainable development contribution of implementing the different EE measures recommended by the energy audits in public buildings in Guyana was assessed. Finally, an assessment of the current institutional framework and its stakeholders for implementing EE measures in public buildings in Guyana was conducted and suggestions on how to improve the institutional framework for energy efficiency were made. A proposal for establishing a MRV system for EE measures, along with a barrier analysis and a roadmap proposal for the implementation of the proposed MRV system was formulated. Estimation of financial cost of the implementation of EE measures and the MRV system as well as the formulation of an initial plausible financial mechanism to fund the implementation of the EE measures as well as the MRV system was presented.

Summary of the Reports

Report 1 – Assessment of the energy audits conducted in Guyana and energy efficiency measures

Report 1 is concerned with the conducted energy audits as such and the overall population of public buildings to be covered by these energy audits. Furthermore, the energy efficiency measures recommended by those audits are assessed mainly through a statistical analysis.

The first step was to review the reports of the energy audits that were provided by the GEA. After the review a comparative matrix of outcome variables from those reports was created and the data analysed for consistency. From this analysis, the main characteristics per type of buildings were identified through statistics. Finally, a matrix of the recommended EE measures was developed and classified by type of measure.

In Section 1 (assessment of the energy audits conducted in public buildings in Guyana), 52 energy audits were reviewed. 16 were conducted in schools, 33 in public offices, and 3 in medical facilities. From these, a total of 47 energy audit reports (15 for schools and 32 for offices) were used for the analysis of statistical trends. Medical facilities were excluded due to an inconsistency of the data and insufficient data.

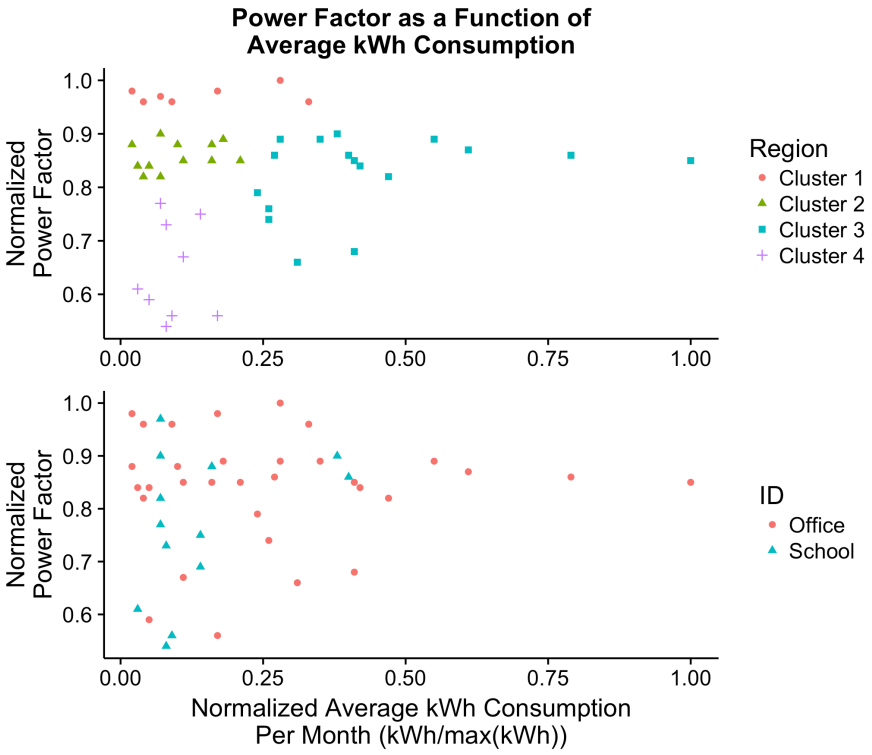
Section 2 presents an assessment of the potential EE measures. The statistical sample size for the energy audits in public buildings in Guyana was contemplated first. The GEA plans to conduct 175 energy audits until 2020. However, the total amount of public buildings reaches 1,936 (data provided by GEA in December, 2016). The statistical sample size with a 95% confidence level was calculated to lie at 321 audits and with a 90% confidence level at 238 audits. The cost for this undertaking lies between 14,9800 – 23,200 USD for the different confidence levels at GEA costs. If commercial costs are used, the amount would rise to 66,600 – 104,400 USD.

Out of the statistical analysis, four clusters were created by grouping all of the buildings following the criteria below:

- Cluster 1: Power factor greater than 0.9
- Cluster 2: Power factor between 0.8 and 0.9, and average monthly kWh consumed less than 23% of the maximum value
- Cluster 3: Power factor less than or equal to 0.9, and average monthly kWh consumed greater than or equal to 23% of the maximum value
- Cluster 4: Power factor less than 0.8, and average monthly kWh consumed less than 23% of the maximum value

The result of this analysis is illustrated in Figure 1.

Figure 1: Offices and schools grouped into four clusters



Source: Own elaboration based on the data from the Energy Audits conducted by GEA

These clusters "typify" the buildings and facilitate targeting those clusters/buildings with the highest energy savings potential.

MAIN RESULTS AND RECOMMENDATIONS

The main findings from Section 1 are:

- The reports reflect that the energy audits execution from the period 2012 to 2015 presented a continuous improvement in comprehension and in complexity of the energy audits analysis
- From report to report, there are some differences in the scope of the energy audits as well as differences in the completeness of variables measured, analyses and recommendations, but most of them include power factor, energy consumption average and building load distribution
- The highest potential of energy savings are EE measures targeting AC units in offices, and IT equipment and appliances in schools.

- Similar trends for schools and offices have been found for average monthly energy consumption in kWh, power factor and peak demand in kW. Regarding average monthly consumption, the majority of schools and offices consume up to 5000 kWh and 10000 kWh respectively. In the case of power factor, over 60% of schools and offices have a power factor in the range of 0.7-0.9. Peak demand also indicates the majority of buildings in the area below 500 kW.
- The EE measures that are recommended by the different energy audit reports mainly focuses on technology substitution for lighting and labelling for IT equipment and appliances. However, they also consider a necessary change in behaviour to achieve energy savings.

The main recommendations for Section 1 are to define whether the GEAP is a tool to define adequate EE measures or whether the objective is to create awareness about EE and the timeline of the GEAP. The increase of capacities and standardized protocols as well as a strategic implementation plan were also identified.

The main results from Section 2 are:

- The statistical sample size for the number of energy audits lies between 321 and 238 audits (for 95% and 90% confidence level).
- Four clusters of public buildings were identified through statistical analysis, based on the average monthly energy consumption and power factor.
- The cluster with the most potential is Cluster 3, since with the implementation of EE measures the power factor can be improved and the average monthly consumption reduced.
- Cluster 3 has an annual savings potential of approximately 471,399 kWh and annual cost savings of 32,984,961 Guyanese dollars.

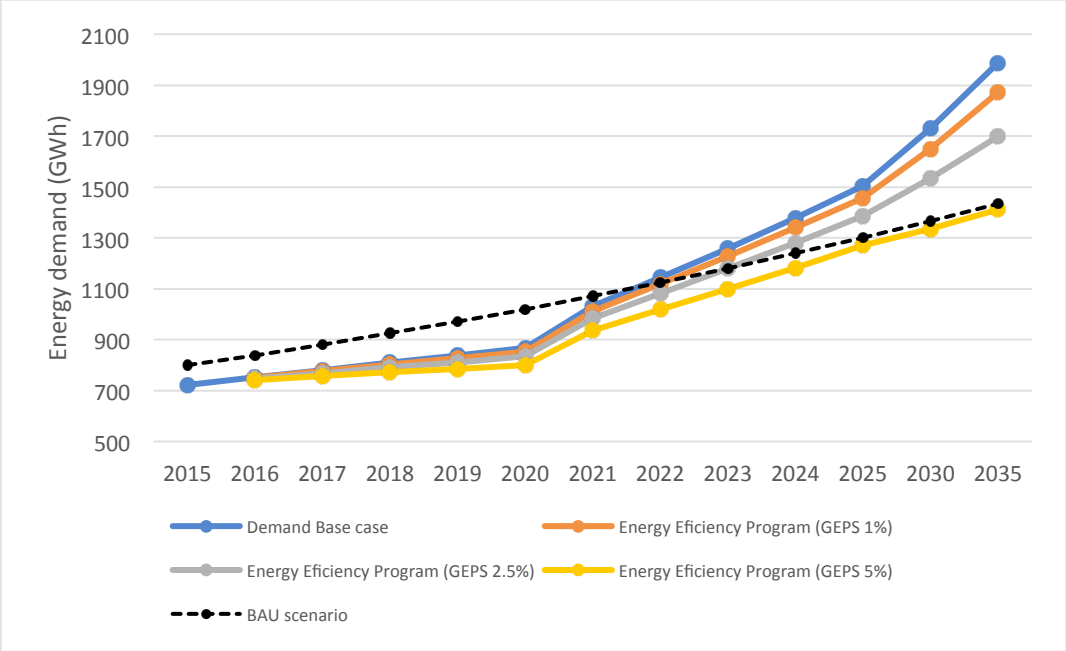
As for Section 2, the main recommendations are to define the overall number or sample size of energy audits that will be conducted by the GEAP and the deadline in terms of time for conducting those audits in Guyana; and that the government of Guyana (through the GEA) expand the current analysis in order to optimise the measures and energy efficiency interventions to be made. It is important that the government of Guyana needs to define a prioritisation tool to define what type of energy efficiency measures will be implemented and in what type of buildings or cluster and it is important that this decision tool should be designed in accordance with the long-term vision of Guyana.

Report 2 - Energy and Emissions scenarios for Guyana

Report 2 focuses on formulating energy scenarios for different energy savings and GHG emissions scenarios to assess the impact of the implementation of EE measures recommended by the energy audits in public buildings. The impact is investigated on an aggregated level for the entire country, presenting energy efficiency scenarios for the entire energy demand and the impact of the implementation of energy efficiency measures in public buildings only. In addition, the report presents a third section regarding the required investment for the implementation of those EE measures.

In Section 1, three energy demand scenarios from Guyana´s Power Generation System Expansion Study (base case, high case and low case) and a Business as Usual (BAU) scenario from historical energy demand data are presented and analysed. According to the Guyana´s Power Generation System Expansion Study the most plausible scenario would be the base scenario, which is why this scenario is selected for further analysis. The second part is dedicated to the introduction of EE measures and their impact on overall energy demand. For this undertaking, three energy efficiency scenarios were introduced and applied to the four previous energy demand scenarios. Since the base case scenario was selected as the most plausible scenario, Figure 2 illustrates the three energy efficiency scenarios parting from the base case demand. The BAU scenario is also illustrated for comparative purposes.

Figure 2: Energy demand for the Base case and EE scenarios

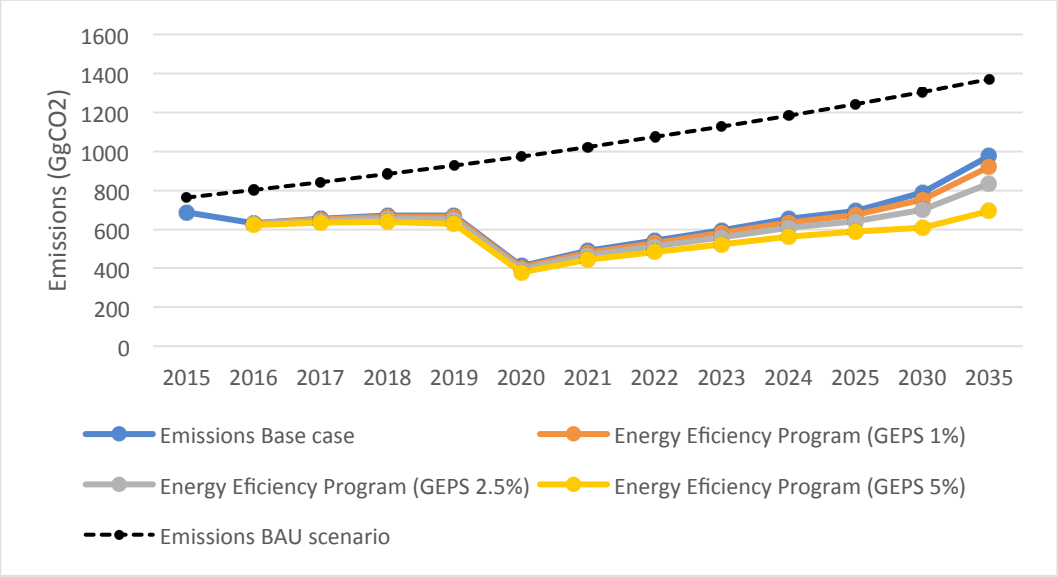


Source: Own elaboration based on data from Guyana's Power Generation System Expansion Study

Finally, the impact of the implementation of energy efficiency measures in public buildings were analysed based on data from energy audits conducted by the Guyana Energy Agency.

Section 2 translates the demand scenarios and the demand from public buildings into GHG emissions. Figure 3 essentially takes the energy demand and energy efficiency scenarios from Figure 2 and translated these into GHG emissions.

Figure 3: GHG Emissions for the Base case and EE scenarios



Source: Own elaboration based on data from Guyana's Power Generation System Expansion Study

Section 2 also translates the demand from public buildings into GHG emissions. Taking the cluster analysis from Report 1, potential emission reductions stemming from the implementation of EE measures in public buildings are summarized in Table 1. Total annual emissions are expanded to the overall population of public buildings parting from the 47 buildings that were analysed in depth.

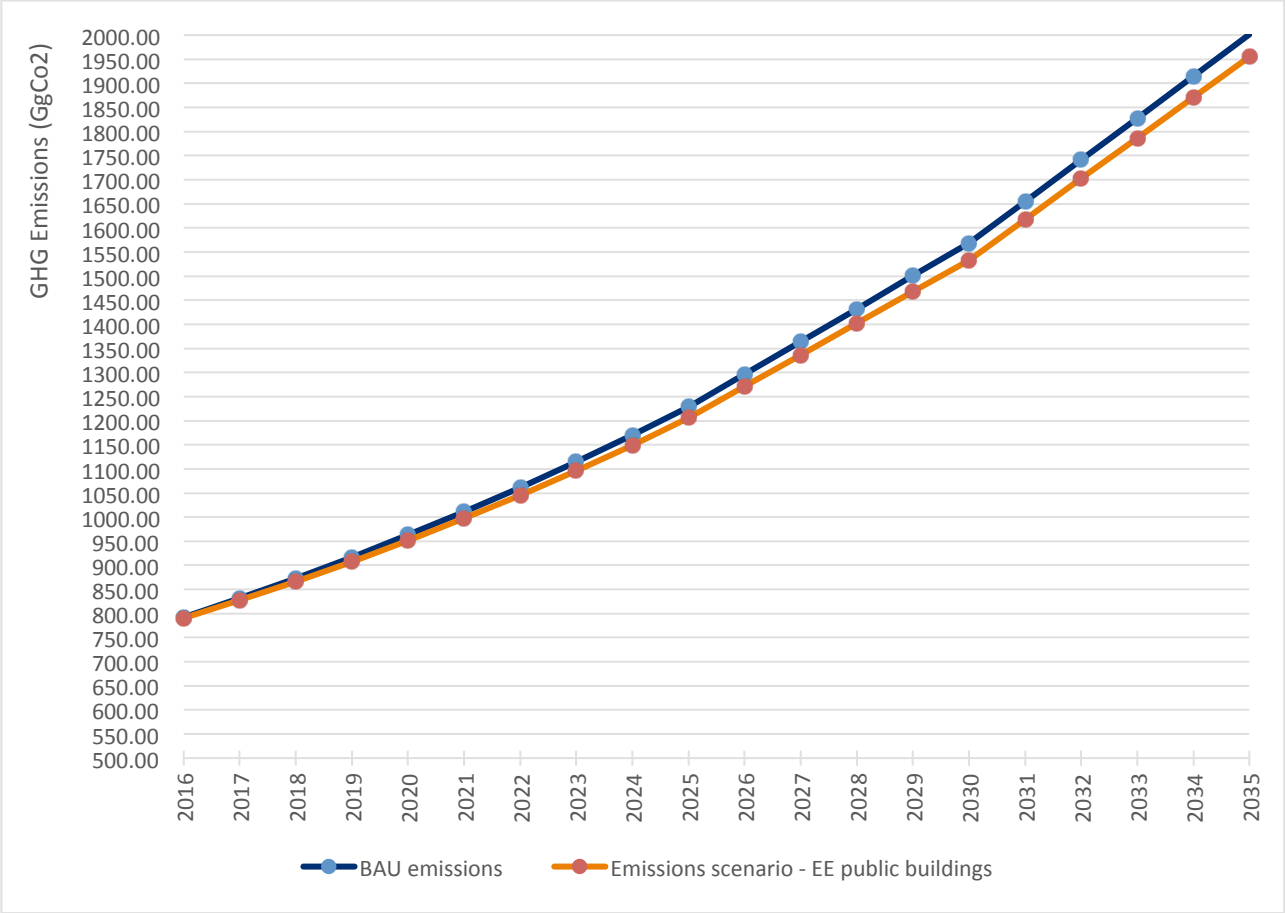
Table 1: GHG Emissions per cluster including the entire population of public buildings

	No. of buildings	Annual Emissions avoided ($GgCO_2$)	% of buildings per cluster	Total No. of buildings	Total annual emissions avoided ($GgCO_2$)
Cluster 1	7	0.089	12%	226	2.876
Cluster 2	14	0.168	22%	427	5.126
Cluster 3	12	0.419	55%	1,063	37.080
Cluster 4	14	0.0867	11%	220	1.361
TOTAL	**47**	**0.762**	**100%**	**1,936**	**46.437**

Source: Own elaboration with data from energy audits provided by GEA

The reduction of GHG emissions coming from the implementation of EE measures in all public buildings in Guyana in comparison to the BAU scenario are shown in Figure 4.

Figure 4: Comparison of GHG emissions between the BAU scenario and EE scenario in public buildings



Source: Own elaboration based on data from the National Energy Balance and energy audits provided by GEA

Section 3 presents the required investment for the implementation of energy efficiency measures in public buildings in Guyana. The information is summarized for the entire population of public buildings in Guyana and can be seen in Table 2.

Table 2: Required investment per cluster including the entire population of public buildings

	No. of buildings	Investment in millions of $G	% of buildings per cluster	Total No. of buildings	Total investment in in millions of $G
Cluster 1	7	24.67	12%	226	796.49
Cluster 2	14	35.68	22%	427	1,088.24
Cluster 3	12	93.40	55%	1,063	8,273.68
Cluster 4	14	15.60	11%	220	245.14
TOTAL	**47**	**169.35**	**100%**	**1,936**	**10,403.55**

Source: Own elaboration with data from energy audits provided by GEA

Main Results and Recommendations

The findings are listed below for each of the three sections.

Section 1: Energy scenarios

- Future energy demand for 2035 could lie between approximately 1,850 and 2,300 GWh;
- The most plausible future energy demand scenario from the four chosen is the base case with 2,055 GWh in 2035.
- Savings of energy demand from the three energy efficiency scenarios (1%, 2.5% and 5% savings) could lie between 115 and 576 GWh for 2035.
- The most plausible energy efficiency scenario lies around 2% of savings.
- 47 public buildings with enough data were analysed in depth
- Annual energy savings (for the 47 public buildings broken down by energy efficiency measure) amount to 436,873 kWh for lighting, 152,847 kWh for AC units, 217,542 kWh for solar systems, 11,217 kWh for IT equipment, 6,123 kWh for appliances and 6,579 kWh for other energy efficiency measures.
- Total annual energy savings amount to 831,191 kWh for the 47 public buildings and could be increased to 51.56 GWh through an implementation of energy efficiency measures in all 1,936 public buildings.

Section 2: GHG Emissions scenarios and GHG emissions reductions

- Future GHG emissions from energy demand for 2035 could lie between 905 and 2,001 $GgCO_2$
- The base case shows GHG emissions of 1,010 $GgCO_2$ in 2035, whereas the Business as Usual (BAU) scenario has a GHG emission of 2,001 $GgCO_2$ by 2035.
- Savings of energy demand from the three energy efficiency scenarios (1%, 2.5% and 5% savings) could lie between 57 and 283 $GgCO_2$ for 2035.
- Annual GHG emissions avoided (for the 47 public buildings broken down by energy efficiency measure) amount to 417 tCO_2 for lighting, 114 tCO_2 for AC units, 208 tCO_2 for solar systems, 11 tCO_2 for IT equipment, 6 tCO_2 for appliances and 6 tCO_2 for other energy efficiency measures.
- Cluster 3 weights 55% in overall GHG emissions reductions from public buildings

- Total annual GHG emissions avoided amount to 0.76 $GgCO_2$ for the 47 public buildings and could be increased to 46 $GgCO_2$ through an implementation of energy efficiency measures in all 1,936 public buildings.
- GHG emissions that could be avoided due to EE measures in public buildings is of 46 $GgCO_2$, which represents only **2%** compared to the BAU emissions scenario.
- **Depending on the GEF used**, the GHG emissions that could be avoided could reach up to **45%** of the total GHG emission reductions of the low case scenario.

Section 3: Required investment for the implementation of EE measures

- Required investment for the implementation of energy efficiency measures (in the 47 public buildings per type of measure) amounts to 31 million $G for lighting, 31 million $G for AC units, 108 million $G for solar systems and 0.5 million $G for appliances and other energy efficiency measures.
- A total of 169 million $G are required for implementing all EE measures in the 47 public buildings
- Cluster 3 with 55% and solar systems with 64% of the total investment require the most
- A total of 10,404 million $G are required for all 1,936 public buildings with buildings in Cluster 3 requiring 80% of the total amount.

The following are the main recommendations for further implementation of EE measures in order to reduce GHG emissions from the energy sector:

- According to the estimation of GHG emissions reductions coming from the implementation of EE measures in public buildings, these could play a significant role in achieving the low case scenario considered under Guyana´s Power Generation Expansion Study. Nevertheless, the estimations are based on very large assumptions, which need to be adjusted through a comprehensive energy audit programme, one that is even more uniform and rigorous than the one that is already in place. Energy audits need to be improved, the information for EE measures need to be more comprehensive and robust including the financial information for every EE measure identified.
- GHG emissions are highly dependent on the energy matrix of the country, which mainly relies on fossil fuels. GHG emissions from the BAU scenario are therefore almost 400 $GgCO_2$ higher than those from the base case scenario. If Guyana really aims at moving towards a Green Economy, it would be imperative to implement all measures considered under the Power Generation Expansion Study at least for the base case or even the high case scenario.
- In Report 1 it was clearly mentioned that the public buildings in Cluster 3 present the most potential for annual energy savings with 70.3% of total energy consumption. Consequently, Cluster 3 accounts for 80% of GHG emission reductions. This highlights the need to tackle this group of buildings.
- Guyana needs to characterise/typify the public buildings in the different clusters as it was suggested in Report 1 of the present consultancy. Furthermore, it is of high relevance to characterise the typical public building that lies in the Cluster 3 due to the fact that this cluster is the one with highest energy saving potential, as well as with the higher GHG emission reduction potential. Consequently, the EE measures should be firstly implemented in the

public buildings which are part of this cluster.

- It is necessary to allocate a national budget and formulate financial mechanisms, as well as to remove barriers in order to increase the ambition an of the implementation of energy efficiency measures.
- There is a need to strengthen capacities that allow to track the progress of the implementation of EE measures and the resulting energy savings, as well as resulting GHG emission reductions. All of this should be built on the basis of establishing a robust Measuring, Reporting and Verification (MRV) system.

Report 3 – Sustainable Development Contribution of implementing energy efficiency measures in Guyana

Report 3 is concerned with the assessment of the contribution of these measures to the sustainable development goals framed by the United Nations. This report presents a qualitative assessment of the contribution of implementing EE measures in public buildings to the sustainable development of the country. For this purpose, the 17 sustainable development goals (SDGs) from the United Nations are adapted to this specific case, selecting 13 from the 17 SDGs for analysis.

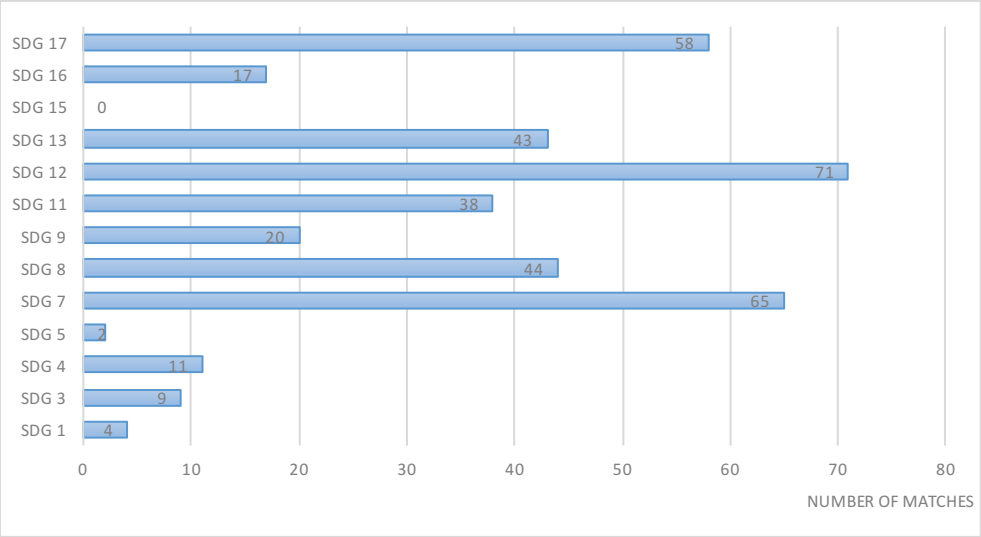
The main results from the analysis are divided into three parts:

1. Contribution to the three sustainable development (SD) dimensions (social, environmental, economic)
2. Contribution to each of the selected SDGs for analysis
3. Participation of sub-measures under each type of EE measure (lighting, AC units, technology, building, energy generation) to the overall contribution of each type

The main results of the assessment conducted for the first section clearly indicates that the energy efficiency measures mainly contribute to the social dimension, followed by the economic and environmental dimension.

Where the results of the assessment conducted to establishing the contribution of the EE measures to the different SDGs, indicates that the EE measures contributes more to achieve the SDGs 12, 7, 17, 8 and 13 (see Figure 5). Here it is important to stress the overall weight that the EE measures in lighting, self-generation and AC units have on the contribution to the SDGs.

Figure 5: Total contribution of EE measures to each SDG



Source: Own elaboration based on information from the UN and GEA

Finally, the sub-measures within each group of EE measures, shows that for lighting "the improvement of the efficiency of the lighting system" has the main contribution to the SDGs. Whereas for AC units the sub-measure of "higher SEER" represents the main contribution. Where for Technology, the "Energy STAR certification and the labelling of electrical appliances" are the sub-measures with higher contribution to the SDGs. For Buildings the "replace of the windows louver type in rooms with operating AC units" contributes more to achieve the SDGs. Finally, for the energy self-generation set of measures, the Solar PV and the Solar Water Heaters have more weight on the contribution to achieve the SDGs.

Conclusion: The assessment of contribution to the sustainable development of the implementation of the EE measures in public buildings clearly indicates that all the EE measures contribute mainly to the social and economical dimensions. Whereas the EE measures clearly contributes to achieve the SDGs 12, 7, 17, 8 and 13. Where the measures coming from lighting have a strong weight on the overall contribution to the SDGs, followed by self-generation and AC units.

The main recommendations for Guyana are:

- It is of high relevance for Guyana to establish its own baseline or base indicator for the different indicators, which entail the 17 SDGs. Although there are overall SDGs to be achieved at global and local level, in many of the cases Guyana will require to establish its own baseline indicator that allows to measure and monitor the progress of achieving the overall SDG and the different indicators.
- In addition, establishing a baseline indicator enables Guyana to properly measure the progress of achieving the different indicators that encompass the overall SDGs. The quantification of the contributions of the different

programmes and projects implemented in Guyana will bring transparency and clearly determine the impact of the implementation of different actions, that stem from state initiatives, such as the implementation of the EE measures or private initiatives.

- Finally, the consultant suggests that Guyana invest time and money into the establishment of a robust and quantitative SDG system with its own national indicators. This will help linking any MRV system and Transparency system required to monitor and measured the progress of the NDC implementation in Guyana to the SDG contribution.

Report 4 – Assessment of the existing institutional framework and proposal of the Measuring, Report and Verification system for energy efficiency in public buildings in Guyana

The present report is concerned with the assessment of the existing institutional framework in Guyana and the proposal of an MRV system for the implementation of energy efficiency measures in public buildings. The report is structured into 6 sections:

- Section 1: Assessment of the current institutional framework for energy efficiency in Guyana
- Section 2: Proposal of the MRV system for EE measures in public buildings in Guyana
- Section 3: Barrier analysis for the implementation of EE measures and for the MRV system
- Section 4: Roadmap proposal for the implementation of the proposed MRV system
- Section 5: Estimation of financial resources for the MRV system
- Section 6: Key messages

Section 1 regards the assessment of the current institutional framework and a suggested reformulated framework in order to establish an MRV system for the implementation of EE measures in public buildings in Guyana. The findings show that the current framework is not entirely suitable for the implementation of EE measures. The GEA is the institution responsible for energy planning. Nonetheless it is at the same level as the operators GPL and HEC and the PUC (regulator). This dilutes responsibility along the entire framework and does not give the GEA the authority to enforce compliance with the energy plan. Thus, a reformulation is recommended and presented in Figure 2. The reformulation recommends a change in the hierarchy placing the PUC on a higher level than before so that the regulator has the authority over the GEA and the operators. GPL and HEC are placed below the GEA to ensure the implementation of energy plans. It is recommended, that an EE Office and a working group should be established to strengthen the framework even further.

Section 2 proposes the MRV system based on the suggested institutional framework. The implementation of the MRV system is conditional upon the reformulation of the current institutional framework. One of the most important aspect within the MRV system is the management of information that includes sources of information and timeliness of the information (Figure 5 and 6 from Report 4).

Section 3 presents barrier analyses for both EE measures specifically and for the MRV system as such. The analysis is based on literature and a quick assessment of the main barriers that the workshop participants encountered for implementing the MRV system during the final workshop. The quick assessment was made on the basis of the main barriers indicated in

the reviewed literature. Two working groups were established and every group identified, characterised and prioritised the main barriers that hinder establishing the suggested MRV system for EE measures in public buildings. Both groups identified in the first set of most relevant barriers: 1) Institutional and Organizational; 2) Policy & Regulatory framework; 3) Economic and Financial, followed by 4) Technical capacities; 5) Information and Public awareness; 6) Market and Network failures; and 7) Others. The main barriers that were repeatedly mentioned are the incorrect data collection and lack of capacities to conduct this process.

Section 4 proposes a suggested roadmap for the implementation of the MRV system including specific activities and a time schedule for the implementation of these activities spanning over a period of 5 years.

Section 5 considers the financial cost for implementing the MRV system and estimates the cost for each step of the implementation that are based on the activities from the roadmap. Furthermore, a suggested structure for the flow of financial resources directed at EE measures is presented to illustrate how funds from international sources and national sources could be attracted, pooled and invested into EE programmes and credit lines for the public and private sector. The suggested structure proposes the creation of an EE fund under the responsibility of the Bank of Guyana where national and international funds are pooled. From this EE fund the resources would flow into the establishment and operation of the MRV system, EE programmes funded by the government (mainly public sector and disadvantaged actors of the private sector) and the creation of credit lines within the services offered by commercial banks to motivate the implementation of EE measures in the private sector.

The key messages from Section 6 are summarized below:

- The MRV system helps monitoring the implementation progress of the planned actions. The proposal is an integral approach of the MRV system:
    - Phase 1: MRV of the GHG emission reductions to be achieved through the implementation of the EE measures
    - Phase 2: MRV of the sustainable development benefits resulting of implementing the EE measures
    - Phase 3: add other progress indicators, which are solely of interest of evaluating the efficiency of the sectorial policies
- An institutional framework that supports the implementation of the energy policy in general and the EE measures specifically
- Development of an energy efficiency strategy that includes the programme of energy audits in order to standardize, articulate and establish objectives and goals, as well as an evaluation of EE measure and programme prioritisation
- Analysis and definition of concrete actions that facilitate the achievement of a green economy in Guyana due to the high dependency between the energy matrix of the country and GHG emissions.
- Establishment of a national budget and formulation of financial mechanisms with the objective to increase the impact of energy savings resulting from the implementation of EE measures. This will be reflected in lower GHG emissions and will contribute to achieve the NDC goals of Guyana.