### Description



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November - 2023

Walk Through Audit Report

{{ edificio.nombre }}

BARBADOS – CONSULTANCY TO PROVIDE ENERGY EFFICIENCY AND RENEWABLE ENERGY TECHNICAL SERVICES

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# Abbreviations and Acronyms{{ @comment abbr }}

**AC** Air conditioner

**ASHRAE** American Society of Heating, Refrigerating and Air-Conditioning Engineers

**CFL** Compact Fluorescent Lamp

**COP** Coefficient of Performance

**DG** Distributed Generation

**EE** Energy Efficiency

**EEM** Energy Efficiency Measures

**EMO** Energy Management Opportunity – refer to any measure whether it is EEM or RE

**GHG** Greenhouse Gas

**GoB** Government Barbados

**HPI-HPIT** Metal-halide discharge lamp

**HPS** High-Pressure Sodium lamps

**LPG** Liquified Petroleum Gas

**PV**  Photovoltaic system

**RE** Renewable Energy

**NAP** National Adaptation Plan

**NDC** National Determined Contribution

**NEP** National Energy Policy

**tCO2** Ton of CO2

# Executive summary{{ @comment “secc 1” }}

This report shows the result of the walk-through audit to check for opportunities for energy saving and optimization of the {{ edificio.nombre }} as well as photovoltaic assessment. This report is part of the consultancy to provide *Energy Efficiency and Renewable Energy Technical Services* being executed by Government of Barbados thought the Ministry of Energy and Business, founded by the Inter-American Development Bank (IDB) and the European Union.

This analysis report shows the energy consumption, the equipment and analysis of different uses of the building after a walk-through audit (WTA) performed to the facility, to understand, analyze and measure the main energy consumption systems.

In the case of PV assessment, available space on roof, open areas in the ground and carport solution on parking space were considered.

# Description of the building{{ @comment “secc 2” }}

## Overview{{ @comment “secc 2.1” }}

The {{ edificio.nombre }} is placed {{ edificio.ubicacion.region }}, Barbados and its main activities are {{ edificio.actividad.principal }} and {{ edificio.actividad.secundaria }}. It is operated Monday to Friday {{ @horaFormat edificio.horario\_laboral.lun\_vie }}, Saturdays {{ @horaFormat edificio.horario\_laboral.sab }} and Sundays {{ @horaFormat edificio.horario\_laboral.dom }}.

The building has different sectors and has {{ edificio.pisos }} floors.

{{ @enumimagen "front\_building" "Front of the building" }}

The total area of the buildings is {{ @numerico edificio.superficie }} m2. The energy indicator is {{ @numerico edificio.indicador }} kWh/year.m2

Location coordinates: {{ edificio.ubicacion.gps }}.

## Building characteristics{{ @comment “secc 2.2” }}

The building is a {{ edificio.pisos }} floors {{ edificio.material }} structure with {{ edificio.ventanas }} framed windows in {{ edificio.condicion }} conditions.

The roofs are {{ @tolower edificio.material\_techo }}. Most of the ceilings have {{ @tolower edificio.techo }} interior cover which reduces the heat gains from the roof.

Comments: From the outside, the building has galvanized screens (figure 3), and from the inside, a galvanize sheeting system to block sun radiation (figure 4). Those devices are used to minimize heat gains, keeping the thermal conditioning in the buildings, avoiding additional cooling requirements. Due to the tropical local climate, there is no need for heating in cold seasons.

{{ @enumimagen "exterior\_sheets" "Exterior sheets." }}

{{ @enumimagen "interior\_sheets" "Interior sheets system." }}

# Energy uses and consumption.{{ @comment “secc 3” }}

{{ @if energeticos.hay\_varios }}

## Energy consumption{{ @comment “secc 3.1” }}

The building uses {{ @join edificio.consumos ", " " and " }}. To compare their consumption, they conversion to kWh is made and shown in figure 4. Also, the cost is compared in figure 5.

From the figures it is noted that the LPG, are very small consumptions compared to the electrical energy and even lower in terms of costs.

{{ @grafica "pie" totales.cons\_kwh "Energy distribution" "Annual Consumption (kWh)" }}

{{ @grafica "pie" totales.costo "Energy costs distribution" "Cost (%)" }}

{{ @end }}

{{ @if energeticos.lpg.consumos }}

## Liquified Petroleum Gas (LPG){{ @comment “secc 3.2” }}

In the building the LPG is used [Description of the use]

According to the received information, {{ @numerico energeticos.lpg.consumos.unit.avg }} kg of LPG are used every month. This consumption of {{ @numerico energeticos.lpg.consumos.unit.total }} kg/year represents an annual cost of {{ @numerico energeticos.lpg.cost.anual }} USD/year. The LPG energy cost is {{ @numerico energeticos.lpg.cost.xkwh }} USD/kWh.

{{ @enumimagen "lpg\_boilers" "LPG boilers" }}

{{ @end }}

{{ @if energeticos.diesel.consumos }}

## Diesel{{ @comment “secc 3.3” }}

The building uses a backup generator to ensure electric energy during power outages. The generator has a rated power of {{ @numerico energeticos.diesel.equipment.rated }} kVA and is run by a {{ energeticos.diesel.equipment.model }} diesel motor. The backup system used approximately {{ @numerico energeticos.diesel.equipment.hours }} hours per year.

{{ @enumimagen "diesel\_generator" "Diesel generator." }}

{{ @numerico energeticos.diesel.consumos.unit.avg }} gallons of diesel are used every month, {{ @numerico energeticos.diesel.consumos.unit.total }} gallons/year, which represent a cost of {{ @numerico energeticos.diesel.cost.anual }}USD/year. The diesel energy cost is {{ @numerico energeticos.lpg.cost.xkwh }} USD/kWh.

{{ @end }}

## Electrical energy{{ @comment secc “3.4” }}

The annual electrical consumption is {{ @numerico energeticos.electricity.consumos.kwh.total }}kWh representing a cost of {{ @numerico energeticos.electricity.cost.anual }}USD. The next figure shows the electricity distribution along {{ @join energeticos.electricity.years ", " " and " }}.

An energy index is calculated by the relation between the annual consumption and the building area, that results in **{{ @numerico edificio.indicador }} kWh/m2. year.**

{{ @grafica "column" energeticos.electricity.graf\_consumos.data "Electric energy consumption." "Electric consumption" energeticos.electricity.graf\_consumos.config }}

### Energy balance{{ @comment “secc 3.4.1” }}

From the collected data, the inspection and measurements during the visits and reference data for certain equipment, the consumption for each use is determined. Figure 9 shows the percentage of each use in the consumption of electric energy. The highest consumption in the facility are the {{ @highest energeticos.electricity.balance 1 0 }}, that demands {{ @highest energeticos.electricity.balance 1 2 “porcentaje” }}%.

{{ @grafica "pie" energeticos.electricity.balance "Electrical uses distribution" "Electricity uses" }}

The building has some equipment, not included in main energy consumptions categories. These devices have minor energy consumptions and are within the group “Other”.

The consumption of each category was estimated form the characteristics of the devices and their usage. In the next subsections will be detailed the list of equipment and consumption for each category.

### Lighting{{ @comment “secc 3.4.2” }}

The lights of all the building were counted and characterized by type, size, and place. To estimate the energy consumption, the quantity, type, and the usage of each light was considered. The lighting fixtures are listed below. It was calculated a consumption of {{ @numerico usos.light.consumo }} kWh per year, which represent {{ @porcentaje usos.light.porcentaje }}% of the electrical consumption of the building.

{{ @tpl\_enumtabla "lighting" usos.light.tabla "Lighting list" }}

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Place** | **Technology** | **Nr.** | **Power (W)** | **Daily use (h/day)** | **Consumption (kWh/year)** |
| place | Tech | {{ @apply “numerico” }} | {{ @apply “numerico” }} | {{ @apply “numerico” }} | {{ @apply “numerico” }} |
| Secretary | LED tube | 2 | 18 | 12 | 118 |
| Instructor office | LED tube | 4 | 18 | 12 | 236 |
| Classroom 1 | LED tube | 12 | 18 | 8 | 472 |
| Classroom 2 | LED tube | 12 | 18 | 8 | 472 |
| Bathrooms/Washrooms | LED lamp | 4 | 7 | 12 | 128 |
| Office Small | LED tube | 2 | 18 | 12 | 118 |
| Dinner room | LED tube | 2 | 18 | 12 | 165 |
| Dinner room | Fluorescent lamp | 1 | 23 | 12 | 105 |
| Kitchen | LED tube | 12 | 18 | 12 | 991 |
| Dinner Officers | LED tube | 4 | 18 | 12 | 236 |
| Female Barracks | Fluorescent tube light | 18 | 17 | 12 | 1,002 |
| Office | Fluorescent tube light | 4 | 17 | 12 | 223 |
| Barracks | Fluorescent tube light | 32 | 32 | 12 | 3,355 |
| SB | LED tube | 5 | 18 | 12 | 413 |
| SB | Fluorescent tube light | 1 | 17 | 12 | 78 |
| SB | Fluorescent tube light | 8 | 32 | 12 | 1,174 |
| Bathrooms/Washrooms | Fluorescent tube light | 9 | 32 | 12 | 1,321 |
| Barracks | Fluorescent tube light | 4 | 32 | 12 | 587 |
| Storeroom | Fluorescent tube light | 9 | 32 | 12 | 1,321 |
| SSU | LED tube | 12 | 18 | 12 | 708 |
| SSU | Fluorescent tube light | 6 | 32 | 12 | 629 |
| Office | LED tube | 2 | 18 | 12 | 118 |
| Office | Fluorescent tube light | 1 | 32 | 12 | 105 |
| Rooms | Fluorescent tube light | 8 | 32 | 12 | 1,174 |
| Garage | Sodum (HPS) | 6 | 400 | 0 | 0 |
| Garage | LED tube | 18 | 18 | 12 | 1486 |
| Garage | Fluorescent tube light | 8 | 32 | 12 | 1174 |
| Exterior | LED lamp | 9 | 16 | 12 | 660 |
| Exterior | Fluorescent tube light | 6 | 32 | 12 | 629 |
| Exterior | Fluorescent tube light | 2 | 17 | 12 | 111 |
| Exterior | LED (projector, others) | 1 | 100 | 12 | 328 |
| Exterior | LED (projector, others) | 1 | 30 | 12 | 98 |

Table 1. Lighting list

{{ @end }}

{{ @enumimagen "lights" "Lights in building" }}

{{ @if usos.comp\_air.is\_present }}

### Compressed air{{ @comment secc 1.2.3. }}

The building uses compressed air for {{ @join usos.comp\_air.devices “, “ “ and “ }}. There are {{ @join usos.comp\_air.usage “, ” “ and “ }} air compressors. [Compressors description (The compressor operates between two working states, on load and when the pressure in the tank reaches the set point, at this point the compressor keeps running but without compressing any air. In their display it is shown the hours working in each of these two states)].

With the data of the compressors and its usage a consumption of {{ @numerico usos.comp\_air.consumo }} kWh per year is calculated. This represents {{ @porcentaje usos.comp\_air.porcentaje }}% of the electrical consumption of the building.

{{ @enumimagen "air\_compressor" "Air compressor " }}

{{ @end }}

{{ @if usos.central\_ac.is\_present }}

### Central air conditioning system.{{ @comment secc 1.2.3 }}

Due to the warm climate of Barbados, the air conditioning systems work through all year, cooling the indoor environment, and there is no need for heating.

The central system uses {{ @numerico usos.central\_ac.outdoor\_qty }} outdoor units {{ @join usos.central\_ac.out\_models “, “ “ and “ }} and {{ @numerico usos.central\_ac.handler\_qty }} air handlers {{ @join usos.central\_ac.han\_models “, “ “ and “ }}. The units are listed below.

{{ @tpl\_enumtabla "central ac" usos.central\_ac.tabla "Central AC" }}

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Zone | System | Type | Brand/model | Quantity | Thermal power (BTU/h) | COP | % de time on load | Consumption (kWh/year) |
| zone | sys | type | {{ @apply “defaultText” }} | {{ @apply “numerico” }} | {{ @apply “numerico” }} | {{ @apply “numerico” }} | {{ @apply “porcentaje” }} | {{ @apply “numerico” }} |
| Student Gym | Central AC | Outdoor unit | Lenox | 1 | 140000 | 0 | 60% | 0 |
| First Floor | Central AC | Air handler | Lenox | 1 | 0 | 0 | 60% | 0 |
| Ground Floor | Central AC | Air handler | Lenox | 1 | 10 | 0 | 60% | 0 |

Table 2. Central AC

{{ @end }}

{{ @enumimagen "ac\_units" "AC units" }}

The system works {{ @numerico usos.central\_ac.hours\_day }} hours and {{ @porcentaje usos.central\_ac.load }}% of the time at full load was estimated. The energy consumption was estimated at {{ @numerico usos.central\_ac.consumo }} kWh/year and accounts for {{ @porcentaje usos.central\_ac.porcentaje }}% of the electrical consumption of the building.

{{ @end }}

{{ @if usos.split\_ac.is\_present }}

### Split air conditioners{{ @comment secc 1.2.3 }}

There are several split air conditioners that are used to reach thermal comfort. The units are in different rooms of the building are operated manually.

{{ @enumimagen "split\_ac\_units" "Split AC units" }}

There are a total of {{ @numerico usos.split\_ac.qty }} AC units. To estimate the consumption, the electric power, quantity, and a percentage of the operating time for each unit was considered. This energy consumption represents a total annual consumption of {{ @numerico usos.split\_ac.consumo }} kWh/year, representing {{ @porcentaje usos.split\_ac.porcentaje }}% of the electrical consumption of the building. The list of AC units and its characteristics is listed below.

{{ @tpl\_enumtabla "ac split" usos.split\_ac.tabla "AC split list" }}

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| # | Zone | System | Type | Brand/model | Quantity | Thermal power (BTU/h) | COP | % time on load | Consumption (kWh/year) |
| 1 | Offices | AC | Split | {{ @apply “defaultText” }} | {{ @apply “numerico” }} | {{ @apply “numerico” }} | {{ @apply “numerico” 2 }} | {{ @apply “porcentaje” }} | {{ @apply “numerico” 2 }} |
| 2 | Student Gym | AC | 0 | 0 | 2 | 12000 | 0 | 60% | 0 |
| 3 | First Floor | AC | Split | Streamline cassette | 0 | 0 | 0 | 60% | 0 |
| 4 | Ground Floor | AC | VRF | Omega | 3 | 10 | 0 | 60% | 0 |
| 5 | Top floor | AC | Split | Omega | 3 | 4 | 0 | 60% | 0 |
| 6 | Top floor | AC | Split | Omega | 1 | 4 | 0 | 60% | 0 |

Table 3. AC split list

{{ @end }}

{{ @end }}

{{ @if usos.refrigeration.is\_present }}

### Refrigeration{{ @comment secc 1.2.3 }}

The refrigeration corresponds to freezers, fridges, cooling chambers and ice machines. It was estimated the consumption for each refrigeration devices from its usage and power. The devices are listed below.

{{ @tpl\_enumtabla "refri" usos.refrigeration.tabla "Refrigeration" }}

|  |  |  |  |
| --- | --- | --- | --- |
| System | Quantity | Set temperature (ºC) | Consumption (kWh/year) |
| Cold Chamber | {{ @apply “numerico” }} | {{ @apply “numerico” 1 }} | {{ @apply “numerico” }} |
| Freezer | 3 | 0 | 10800 |
| Fridges | 1 | 0 | 3600 |

Table 4. Refrigeration

{{ @end }}

The total annual consumption of {{ @numerico usos.refrigeration.consumo }} kWh/year, {{ @porcentaje usos.refrigeration.porcentaje }}% of the electrical consumption of the building.

{{ @end }}

{{ @if usos.pumps.is\_present }}

### Pumps{{ @comment secc 1.2.3 }}

There are several water pumps in the building. There are a total of {{ @numerico usos.pumps.qty }} water pumps, {{ @join usos.pumps.potencias\_qty “, “ “ and “ }}, for pressurize the potable water that is used in the building but only. They {{ usos.pumps.have\_vsd }} have VSD to operate them. The pumps represent a total annual consumption of {{ @numerico usos.pumps.consumo }} kWh/year, {{ @porcentaje usos.pumps.porcentaje }}% of the electrical consumption of the building.

{{ @enumimagen "water\_pumps" "Water pumps" }}

{{ @end }}

{{ @if usos.ventilation.is\_present }}

### Ventilation{{ @comment secc 1.2.3 }}

There are several fans in the building use for {{ @join usos.ventilation.usos ", " " and " }}. There are a total of {{ @numerico usos.ventilation.qty }} fans, for different uses places in different areas around the building. The fans represent a total annual consumption of {{ @numerico usos.ventilation.cons\_kwh }} kWh/year, {{ @porcentaje usos.ventilation.porcentaje }}% of the electrical consumption of the building.

{{ @end }}

{{ @if pv.is\_present }}

### PV system{{ @comment secc 1.2.3 }}

[Description of the actual system]

The hospital has a PV system mounted on the roof with a rated power of 200 kW. Most of the roof is occupied by PV panels. The roofs have different tilts and orientations, so no individual group of panels produce the same energy. The energy generation measures for the PV system were requested and, in 2021 the total was 240,448 kWh/year, 4.3% of the electrical energy consumption.

{{ @enumimagen "pv\_panels" "PV panels" }}

{{ @end }}

{{ @if medidas.is\_present }}

# On site measurements{{ @comment secc 1 }}

To get a better understanding of the energy consumption in the building, different instant measurements were made.

The main electrical panel was measured to quantify the active power, reactive power, and power factor.

|  |  |  |
| --- | --- | --- |
| **Active Power (kW)** | **Reactive Power (kW)** | **PF (cos phi)** |
| {{ @numerico medidas.act\_power }} | {{ @numerico medidas.rea\_power }} | {{ @numerico medidas.pf }} |

Table 4. Main electrical panel

{{ @end }}