PUBLIC LIGHTING IN BRAZIL GROUPED PROJECT

Document Prepared by Future Energy

Project Title	Public Lighting in Brazil Grouped Project
Version	01.1
Date of Issue	27-March-2023
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1 PROJECT DETAILS

1.1 Summary Description of the Project

The project involves demand side energy efficiency measures in public lighting infrastructure through the replacement of existing luminaires with more efficient luminaires, including "Light Emitting Diodes" (hereinafter referred to as "LEDs") lightings in urban area of the municipality of Feira de Santana, state of Bahia (Instance 1) and Aracaju, state of Sergipe (Instance 2) in Brazil.

The project covers activities such as installation, maintenance, expansion, replenishment, operation and management of all the public lighting infrastructure in the municipality of Feira de Santana and Aracaju (Brazil).

These grouped project (Instances 1 and 2) will install 118,636 luminaires.

The public lighting infrastructure based on inefficient luminaires was the scenario prior to the implementation of the project.

The power requirement of the project activity luminaires (in terms of Watt) is expected to be almost half of the power requirement of the baseline luminaires. Replacing existing luminaires would therefore significantly reduce electricity consumption (between 50-80% less than existent luminaires) and thus will also contribute to reducing GHG emissions associated with electricity generation.

The sodium-mercury luminaires produce yellow light, and the LED luminaires produce white light, and according to the colorimetric yield index, which indicates the fidelity of the reproduction of the colors, the value for LED lights is 80 and for sodium-mercury luminaires is 20. Sodium-mercury luminaires are omnidirectional (losing efficiently) LED lights are unidirectional and in this sense the efficiency in projection of the sodium-mercury lights is inferior to LED lights.

The annual average estimate of GHG emission reductions and removals is 47,404 tCO_{2e}, the total for the crediting period is 474,046 tCO_{2e}.

1.2 Sectoral Scope and Project Type

Sectoral Scope(s): 03 Energy demand

This category comprises activities that lead to efficient use of electricity through the adoption of energy efficient lamps and/or fixture combinations to replace less efficient lamps and/or fixture combinations in public- or utility-owned street lighting systems. Project and baseline lamps and/or fixture combinations are referred to here as luminaires, which encompasses all of the components in an individual assembly of street lighting equipment, including lamp, lens and reflector, fixture housing, wiring, and driver or ballast and individual and centralized controls.

components/system(s). This methodology covers projects involving multiple luminaires used to illuminate roadways.

This is a grouped project.

1.3 Project Eligibility

According to the VCS Methodology Requirements[1], for Energy demand projects, eligible activities are those that reduce net GHG emissions. Thus, the project is eligible under the scopes of the VCS Program[2], following the VCS Standard[3]:

Eligibility Conditions	Justification of Eligibility
Projects shall meet all applicable rules and requirements set out under the VCS Program, including this document.	The project meets all applicable rules and requirements set out under the VCS Program, as detailed in this section and in Applicability of Methodology.
Projects shall apply methodologies eligible under the VCS Program. Methodologies shall be applied in full, including the full application of any tools or modules referred to by a methodology	The applied methodology is AMS.II.L (Version 2.0) – Demand-side activities for efficient outdoor and street lighting technologies. Applicability conditions are detailed in section 3.2.

[1] Available at < https://verra.org/documents/vcs-methodology-requirements-v4-3/>
[2] Available at: https://verra.org/documents/vcs-program-guide-v4-3/>
[3] Available at < https://verra.org/documents/vcs-standard-v4-4/>

Eligibility Conditions	Justification of Eligibility
Projects and the implementation of project activities shall not lead to the violation of any applicable law, regardless of whether or not the law is enforced.	The project activity applies to street lighting projects that provide lighting performance quality equivalent to or better than the baseline lighting performance. These activities are eligible under the Brazilian law according to conditions set out in sections 1.14 and 3.5.
Where projects apply methodologies that permit the project proponent its own choice of model (see the VCS Program document Program Definitions for definition of model), such model shall meet with the requirements set out in the VCS Program document VCS Methodology Requirements and it shall be demonstrated at validation that the model is appropriate to the project circumstances (i.e., use of the model will lead to an appropriate quantification of GHG emission reductions or removals).	Not applicable. Project applies the AMS.II.L Methodology.
Where projects apply methodologies that permit the project proponent its own choice of third-party default factor or standard to ascertain GHG emission data and any supporting data for establishing baseline scenarios and demonstrating additionality, such default factor or standard shall meet with the requirements set out in the VCS Program document VCS Methodology Requirements.	Not applicable. Project applies the AMS.II.L

Eligibility Conditions	Justification of Eligibility
Projects shall preferentially apply methodologies that use performance methods (see the VCS Program document VCS Methodology Requirements for further information on performance methods) where a methodology is applicable to the project that uses a performance method for determining both additionality and the crediting baseline (i.e., a project shall not apply a methodology that uses a project method where such a performance method is applicable to the project).	Not applicable. Project applies the AMS.II.L Methodology.
Where the rules and requirements under an approved GHG program conflict with the rules and requirements of the VCS Program, the rules and requirements of the VCS Program shall take precedence	The project applies approved VCS methodology and tools. The project shall take precedence to the rules and requirements of the VCS Program over other approved GHG Program.
Where projects apply methodologies from approved GHG programs, they shall comply with any specified capacity limits (see the VCS Program document Program Definitions for definition of capacity limit) and any other relevant requirements set out with respect to the application of the methodology and/or tools referenced by the methodology under those programs.	The project applies approved VCS methodology and tools. The project shall take precedence to the rules and requirements of the VCS Program over other approved GHG Program.

Eligibility Conditions	Justification of Eligibility
Where Verra issues new requirements relating to projects, registered projects do not need to adhere to the new requirements for the remainder of their project crediting periods (i.e., such projects remain eligible to issue VCUs through to the end of their project crediting period without revalidation against the new requirements). The new requirements shall be adhered to at project crediting period renewal.	Project was designed under the VCS Standard, v4.4 and AMS.II.L, v2. Any new requirements shall be adhered to at project crediting period renewal.

1.4 Project Design

This is a grouped project and has been designed to include multiple project activity instances.

Eligibility Criteria

Being a Grouped Project Activity, this project will be implemented while fulfilling the eligibility criteria provided in the Table below.

VCS Standard Eligibility criteria for the inclusion of new project activity instances	Public Lighting in Brazil Grouped Project
Project Activity Instances (PAIs) must meet the applicability conditions set out in the applied methodology	Yes, the instances included in this project meet/will meet the applicability conditions established in the methodology. See section 3.2
Projects shall use the technologies or measures specified in the project description.	Yes, the project has instances that use the technologies specified in the project description: More efficient Lighting systems

VCS Standard Eligibility criteria for the inclusion of new project activity instances	Public Lighting in Brazil Grouped Project
Apply the technologies or measures in the same manner as specified in the project description.	Yes, the most efficient equipment technology applied is the same specified in the project description, and must be the same applied in new instances.
Are subject to the baseline scenario determined in the project description for the specified project activity and geographic area.	Yes, the project instances have similar baseline scenario.
Have characteristics with respect to additionality that are consistent with the initial instances for the specified project activity and geographic area. For example, the new project activity instances have financial, technical and/or other parameters (such as the size/scale of the instances) consistent with the initial instances, or face the same investment, technological and/or other barriers as the initial instances.	Yes, the characteristics of the instances must be similar to the characteristics of the initial instances. The projects must be carried out in Brazil and must be connected to the National Interconnected System (SIN).

1.5 Project Proponent

Organization name	Future Carbon Holding S.A. (Future Carbon Group)
Contact person	Guilherme Lucas Medeiros Prado Jamile Cristina Barbosa Moraes Lígia Braggion Matheus Anjo Rafael Ribeiro Borgheresi

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1.6 Other Entities Involved in the Project

Organization name	CONCESSIONÁRIA DE ILUMINAÇÃO PÚBLICA CONECTA FEIRA DE SANTANA S.A
Role in the project	Owner of Project Activity Instance 1 (Applied Technology)
Contact person	João Paulo Zariff Hanna
Title	Investment Analyst
Address	Alameda Santos, 787, conjunto 42-B, CEP: 01419-000, São Paulo -SP
Telephone	-
Email	jhanna@framcapital.com

Organization name	CONCESSIONÁRIA DE ILUMINAÇÃO PÚBLICA CONECTA ARACAJU S.A
Role in the project	Owner of Project Activity Instance 2 (Applied Technology)
Contact person	João Paulo Zariff Hanna
Title	Investment Analyst
Address	Alameda Santos, 787, conjunto 42-B, CEP: 01419-000, São Paulo -SP

Telephone	-
Email	jhanna@framcapital.com

1.7 Ownership

The Project Owners, Concessionária De Iluminação Pública Conecta Feira De Santana S.A and Concessionária de Iluminação Pública Conecta Aracaju S.A has a concession agreement with the municipalities of Aracaju and Feira de Santana. The concession contract grants full powers to the concessionaire, for a specified period, to carry out activities such as: updating, maintenance, operation, installation and administration of the lighting park in Feira de Santana and Aracaju. The project contract will be submitted to the standard under validation.

1.8 Project Start Date

The Project Start Date is on 26-August-2021, for the municipality of Feira de Santana. The start date of the project refers to the first replacement of light fixtures in the respective municipality.

1.9 Project Crediting Period

The project will have a crediting period of twenty one years, 3 times renewable (7 years per baseline assessment) in which the start date will be in 26-August-2021 and the end date of the credits will be on 25-August-2042.

1.10 Project Scale and Estimated GHG Emission Reductions or Removals

The estimated annual GHG emission reductions/removals of the project are:

☐ <20,000 tCO_2e/year

☒ 20,000 – 100,000 tCO_2e/year

☐ 100,001 – 1,000,000 tCO_2e/year

☐ >1,000,000 tCO_2e/year

Project Scale	
Project	X
Large project	

Year	Estimated GHG emission reductions or removals (tCO_2e)
2021	7,525
2022	22,574
2023	22,574
2024	22,574
2025	22,574
2026	22,574
2027	22,574
2028	22,574
2029	22,574
2030	22,574
2031	22,574
2032	22,574
2033	22,574
2034	22,574
2035	22,574
2036	22,574
2037	22,574
2038	22,574

2039	22,574
2040	22,574
2041	22,574
2042	15,049
Total estimated ERs	**474,046**
Total number of crediting years	21
Average annual ERs	47,404

1.11 Description of the Project Activity

The project covers activities such as installation, maintenance, expansion, replenishment, operation and management of all the public lighting infrastructure in the municipalities of Aracaju and Feira de Santana (Brazil)

The project will introduce demand side energy efficiency measures in public lighting infrastructure through the replacement of existing luminaires with more efficient luminaires, including "Light Emitting Diodes" (hereinafter referred to as "LEDs") lightings in the municipalities of Aracajú and Feira de Santana, in Brazil.

Since Brazil national electric grid has a percentage of power generation by fossil fuels the energy efficiency measures associated to this project will reduce GHG emissions by reducing electricity consumption from these sources.

Technical details on the LED luminaire technology

The LED luminaires, including the LED's, and all accessories are designed for lasting operations. The luminaires and its drivers will be able to fully withstand the current and voltage surges of lightning strikes and the frequent switching operation of the power supplies. The LED luminaires will have operational lifetime of around 50,000 hours2 (i.e. more than 11 years, based on 12 operating hours a day).

The power requirement of the new luminaires (in terms of Watt) is expected to be almost half of the power requirement of the baseline luminaires. Replacing existing luminaires would therefore significantly reduce electricity consumption and thus will also contribute in reducing GHG

emissions associated with electricity generation. The table below provides the number of LEDs which will be installed in the project and the power (wattage) of such LEDs.

Project Luminaire type	Power (pi) (watts)	Number of luminaires replaced (ni)	lamps output (in lumens per watt)
LEDs	20w	1063	95-100 LM/W
LEDs	30w	11097	95-100 LM/W
LEDs	40w	8004	95-100 LM/W
LEDs	60w	7256	95-100 LM/W
LEDs	90w	3046	95 LM/W
LEDs	120w	2857	95 LM/W
LEDs	150w	254	95-100 LM/W
LEDs	Reflector 210w	544	95-100 LM/W
LEDs	Farol 30w	721	90 lm/w
LEDs	Farol 60w	104	90 lm/w
LEDs	**Total**	34.946	

Working hours are on the basis of the change in streetlights turning ON time and OFF time depending on the sunrise and sunset times through the year.

It is assumed that the luminaires work for 12 hours 365 days a year.

In order to provide evidence of how project has established procedures to eliminate double counting of emission reductions, due to project luminaire manufacturers, wholesale providers or others possibly claiming credit for emission reductions for the project luminaires.

All technical details will be carried out during the full VCS PD

1.12 Project Location

The project activities are intended to take place within the Brazil geographic borders. The Project Activity Instance 1 is the municipality of Feira de Santana, State of Bahia, located at Northeast of Brazil. The Project Activity Instance 2 is the municipality of Aracaju, State of Sergipe. The further municipalities will be included on an ongoing basis.

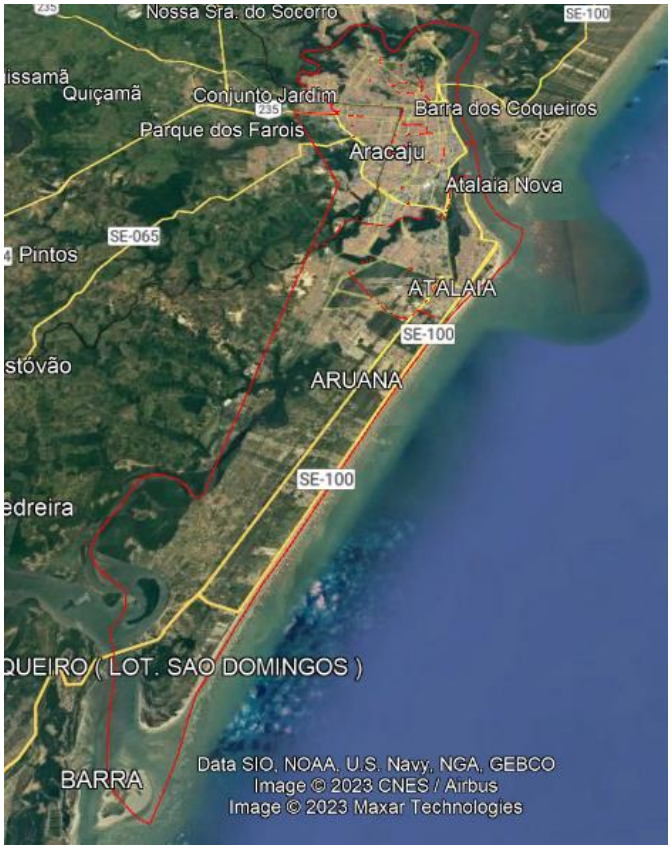


Figure 1 - Municipality of Aracajú/SE

Figure 2 - Municipality of Feira de Santana/BA

1.13 Conditions Prior to Project Initiation

In this case, the baseline scenario is the same as the conditions existing prior to the project initiation, please refer to Section 3.4 (Baseline Scenario).

As provided under section 1.1 and 1.8 the power requirement of the new luminaires (in terms of Watt) is almost half of the power requirement of the existing baseline luminaires. Therefore, replacing existing luminaires would significantly reduce the electricity consumption and thereby reduce the GHG emissions associated with electricity production.

Thus, it is concluded that the project has not been implemented to generate GHG emissions for the purpose of their subsequent reduction, removal or destruction.

1.14 Compliance with Laws, Statutes and Other Regulatory Frameworks

The national standard stipulates the requirements of technology used for exterior lighting to which the project will be in compliance with. The luminaire are installed with the prior approval of local government, ensuring that it's in compliance with the national standard.

1.15 Participation under Other GHG Programs

1.15.1 Projects Registered (or seeking registration) under Other GHG Program(s)

The project has not been registered and is not seeking registration under any other GHG programs.

1.15.2 Projects Rejected by Other GHG Programs

Not applicable. This project is not requesting registration in any other GHG Programs nor has the project been rejected by any other GHG programs.

1.16 Other Forms of Credit

1.16.1 Emissions Trading Programs and Other Binding Limits

The project activity is not included in an emission trading program or any other mechanism that includes GHG allowance trading.

1.16.2 Other Forms of Environmental Credit

The project area has not sought or received any other form of GHG-related environmental credit, including renewable energy certificates.

Supply Chain (Scope 3) Emissions

The present energy efficiency project's GHG emission reductions are not in a supply chain, i.e., there is no network of organizations (e.g., manufacturers, wholesalers, distributors, and retailers) involved in the production, delivery, and sale of a product or service to the consumer. Therefore, there are no organizations upstream and downstream of the goods and services whose GHGs are impacted by the present REDD project activity.

1.17 Sustainable Development Contributions

The primary objective of the present Project Activity is providing lighting performance quality of its instances.

These measures contribute to several nationally stated sustainable development priorities, such as the objectives from the Brazilian Government related to the UN Sustainable Development Goals (SDGs)[4] and the Nationally Determined Contribution (NDC).

In Brazil, the National Commission for Sustainable Development Objectives (CNODS) is responsible for internalizing, disseminating and providing transparency to the process of implementing the 2030 Agenda for Sustainable Development in Brazil[5]. The monitoring of the country's advances in relation to the SDGs established as priorities is carried out by the Institute of Applied Economic Research (IPEA) and the Brazilian Institute of Geography and Statistics (IBGE), which are also permanent technical advisory bodies.

There is no monitoring at the specific level of projects, and progress at the national level can be accompanied by the synthesis report carried out by IBGE[6] and by the IPEA reports[7].

Based on this definition, the project contributes to sustainable development since the use of LED lighting: reduces greenhouse gas emissions (GHG) since its use represents a low energy consumption, reduces the consumption of Natural Resources, thanks to its long Useful life, besides the LED illumination emits cold white light, that allows to reach a safe illumination for the users of the street (low times of reaction before an unexpected one) with less consumption of energy, the white light crosses much better the fog, doing To the most visible vehicles and increasing the quality of the images captured by the security cameras. In addition to this, using LED technology in road lighting also stems from the latest study on visibility with white light that are based on the fact that we do not use the entire perceptual system of our eye (cones and sticks). The results indicate that white light sources such as LED light sources are preferred without using high light values, since high pressure sodium vapor lamps have a spectrum centered on the red band far outside the sensitivity peak of the Human eye.

All details regarding the project SDG will be described in the full PDD.

[4] UN's Sustainable Development Goals and targets available at: https://sdgs.un.org/goals
[5] More information on the CNODS available at < http://www4.planalto.gov.br/ods/noticias/governanca-nacional-para-os-ods>
[6] Available at < https://odsbrasil.gov.br/relatorio/sintese>
[7] Available at < https://www.ipea.gov.br/ods/publicacoes.html>

1.18 Additional Information Relevant to the Project

Leakage Management

The methodology used for the project is a CDM methodology AMS II L (version 2.0). As per the methodology, leakages are only applicable.

Commercially Sensitive Information

No commercially sensitive information has been excluded from the public version of the project description.

Further Information

Not applicable.

2 SAFEGUARDS

2.1 No Net Harm

No potential negative environmental and socio-economic impacts have been identified in this Project.

2.2 Local Stakeholder Consultation

As preconized by the VCS Standard, the project proponent has conducted an assessment of the local stakeholders that are potentially impacted by the project. Information on the local stakeholders identified are discussed throughout this Section.

All details regarding the Local Stakeholder Consultation will be addressed during the validation process.

2.3 Environmental Impact

In accordance with the Brazilian environmental regulations an environmental assessment not required for a lighting system installation or replacement activity, as long as Street Lighting energy efficiency is not considered as a potentially polluting activity.

However, the luminaries when retired, may cause environmental impacts if not correctly disposed. Therefore, all the replaced luminaries will be correctly disposed in accordance with the local regulations.

2.4 Public Comments

The project will undergo a public comment period. Furthermore, the Local Stakeholder Consultations will collect comments and/or suggestions regarding the project design.

2.5 AFOLU-Specific Safeguards

Not applicable. This is not an AFOLU project.

3 APPLICATION OF METHODOLOGY

3.1 Title and Reference of Methodology

Title of the methodology: AMS II L: "Demand-side activities for efficient outdoor and street lighting technologies." Version 2.0[8]

Reference: Small Scale CDM Methodology.

3.2 Applicability of Methodology

The project complies with all the applicability conditions under the AMS II L (Version 02) (Hereinafter referred to as the "methodology") and the same is demonstrated below:

Justification for applicability of the methodology:

[8] Applied methodology available at: < https://cdm.unfccc.int/filestorage/H/Z/N/HZNSCQRJW9EB3PMVYD60K124XLFT8U/EB%2075_repan20_AMS-II.L_ver%2002.0.pdf?t=ZWd8cnF5bzM5fDD3ruoTiVlsI0iRFBWxlbD6>

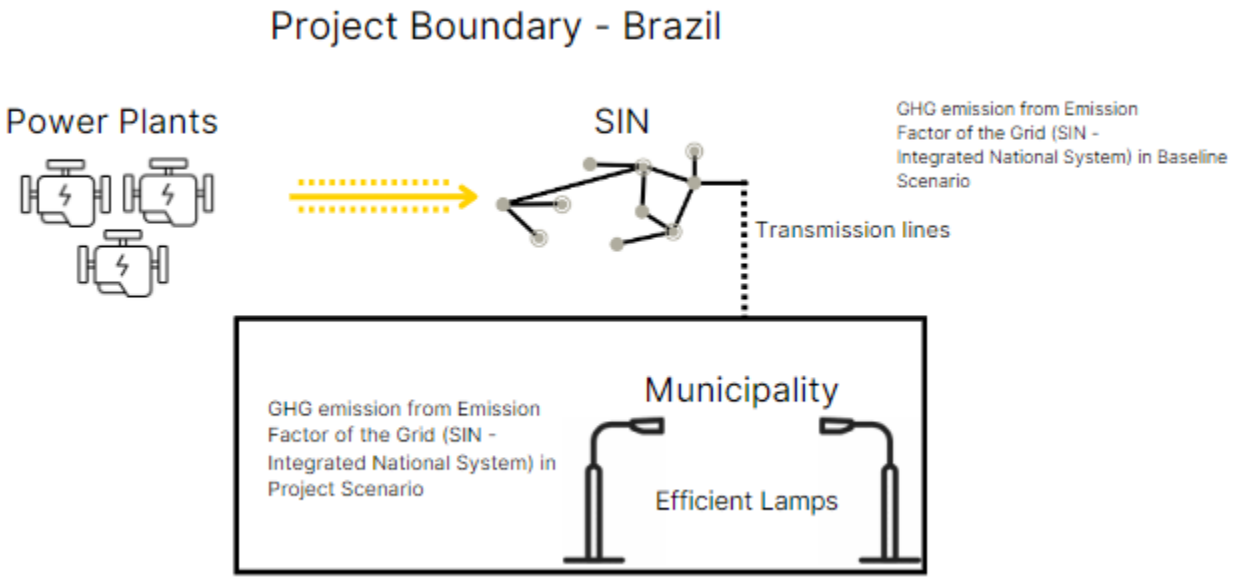
Applicability conditions under the methodology	Justification for the project
This methodology is applicable for one-for-one replacements of baseline luminaires with project luminaires or for replacing multiple baseline luminaires with multiple project luminaires. This methodology is also applicable to projects that involve the implementation of lighting controls that reduce total operating hours or average wattage of the lighting system as well as for new construction installations.	The project involves supply and installation of energy efficient luminaires as a replacement to existing sodium-mercury luminaires; 118,636 luminaires will be replaced one to one and 2,613 will be new luminaires.
This methodology is only applicable if failed project equipment will continuously be replaced based on local maintenance practices, during the crediting period, with equipment of equivalent or better lighting and energy performance specification.	The project equipment will be continuously replaced during the crediting period based on the maintenance protocols established by de project owner, with equipment of equivalent lighting and energy performance specifications.
The luminaires selected to replace existing equipment must be new equipment and not transferred from another project activity.	The luminaires that will replace the existing equipment are new and are not transferred from another project activity.
Controls covered by this methodology may include simple photocells and/or astronomical time clocks that provide basic streetlight scheduling control. Controls may also include advanced systems that allow for more sophisticated strategies, such as dynamically altering street lighting power (dimming or multiple levels of operation such as bi-level lighting) based on vehicle and/or pedestrian traffic sensors or schedules, time of night, ambient conditions, etc.; a practice known as adaptive lighting.	Controls for the new luminaries are photocells.

This methodology applies to street lighting projects that provide lighting performance quality either: (a) equivalent to or better than the baseline lighting performance; or (b) equivalent to or	This project implements street lighting with a better performance quality than the baseline street lighting installed in the project activity instances municipalities.

3.3 Project Boundary

Source		Gas	Included?	Justification/Explanation
Baseline	Source 1	CO_2	Yes	Main Emission Source.
		CH_4	No	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small.
Project	Source 1	CO_2	Yes	Main Emission Source.
		CH_4	No	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small.

The project boundary is the physical, geographical location of each project luminaires installed and it is demonstrated in the following diagram.



3.4 Baseline Scenario

The baseline scenario for the project is the continuation of the current practice, urban area participating in the project will continue using the inefficient luminaires, thus resulting in higher electricity consumption compared with what will be consumed in the project scenario.

3.5 Additionality

The "Energy Efficiency" project falls in the category of small scale energy efficiency projects (under the CDM guidelines) as the expected electricity savings from the project are less than 60 GWh per year.

As per the CDM Guidelines for demonstrating additionality of small scale project activities (TOOL 21[9]), a project is additional if it satisfies both the below conditions:

According to the TOOL 21 the project participants shall provide an explanation to show that the project activity would not have occurred anyway due to at least one of the following barriers:

[9] Available at: <https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-21-v13.1.pdf>

(a) Investment barrier: a financially more viable alternative to the project activity would have led to higher emissions;

(b) Technological barrier: a less technologically advanced alternative to the project activity involves lower risks due to the performance uncertainty or low market share of the new technology adopted for the project activity and so would have led to higher emissions;

(c) Barrier due to prevailing practice: prevailing practice or existing regulatory or policy requirements would have led to implementation of a technology with higher emissions;

(d) Other barriers: without the project activity, for another specific reason identified by the project participant, such as institutional barriers or limited information, managerial resources, organizational capacity, financial resources, or capacity to absorb new technologies, emissions would have been higher.

The conclusion regarding the project additionality will be defined during the validation process.

3.6 Methodology Deviations

No methodology deviations have been implemented.

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

The Baseline emissions associated with electricity consumption.

Ex ante calculations are done as per the following steps:

Baseline emissions associated with electricity consumption are calculated by multiplying the electricity consumption of the baseline luminaires with the electricity grid emission factor.

Electricity consumption of the baseline luminaires is determined based on:

(a) Quantity of baseline ($Q_{i,BL}$) of type i luminaires replaced for each type of baseline luminaire

(b) Rated Power ($P_{i,BL}$) of each type of baseline luminaires and

(c) Average annual operating hours ($O_{i,BL}$) of the baseline luminaires.

(d) System Outage Factor (SOF)

$$E_{i,BL} = (Q_{i,BL})(P_{i,BL})(O_{i,BL})(1 - SOF_{i,BL})$$

4.2 Project Emissions

Project emissions associated with electricity consumption.

The gross electricity savings are calculated by comparing the total average power of the project luminaires multiplied by project annual hours of operation, with the average power of the baseline luminaires multiplied by baseline annual hours of operation.

The net electricity saving (NES) are calculated by correcting the gross electricity savings for any leakage and transmission & distribution losses.

Once the project is installed, the electricity saved by the project activity in year y is calculated as follows:

$$NES_y = \sum_{i=1}^{n} ES_{i,y} \left(\frac{1}{1 - TD_y}\right)$$

Where:

$$ES_{i,y} = -\left((Q_{i,BL})(P_{i,BL})(O_{i,BL})(1 - SOF_{i,BL})\right) - \left((Q_{i,\mu})(P_{i,\mu,y})(O_{i,y})(1 - SOF_{i,y})\right)$$

and

$$SOF_{i,BL} = (AFR_{i,BL})(OF_{i,BL})$$

$$SOF_{i,y} = (AFR_{i,y})(OF_{i,y})$$

Where:

NESy = Net electricity saved in year y (kWh)

ESi,y = Estimated annual electricity savings for equipment of type I, for the relevant type of project equipment in year y (kWh)

Y = Credigin year counter

I – Counter for luminaire type

N = Number of luminaires

TDy = A default value of 10 per cent shall be used for average annual technical grid losses, if no recent data are available or the data cannot be regarded accurate and reliable

Qi, (QiBL and Qi,BL) = Quantity of baseline (BL) or project (P) luminaires of type i distributed and installed under the project activity (units). Once all of the project luminaires are distributed or installed, $Q_{i,P}$ is normally a constant value independent from y unless size of operating luminaire inventory decreases during crediting period, in which case only operating project luminaires shall be credited. Note that $Q_{i\ BL}$ and $Q_{i\ P}$ may represent a different number of luminaries (e.g. a larger number of LEDs with less output), but they must represent the same illuminated area

Pi,BL = Rated power of the baseline luminaires of the group of i lighting devices (kW), or time-integrated average power if equipment operates at various power settings, constant value independent from y. For retrofit projects, project proponents shall maintain records to demonstrate what type of luminaire are replaced

Pi,u,y = Rated power of the project luminaires of the group of i lighting devices (kW), or time-integrated average power if equipment operates at various power settings, normally constant value independent from y unless operating schedule or parameters changes during crediting period.

Time-integrated average power takes into account controls savings such as dimming or bi-level operation that reduce lighting power for periods of time. For example, if on average, project equipment operates at full power 50 per cent of annual operating hours, and half power 50 per cent of annual operating hours, $P_{i,\ P}$ will be de-rated from full value to 75 per cent of full value ((1 x 50%)+(0.5 x 50%))

Oi and Oi,y = Annual operating hours for the baseline and project luminaires in year y. May differ from BL to P. This value is based on continuous measurement of daily average usage hours of

luminaires for a minimum of 90 days at monitoring survey sample locations (sampling determined by minimum 90 per cent confidence interval and 10 per cent maximum error margin) corrected for seasonal variation of lighting hours and multiplied by 365 days. The method used to extrapolate the 90 days of data to annual values must be documented.

SOFi = System Outage Factor (SOF) for equipment type i in year y. SOF is calculated as the product of the equipment Outage Factor and the equipment Annual Failure Rate. The value for BL is assumed to be the same as monitored for P and may vary from year to year.

OFi = Outage Factor is the average time, in hours, elapsed between failure of luminaires type i and their replacement, divided by $O_{i,y}$, annual operating hours. This shall be determined by documented maintenance practice and records of maintenance turn-around time from failure to replacement. The outage factor value during the baseline (BL) is assumed to be the same as determined for each year of the crediting period (y) and may vary from year to year.

AFRi = Annual Failure Rate of luminaires calculated as a fraction of Q. The value for failure rate during the baseline (BL) is assumed to be the same as determined for each year of the crediting period y and may vary from year to year. Failure rates during the crediting period should be determined ex post from maintenance records that indicate the actual fraction of system-wide equipment of type i that fail annually. For ex ante calculations, failure rate in year y could be assumed to equal to $O_{i,y}$ divided by the rated average life for project equipment type i

The Emissions reduction are calculated as following:

$$ER_y = NES_y(EF_{CO2,ELEC,y})$$

Where:

EFco2,elec,y = Emission factor in year y calculated in accordance with the provisions in AMS-I.D (t CO_2/MWh). Brazil 2021 emission factor: 0.2950 t of CO_2/MWh

ERy = Emission reductions in year y (tCO2e)

Describe the procedure for quantification of project emissions and/or removals in accordance with the applied methodology. Include all relevant equations, and explain and justify all relevant methodological choices (e.g., with respect to selection of emission factors and default values).

4.3 Leakage

Leakages are not applicable because the new luminaires installed in the project are not transferred from another activity.

A default value of 10 per cent shall be used for average annual technical grid losses, if no recent data are available or the data cannot be regarded accurate and reliable.

4.4 Net GHG Emission Reductions and Removals

Year	Estimated baseline emissions or removals (tCO_2e)	Estimated project emissions or removals (tCO_2e)	Estimated leakage emissions (tCO_2e)	Estimated net GHG emission reductions or removals (tCO_2e)
2021	7,425	0	0	7,425
2022	22,574	0	0	22,574
2023	22,574	0	0	22,574
2024	22,574	0	0	22,574
2025	22,574	0	0	22,574
2026	22,574	0	0	22,574
2027	22,574	0	0	22,574
2028	22,574	0	0	22,574
2029	22,574	0	0	22,574
2030	22,574	0	0	22,574
2031	22,574	0	0	22,574
2032	22,574	0	0	22,574
2033	22,574	0	0	22,574
2034	22,574	0	0	22,574
2035	22,574	0	0	22,574
2036	22,574	0	0	22,574

2037	22,574	0	0	22,574
2038	22,574	0	0	22,574
2039	22,574	0	0	22,574
2040	22,574	0	0	22,574
2041	22,574	0	0	22,574
2042	15,049	0	0	15,049
Total	473,954			473,954

5 MONITORING

5.1 Data and Parameters Available at Validation

Data / Parameter	**EF Grid**
Data unit	t CO2/MWh
Description	CO2 emission factor of the grid electricity in year y
Source of data	Operating Margin and Build Margin emission factor are calculated based on data from UT (unidad de transaccion S.A de C.V.) which is the Electricity Wholesale Market Administrator in Brazil and annual SIGET reports
Value applied	0.6792 t de CO2/MWh
Justification of choice of data or description of measurement methods and procedures applied	The project owner has calculated the Operating Margin and Build Margin Emission Factor for Brazil Electricity Grid. These factors have been calculated using the "Tool to calculate the emission factor for an electricity system" (provided by the CDM EB of the UNFCCC). The option 1 was chosen to calculate the build margin emission factor for Brazilian electrical grid, according to the options presented in version 06.0, paragraph 73.
Purpose of Data	Calculation of baseline emissions Calculation of project emissions

Comments	The emission factor for brazilian electrical grid is calculated in accordance with the applied methodology provisions calculated using the latest available official data.

Data / Parameter	$Q_{I,BL}$
Data unit	Number
Description	Quantity of baseline (BL) luminaries of type i replaced under the project activity.
Source of data	Implementer
Value applied	27,436
Justification of choice of data or description of measurement methods and procedures applied	Data on number of baseline HPS units to be replaced with new units More detailed information may be provided in an appendix.
Purpose of Data	Calculation of baseline emissions Calculation of project emissions
Comments	Number of luminaires to be replaced

Data / Parameter	$Q_{I,P}$
Data unit	Number
Description	Quantity of Project (P) luminaries of type i
Source of data	Implementer
Value applied	The number is given per type of Luminaire
Justification of choice of data or description of measurement methods and procedures applied	Data on number of baselines HPS units to be replaced with new units More detailed information may be provided in an appendix.

Purpose of Data	Calculation of baseline emissions Calculation of project emissions
Comments	Number of luminaires to be replaced

Data / Parameter	*Oi,BL and Oi,y*
Data unit	Hours
Description	Annual operating hours for the luminaries in year y
Source of data	Thecnical especifications of the controls
Value applied	4,380
Justification of choice of data or description of measurement methods and procedures applied	Working hours are on the basis of the change in streetlights turning ON time and OFF time depending on the sunrise and sunset times through the year. It is assumed that the luminaires work for 12 hours 365 days a year
Purpose of Data	Calculation of baseline emissions Calculation of project emissions
Comments	

Data / Parameter	*Pi,BL*
Data unit	kW
Description	Rated power of the baseline luminaries of the group of i lighting devices.
Source of data	Equipment specification
Value applied	20,942.052
Justification of choice of data or description of measurement methods and procedures applied	The nameplate/rated power of the equipment (including lamp + ballast) are used to calculate baseline energy consumption. Implementer shall maintain records to demonstrate what type of luminaires are replaced.

	More detailed information may be provided in an appendix.
Purpose of Data	Calculation of baseline emissions Calculation of project emissions
Comments	

Data / Parameter	*Pi,BL*
Data unit	kW
Description	Rated power of the baseline luminaries of the group of i lighting devices.
Source of data	Equipment specification
Value applied	20,942.052
Justification of choice of data or description of measurement methods and procedures applied	The nameplate/rated power of the equipment (including lamp + ballast) are used to calculate baseline energy consumption. Implementer shall maintain records to demonstrate what type of luminaires are replaced. More detailed information may be provided in an appendix.
Purpose of Data	Calculation of baseline emissions Calculation of project emissions
Comments	

5.2 Data and Parameters Monitored

Data / Parameter	*Pi,P,Y*
Data unit	kW

Description	Rated power of the Project luminaires
Source of data	Equipment specification
Description of measurement methods and procedures to be applied	The nameplate/rated power of the equipment (including lamp + ballast) are used to calculate Project energy consumption. Implementer shall maintain records to demonstrate what type of luminaires are replaced.
Frequency of monitoring/recording	*Annually*
Value applied	*X*
Monitoring equipment	*N/A*
QA/QC procedures to be applied	*N/A*
Purpose of data	Calculation of project emissions
Calculation method	N/A
Comments	

Data / Parameter	***Oi***
Data unit	Hours
Description	Annual operating hours for the luminaries in year y
Source of data	Technical specifications of the controls
Description of measurement methods and procedures to be applied	Working hours are on the basis of the change in streetlights turning ON time and OFF time depending on the sunrise and sunset times through the year. It is assumed that the luminaires work for 12 hours 365 days a year

	An ex post monitoring survey will be carried out for this parameter
Frequency of monitoring/recording	*Anually*
Value applied	4,380
Monitoring equipment	*N/A*
QA/QC procedures to be applied	*N/A*
Purpose of data	Calculation of baseline emissions Calculation of project emissions
Calculation method	
Comments	

Data / Parameter	
Data unit	*Indicate the unit of measure*
Description	*Provide a brief description of the data/parameter*
Source of data	*Indicate the source(s) of data*
Description of measurement methods and procedures to be applied	*Specify the measurement methods and procedures, any standards or protocols to be followed, and the person/entity responsible for the measurement. Include any relevant information regarding the accuracy of the measurements (e.g., accuracy associated with meter equipment or laboratory tests).*
Frequency of monitoring/recording	*Specify measurement and recording frequency*
Value applied	*Provide an estimated value for the data/parameter*

Monitoring equipment	*Identify equipment used to monitor the data/parameter including type, accuracy class, and serial number of equipment, as appropriate.*
QA/QC procedures to be applied	*Describe the quality assurance and quality control (QA/QC) procedures to be applied, including the calibration procedures where applicable.*
Purpose of data	*Indicate one of the following:* • *Calculation of baseline emissions* • *Calculation of project emissions* • *Calculation of leakage*
Calculation method	*Where relevant, provide the calculation method, including any equations, used to establish the data/parameter.*
Comments	*Provide any additional comments*

5.3 Monitoring Plan

Description of the monitoring plan

Electricity consumption in both, baseline and project scenario are calculated based on:

1. Name plate capacity of the luminaires
2. Power of the luminaire
3. Annual average operating hours of the luminaries.

The name plate capacity and the power of both baseline luminaires and project luminaires was determined at the time of replacement, this will now be required to be multiplied with the annual average operating hours during each of the crediting years so as to calculate the annual electricity savings from the project.

Baseline luminaires and project luminaires are expected to operate for the same number of hours as the ones installed. Therefore, operating hours monitored during the crediting period will be applied for calculating electricity consumption for baseline as well as project scenario.

1. The expected mean – which in the case of the project activity is from sundown to sunrise an average or 12 hours a day.
2. Standard deviation – Since each luminaire is programmed to operate for an average of 12 hours a day, the standard deviation is expected to be close to zero.
3. The level of confidence and precision – 90/10 confidence/precision levels are applicable to the project.

Within the first year after installation of all project luminaires, ex post monitoring survey will be carried out.

This survey shall provide a value for:

(i) Outage factor (OFi);

(ii) Annual failure rate (AFRi);

(iii) Average annual operating hours (Oi);

(iv) Average project equipment power (Pi);

(v) Number of project luminaires placed in service and operating under the project activity.

Subsequent ex post monitoring surveys will be carried out at least every other year after the first year of the crediting period (for years 3, 5, 7, 9) to determine ex post OFi, AFRi, Oi, and Pi for use in ex post emission reduction calculations until such time as CERs are no longer being requested.

For each ex post monitoring survey, the project monitoring plan includes continuous monitoring of equipment run-time for 90 continuous days to determine average daily operating hours for extrapolation to annual operating hours (Oi).

The organizational structure, responsibilities and competencies of the personnel that will be carrying out monitoring activities:

The methodologies require the following monitoring activities: (i) Recording of luminaire distribution and installation data; (ii) Ex post monitoring surveys carried out within the first year after installation and once for every two years after the first monitoring survey.

(i) Recording of luminaire distribution and installation data

In the project, the distribution and installation of the project luminaires was done by installation teams one-to- one.

The O&M teams will physically register each street light site an all this information will be integrated in the EFICEN platform.

Project coordinator, systems administrator

During project activity implementation, the following data are to be recorded:

Number of project luminaires distributed and installed under the project activity, identified by the type, operating schedule and the date of installation, The nameplate/rated power of the equipment (including lamp + ballast) The number, power, and operating schedules of the replaced project luminaires.

Project manager

Each luminaire has a STICKER with the code that allows Geo-reference information to be searched, giving the Operations and Maintenance coordinator and the Operations and Maintenance crew for maintenance purposes, but also information to the EFICEN system platform for monitoring and reporting.

Project coordinator, systems administrator

Forms will be filled out immediately while replacement of project luminaires is taking place. The forms will be designed in such a way that filling in of the forms can be done very easily to avoid mistakes.

Field supervisor, Digitizer

All information from the installation forms will be entered one by one into the EFICEN platform database. Consequently, the database will have per street light the number of replaced project luminaires with date of replacement, wattage of replaced project luminaires and wattage of project luminaires.

systems administrator

(ii) Ex post monitoring surveys

According to AMS-II.L, ex-post monitoring surveys must be conducted to adjust the net electricity savings calculations.

The first monitoring survey will be carried out within the first year after installation of all the project luminaires for the project. The results of this survey will be used to ascertain the number of project luminaires installed and operating and will be used to determine OFi , AFRi , Oi , Pi,P ,QP,i ,in the emission reduction calculation.

O & M Coordinator

Subsequent monitoring surveys will be carried out to determine the ex-post OFi , AFRi , Oi , Pi,P

,QP,i for use in ex-post emission reduction calculations.

The sample monitoring survey provided in AMS-II.L will be completed during the monitoring surveys. In conducting the surveys, the following survey principles will be followed:

Sampling must be statistically robust and relevant i.e. the survey has a random distribution and is representative of target population (size, location);

APPENDIX

Not applicable