LUX DEV
Luxembourg Development Cooperation Agency

THE GOVERNMENT
OF THE GRAND DUCHY OF LUXEMBOURG
Ministry of the Environment, Climate
and Sustainable Development

UBND TỈNH
THỪA THIÊN HUẾ

DỰ ÁN THÍ ĐIỂM NAMA - HỆ THỐNG CHIẾU SÁNG SỬ DỤNG NĂNG LƯỢNG HIỆU QUẢ Ở THÀNH PHỐ HUẾ
ENERGY EFFICIENT LIGHTING NAMA PILOT IN HUE CITY • VIE/401

FINAL REPORT

PROJECT RESULTS ON GHG EMISSION REDUCTIONS ACHIEVED BY LED LIGHTING SYSTEMS IN 54 SCHOOLS AND AT 26 STREETS

NOVEMBER 2022

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LIST OF ABBREVIATIONS

CC	Climate Change
CCA	Climate Change Adaptation
CCM	Climate Change Mitigation
CDM	Clean Development Mechanism
CO2	Carbon Dioxide
CO2e	Carbon dioxide equivalent
CTA	Chief Technical Adviser
DCC	Department of Climate Change
DOET	Department of Education and Training
DOIT	Department of Industry and Trade
DONRE	Department of Natural Resources and Environment
EE	Energy Efficiency
EF	Emission Factor
GHG	Greenhouse Gas
GOV	Government of Vietnam
HEPCO	Hue Urban Environment and Public Works Joint Stock Company
KWh	Kilowatt-hour
IEC	Information-Education-Communication
LED	Lighting Emitting Diode
LuxDev	The Luxembourg Development Cooperation Agency
Luxembourg PMB	Luxembourg Projects Management Board
M&E	Monitoring and Evaluation
MOIT	Ministry of Industry and Trade
MONRE	Ministry of Natural Resources and Environment
MRV	Measurement, Reporting, Verification
MWh	Megawatt-hour = 1,000 KWh
NAMA	Nationally Appropriate Mitigation Action
NDC	Nationally Determined Contributions
IPCC	Inter-govenmental Panel on Climate Change
PPC	Provincial People's Committee
PTF	Project Task Force
SMB	School Management Board
TA MRV	Technical Adviser on Climate Change Measurement, Reporting, Verification
TA PIPP	Technical Adviser on Physical Infrastructure Planning and Procurement
TAO	Technical Assistance Office
tCO2	Ton of Carbon Dioxide (=1000 Kg CO2)
TT Hue	Thua Thien Hue
UNFCCC	United Nations Framework Convention on Climate Change

I. INTRODUCTION

1. Background

Within the framework of implementing the Paris Agreement, the Government of Vietnam has committed to reduce GHG emissions by 9% (83.9 million tons of CO2 equivalent - tCO2e) with domestic resources by 2030 compared to the BAU scenario in 2010. In the field of GHG emissions, the national target on GHG emission reduction in the energy sector is the highest, accounting for 5.5% of the total national emission reduction target, equivalent to 51.5 million tCO2e. This national GHG emission reduction target could be increased up to 27% (250.8 million of tCO2e) with international support including bilateral and multilateral cooperation and new mechanisms under the Global Climate Agreement [1].

With funding from the Climate and Energy Fund coordinated by the Luxembourg Ministry of Environment, Climate and Sustainable Development (MECSD), the Luxembourg Development Cooperation Agency (Lux Dev) has supported and coordinated with Thua Thien Hue Provincial People's Committee to implement the Energy Efficient Lighting NAMA Pilot Project - VIE/401. VIE/401 is a pilot project of a Nationally Appropriate Mitigation Action (NAMA) to achieve the target of GHG emission reduction (CO2) through pilot installation of high efficient LED (Light Emitting Diodes) to replace traditional lamps (such as fluorescent and Sodium lights) in public schools and streets in Hue city. In addition, the project has also supported capacity building and communication activities to raise awareness of climate change and energy efficiency in schools and communities.

The main purpose of the project is to report and register the results of CO2 emission reductions, estimated from the amount of electric energy saved by project LED lighting systems, with the Government of Vietnam (through the Ministry of Natural Resources and Environment), after being verified by a competent independent entity. The recognized GHG emission reduction results will contribute to the GHG mitigation target committed in Vietnam Nationally Determined Contribution (NDC) biennially updated.

The Ozone Layer Protection and Low Carbon Economy Development Centre (CCOZONE), Department of Climate Change, MONRE is the agency which have verified and endorses the project results on GHG emission reductions presented in this report. After making justifications and take into account the critical technical comments of the verification team, TAO has revised and supplement information and data, and complete this report, which can be used to report on project achievements of GHG emission reductions to concerned authorative govervement agencies and to register project results on GHG emission reductions with MONRE for recognition and integration into national and provincial GHG mitigation in energy sector.

2. Project information

2.1. Project profile

Project name & code	Energy Efficient Lighting NAMA Pilot in Hue City-VIE/401
Total budget	2,200,000 EUR
Local contribution	*200,000 EUR*
Luxembourg Government funding	*2,000,000 EUR*
Project starting time	July 2018
Duration (years)	4.5 years from July 2018 to December 2022
Local counterpart	Thua Thien Hue Provincial P.C and DPI
Primary beneficiaries (target groups)	Students, teachers and staff of high schools, secondary schools, primary schools and local people in Hue city

2.2 Project organisational structure

Project Steering Committee (PSC)

The Project Steering Committee (PCS) brings together the governing and owning entities, and is responsible for major strategic decisions, approval of the workplans and steering to ensure the project progress. The PSC members from the Vietnamese Government includes Chairman of Thua Thien Hue Provincial People's Committee, representatives of Ministry of Planning and Investment, Ministry of Finance, and leaders, provincial Department of Planning and Investment (DPI) and provincial Department of Natural Resources and Environment (DONRE). The Luxembourg Government donor includes the representative of the Ministry of the Environment, Climate and Sustainable Development (MECSD), the Luxembourg MFEA and Lux Development based in Vientiane, Lao. The deputy director of TTH DPI as Director of the Provincial Project Management Board, and the Chief Technical Advisor (CTA) as head of the Lux Dev Technical Assistance Office are also the members of the Steering Committee.

TTH Provincial People's Committee (PPC)

As defined in the Government Decree No. 16/2016/ND-CP dated 16 March 2016, the governing agency for Vietnam will be the TTH PPC. The DPI will be delegated as the project owner.

Luxembourg Projects Management Board (Luxembourg PMB)

The Luxembourg Projects Management Board (Lux PMB) established in January 2018 to support implementation of Luxembourg's two climate change projects, is headed by the same DPI Deputy Director. He and Lux PMB staff (five technical and one admin-finance) are existing DPI staff and will support the two Luxembourg projects for 50% of their time.

Technical Assistance Office (TAO)

The TAO, established by Lux Dev, has responsibility for technically supporting the project implementation in close cooperation with Lux PMB. The TA team for VIE/401 consists of 03 technical staff including 01 international Chief Technical Adviser and 02 national Technical Advisers. Two national technical advisers include a CC MRV Technical Adviser and a Physical Infrastructure Planning and Procurement (PIPP) Technical Adviser.

Project Task Force (PTF)

In addition to the technical advisers of the TAO and Lux PMB, the PTF includes the representatives from three provincial departments such DONRE, DOIT and DOET and Hue Municipal P.C. In addition, HEPCO, a project implementing partner, also has a technician involved in the PTF. The key function of the PTF is to assist, provide technical advice and comments as well as endorsing the technical issues related to procurement, LED installation and monitoring, measurement and calculation of the project results of power saving and GHG emission mitigation.

Project Implementing Partners

Hue Municipal P.C is the key partner for project who delegated authority to Hue City Investment Construction Management Board to organise procurement and installation of LED lamps at primary,

secondary & high schools. For street lightings, HEPCO is the implementing partner authorised by Hue MPC to organise procurement and installation of LED lamps. The provincial DOET and Hue Municipal DOET as well as Management Boards of target schools are also key project partners for capacity building and IEC activities at schools.

2.3 Overall and specific objectives

The overall objective of VIE/401 is to "contribute to the national and provincial Green Growth, Climate Change, and Energy Efficiency Target Programmes in Hue City, TT Hue Province". VIE401 is a pilot project of Nationally Appropriate Mitigation Action of energy efficient lighting. The main objective of the project is to reduce CO2 emissions from the national grid indirectly by using energy efficient LED technology to replace low energy efficient traditional lamps in schools and at streets. In addition to the support of LED light installation, the project also has implemented various activities to improve capacity, knowledge and awareness of climate change, energy efficiency in the schools & community, and effective energy management for the industry and trade sector.

The project targets to achieve an average power saving of 1,610MWh/year (estimated based on the rated power of lamps/luminaires and the assumed operating time of 8 hours/day for 365 days/year on average), contributing to reducing the emission an average of about 1,392 tCO2/year, estimated based on the emission factor (EF) for national power grid in 2018, which is 0.8649 tCO2/MWh at the project inception Within a time period of 12-year estimated based the life time of project LED lights >36,000 hours, it was estimated that project street and school LED lighting system schools would result in a total electric energy savings of approximately 19.32 GWh, contributing to reducing emissions of about 16,187 tons of CO2 [4]. The above performance target of electric energy savings was calculated based on the data such as rated power of lamps/luminaires and the assumed values of operating time, not on actually measured and monitored data. In addition, the amount of GHG emission reduction was estimated on the update emission factor (EF) for national power grid at that time of project inception. The project results presented in this report were calculated on the basis of actually measured and monitored data, and the application of the EF 2020, which is the most updated EF at the calculating time.

3. Project Results Achieved

3.1 Final outcomes related to enhanced knowledge, capacity and awareness

Prior to the implementation of IEC activities that increase the awareness of teachers and staff in primary, secondary and high schools, the project had organised numerous training courses to improved capacity and knowledge of climate change and energy efficiency for mastertrainers, particularly 05 TOT training courses for 126 school teachers of primary, secondary and high schools, who subsequently conducted 60 roll-out trainings at their respective schools for a total 1,886 teachers and colleagues. In addition, the project supported the establishment of 30 Student Action Groups (SAGs) in 8 high schools and 22 secondary schools, with the participation of 300 students as core members. These core members were also trained on relevant and necessary knowledge and skills prior to the establishment of their groups.

The project also implemented a great deal of awareness raising activities on CC and EE, such as golden bell ring and drawing contests that involved 8,580 students in 08 high schools, 22 secondary schools and 27 primary schools. With the project financial support, multifarious IEC activities on topics of environmental protection, climate change and electric energy savings, organised by the SAGs, have contributed to the knowledge improvement and awareness increase of 7,048 students. There were 416 IEC materials and tools (video clips, leaflets, posters) on CC and EE themes were developed and distributed to students, teachers and school staff in implemented activities. Besides, the project organised 02 study tours on topics of climate change mitigation and renewable energy for 68 students and teachers from selected schools.

The endline survey of 370 students and 285 teachers from 22 beneficiary secondary schools indicated that the rate of students, teachers and schools staff with improved knowledge, attitudes and practices (KAP) toward climate change and energy efficiency has increased by 40.5 percentage points on average, compared to the baseline survey figure (from 23.4 to 63.9 percentage points).

For college and university students, the Project collaborated with Hue University on the EE Initiatives Contest that engaged over 200 students and teachers. 06 TV reportages and news and 03 newspaper articles on LED lighting systems for energy efficiency in schools and streets were broadcast/posted as a result of the project support of/collaboration with TV and newspaper agencies.

3.2 Results of LED light installation in schools and at streets

3.2.1 Results of LED light installation in public schools

The Project has completed the installation and put into operation of LED lighting systems in 54 schools in Hue city. The total number of lamps is 18,692 LED T8 tubes of 1.2m (15,452 14W, 3,240 24W), installed for lighting systems in 1,343 rooms, replacing 13,676 conventional lamps including (1) T8 Fluorescent tubes,1.2m, 36W, (2) T10 40W and LED T8 18W (poor quality & short lifespan). The life time of LED lamps is 50,000 hours, L_{70} with the warranty period of 5-year time. Aggregated results in 54 schools are presented in Table 1 below and the detailed outcome data per schools is attached in the Appendix 1.

Table 1: Aggregate outcomes of LED light installation in 54 schools

No	Installation location	Total No. of school	Total No. of rooms	Total No. of conventional lamps replaced	Total No. of LED lamps installed (tube 1,2m, 14W &24W)	Time of official operation
1	Primary schools	29	627	6,677	8,341	15/5/2021
2	Secondary schools	22	583	5,197	8,014	
3	High schools	03	133	1,802	2.337	
	Total	**54**	**1,343**	**13,676**	**18,692**	

The Methodology AMS-II.N requires the LED lamps that replace conventional lamps should have the life time ≥ 25,000 hours, L_{70} and have the warranty period of time of at least 3 years.

3.2.2 Results of LED light installation at target streets

The project implemented 02 batches of installations with 1,564 LED luminaires (982 luminaires 120W, 558 luminaires 150W and 24 luminaires 180W) to replace the same number of HP SODIUM luminaires (894 luminaires 150W and 670 luminaires 250W) at 26 streets. The life time of all LED luminaires is 100,000 hours, L_{70}, with the warranty period of 5-year time. Aggregate outcomes are presented in Table 2 below and the detailed outcome data per street are attached in the Appendix 2.

Table 2: Aggregate outcomes of LED light installation at 26 streets

No	Installation location	Total No. of streets	Total length (km)	Total No. of HP SODIUM luminaires replaced		Total No. of LED luminaires installed	
				Qty	Rated Power (W)	Qty	Rated Power (W)
1	Street lighting-Batch 1	18	25.96	1,071	150, 250	1,071	120,150, 180
2	Street lighting-Batch 2	8	12.26	493	150, 250	493	120, 150
	Total	**26**	**38.2**	**1,564**		**1,564**	

3.2.3 Disposal of replaced conventional lamps

During the dismantlement of conventional lamps, Dien Quang Lamp Joint Stock Company collected and transported T8 and T10 fluorescent lamps from the schools to the factory, which treats hazardous waste, in compliance with the strict control procedures that ensured safety, did not break any lamps or pollute the environment. Hue Urban Environment and Public Works Joint Stock Company (HEPCO) was the consulting entity that disposed fluorescent lamps collected from schools [5]. The service

completion report indicates that 8,657 fluorescent tubes were disposed in compliance with the standard procedures such as crushing, solidifying with high-grade concrete and burying at Loc Thuy landfill,

$$ES_y = \sum_{u,i} \left(\frac{1}{1{,}000{,}000}\right) \times [(W/fixture_{b,u,i} \times N_{b,u,i} \times Hours_{b,u,i}) - (W/fixture_{p,u,i} \times N_{p,u,i,y} \times Hours_{p,u,i,y})] \quad \text{Equation 1}$$

thereby contributing to reducing emissions into the environment, an estimated amount of mercury (Hg) of 34,628 mg.

II. GREENHOUSE GAS MITIGATION MEASURE AND MEASUREMENT METHODOLOGY

1. GHG mitigation measure

The project measure to mitigate GHG emissions is to support the retrofitting of conventional lamps such as fluorescent tube lamps (T8 & T10) in 54 schools and HP Sodium luminaires with energy efficient LED lights at 26 streets, thereby saving an amount of electric energy consumption from the national power grid, contributing to reduce CO2 emissions estimated on the updated emission factor for the national power grid.

2. Methodology for GHG mitigation calculations

-Baseline GHG emission refers to the amount of GHG emissions (tCO2/year) determined in a business as usual scenario (of conventional lighting systems) in the absence of project interventions.

-Project GHG emissions refers to the amount of GHG emissions (tCO2/year) of project supported LED lighting systems determined after being installed and put into use.

-The quantity of GHG emission reduction as a result of project interventions (tCO2/year) is the variance between baseline CO_2 emission and project CO_2 emission on annual average calculated on monitoring and measurement data from project MRV system.

Project GHG emission reduction (tCO_2/year) = [Baseline GHG emissions (tCO_2/year) – Project GHG emissions (tCO_2/year)]

-The project has adopted the instructions of two UNFCCC CDM methodologies: AMS-II.N and AMS-II.L [2,3] to implement the collection of monitoring data, measurements of calculating parameters such as the power of lamps (W), the power of lighting systems (KWh), operating time and electric energy consumption, and calculations of GHG emissions.

-The emission factor (EF) for Vietnam power grid in 2020 is 0.8041 tCO_2/MWh (Correspondence No.1313/BĐKH-TTBVTOD dated 31/12/2021, DCC, MONRE is used to calculate the tCO2 emissions and emission reductions in this report.

3. Measurement Methods

3.1 School lighting systems

-The project has adopted the small scale Methodology AMS-II.N*: Demand-side energy efficiency activities for installation of energy efficient lighting and/or controls in buildings* [2].

- Equations (1) and (1-2) as below are applied to calculate electric energy savings and CO2 emission reductions as a results of project LED light replacement in schools.

-Equation (1) is used when baseline and project lamps counts and lamp power (wattages) are surveyed and operating hours are monitored.

Where

ES_y	=	Lighting energy savings associated with project in year *y* (MWh)
$W/fixture_{b,u,i}$	=	Baseline lighting demand per fixture of type *i* in usage group *u*, Watts
$W/fixture_{p,u,i}$	=	Project lighting demand per fixture of type *i* in usage group *u*, Watts (for projects that involve only lighting controls, this value may be same for project and baseline)
$N_{b,u,i}$	=	Quantity of baseline affected fixtures, adjusted for inoperative lighting fixtures, of type *i* in usage group *u*
$N_{p,u,i,y}$	=	Quantity of project affected fixtures of type *i* in usage group *u* (for controls and efficiency projects, this value may be same for project and baseline) in operation in year *y*
$Hours_{b,u,i}$	=	Baseline annual operating hours for operative lighting fixtures, of type *i* in usage group *u*, hours and adjusted to represent an annual value. For efficiency only projects (no controls), this value equals $Hours_{p,u,i,y}$
$Hours_{p,u,i,y}$	=	Project annual operating hours for operative lighting fixtures, of type *i* in usage group *u*, hours in year *y* adjusted to represent an annual value
u	=	Building usage groups with similar operating hour characteristics, for example private offices, conference rooms, hallways, and storage areas. Building usage areas will be identified for areas with comparable average operating hours, as determined by the lights operating during the year or by each of the electric utility's costing periods. Usage areas must be defined in a way that groups together areas that have similar occupancies and lighting operating-hour schedules
i	=	Unique fixture/lamp/ballast combinations

- Emission reductions achieved as a result of project LED light installation in schools are calculated with equations (1-2) below:

$$ER_y = \left[ES_y \times \left(1 + IF_{e,c} + IF_{e,h}\right) \times \frac{3600{,}00kJ}{1MWh} \times EF_{CO2,ELEC,y}/\left(1 - l_y\right)\right] + TIF_y \qquad \text{Equation 1}$$

$$TIF_y = \left[\left(ES_y \times IF_{ff,c} \times EF_{CO2,ff,c}\right) + \left(ES_y \times IF_{ff,h} \times EF_{CO2,ff,h}\right)\right] \times \frac{3600{,}00kJ}{1MWh} \qquad \text{Equation 2}$$

-$IF_{e,c}$ = Interactive factor for electric space cooling system impacts in buildings in which project is implemented. Factor is zero if building has no electric space cooling.

-$IF_{e,h}$ = Interactive factor for electric space heating system impacts in buildings in which project is implemented. Factor is zero if building has no electric space heating

-$IF_{ff,c}$ = Interactive factor for fossil fuel based space cooling system impacts in buildings in which project is implemented. Factor is zero if building has no fossil fuel based space cooling

-$IF_{ff,h}$ = Interactive factor for fossil fuel based space heating system impacts in buildings in which project is implemented. Factor is zero if building has no fossil fuel based space heating

-$EF_{CO2,ff,c}$= Emission factor for fossil fuel (s) used in cooling system(s) (tCO_2/kJ)

-$EF_{CO2,ff,h}$ = Emission factor for fossil fuel (s) used in heating system(s) (tCO_2/kJ)

-TIF_y = Thermal Interactive Effect

-l_y =Average annual technical grid losses (transmission and distribution) during year y for the grid serving the locations where the devices are installed, expressed as a fraction.

The target schools in Hue city do not have electric and fossil fuel based space cooling and heating systems in building, so the above interactive factors are zero (TIF_y =0). Therefore, the equation to calculate the average annual CO2 emission reductions of the project interventions is shortened as follows:

$$ER_y = (ES_y \times EF_{CO2,ELEC,y})/(1 - ly)$$

Where

$EF_{CO2,ELEC,y}$	=	Grid electricity emission factor in year *y* (tCO_2/MWh)
ES_y	=	Lighting energy savings associated with project in year *y* (MWh)
ER_y	=	Emission reductions in year *y* (tCO_2)
ly	=	Average annual technical grid losses (transmission and distribution) during year y (%).Defauld value of 0.1 shall be used for average annual technical grid losses.

3.2 Street lighting systems

- The project has adopted the small scale Methodology AMS-II.LDemand-side activities for efficient outdoor and street lighting technologies [3].

- The below equation is applied to calculate electric energy savings as a results of project interventions.

$$NES_y = \sum_{i=1}^{n} ES_{i,y} \times \frac{1}{(1 - TD_y)} \quad \text{Equation (1)}$$

Where:

$$ES_{i,y} = \left(Q_{i,BL} \times P_{i,BL} \times O_{i,BL} \times (1 - SOF_{i,BL})\right) - \left(Q_{i,P} \times P_{i,P,y} \times O_{i,y} \times (1 - SOF_{i,y})\right) \quad \text{Equation (2)}$$

$$SOF_{i,BL} = AFR_{i,BL} \times OF_{i,BL} \quad \text{Equation (3)}$$

$$SOF_{i,y} = AFR_{i,y} \times OF_{i,y} \quad \text{Equation (4)}$$

Where

NES_y	=	Net electricity saved in year *y* (kWh)
$ES_{i,y}$	=	Estimated annual electricity savings for equipment of type *i*, for the relevant type of project equipment in year *y* (kWh)
y	=	Crediting year counter

i	=	Counter for luminaire type
n	=	Number of luminaires
TD_y	=	Average annual technical grid losses (transmission and distribution) during year *y* for the grid serving the locations where the luminaires are installed, expressed as a fraction. This value shall not include non-technical losses such as commercial losses (e.g. theft/pilferage). The average annual technical grid losses shall be determined using recent, accurate and reliable data available for the host country. This value can be determined from recent data published either by a national utility or an official governmental body. Reliability of the data used (e.g. appropriateness, accuracy/uncertainty, especially exclusion of non-technical grid losses) shall be established and documented by the project participant. 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
Q_i ($Q_{i,BL}$ and $Q_{i,Py}$)	=	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
$P_{i,BL}$	=	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
$P_{i,P,y}$	=	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%))

O_i ($O_{i,BL}$ and $O_{i,y}$)	=	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. For projects involving the following control strategies, the monitoring for determination of annual operating hours shall be continuous for 365 days per year: (i) Luminaires controlled by motion sensors; (ii) Luminaires controlled by advanced controls that allow scheduling options other than light sensing or time clock. The measurements shall be repeated at the monitoring survey sample locations at the time of ex post monitoring as indicated in paragraph 24. In no case can a value greater than the daily average annual number of hours between sunset and sunrise hours, per 24 hour period, be used under this methodology to calculate annual operating hours
SOF_i ($SOF_{i,BL}$ and $SOF_{i,y}$)	=	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
OF_i ($OF_{i,BL}$ and $OF_{i,y}$)	=	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
AFR_i ($AFR_{i,BL}$ and $AFR_{i,y}$)	=	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 following equation is applied to calculate the CO_2 emission reductions as a result of project interventions and the update emission factor for the national power grid is used.

$$ER_y = NES_y \times EF_{CO2,ELEC,y}$$

Where:

$EF_{CO2,ELEC,y}$	=	Emission factor in year *y* calculated in accordance with the provisions in AMS-I.D (tCO_2/MWh)
ER_y	=	Emission reductions in year *y* (tCO_2)
NES_y	=	Net electricity saved in year *y* (kWh)

III. IMPLEMENTATION OF BASELINE SURVEY AND MEASUREMENT

1. Baseline survey and measurement in schools

1.1 Verify and survey baseline data of conventional lighting lamps

This activity was carried out to collect baseline information of lighting systems including quantity of conventional luminaires, rated power of luminaires, room lighting area and operating status of lighting systems, based on the number of rooms proposed for support in each school.

1.2 Measurement of actual lighting demand and average illuminance of conventional lightings in sampled rooms

This activity was to collect measurement data for calculating parameters such as actual average power of lamps, electricity consumption demand of lighting systems by room type and lighting level based on the average illuminance of each room.

Because the quantity of rooms in 54 schools proposed for project support is 1,285 rooms, the project had to determine a statistical sample size of which the measurement outcomes can be extrapolated for the calculation parameters of total room population based on the mean values measured in sample rooms. The project has employed the Stratified random sampling and calculate the measurement sample size with the formula/equation as guided in the UNFCCC guidelines for sampling and surveys for CDM project activities and programme of activities [6]. With 90% confidence level and precision/margin of error ± 5%, the statistical sample size for measurement of lamp power/lighting demand and average illuminance of target room lighting systems is 116 rooms (as compared to the required sampled size with 90% confidence level and precision/margin of error ±10% [6]). This sample size is pro-rated on the proportional probability to determine sub-samples/stratified samples by room category by educational level, using the Probability Proportional to Size (PPS) method. The sub-samples/stratified samples are presented in Table 3 below.

Table 3: Stratified room samples by usage group for baseline survey and measurement

Usage Group/Room Category		Primary school	Secondary school	High schools	Sub-samples by room category
1	Classsrooms	45	30	6	81
2	Computer-Foreign languages rooms	4	4	1	9
3	Practical-Experimental rooms (physics, chemistry, biology…)	0	4	2	6
4	Private & Common offices	3	5	1	9
5	Functional-service rooms, including libraries	4	5	2	11
	Total	**56**	**48**	**12**	**116**

The minimum sample size for measurement of average illuminance of conventional lighting systems that has 90% confidence level and precision/margin of error ± 10% is 63 rooms. However, the project has used a sample size of 116 rooms (the same sample size used to measure the actual power of lamps and lighting systems) to measure the average lighting level of conventional lighting systems. This sample size has 95% confidence level and precision/margin of error ± 7%. For more detailed information on how to determine the room sample size, please refer to the Annex 3.

1.3 The implementing entity of the baseline survey and measurement

The consultant agency implementing the baseline survey and measurement was the Industry Promotion and Development Consultancy Centre (IPDCC) which belongs to the TT Hue provincial DOIT with legally designated functions in consultancy services in energy efficiency and energy auditing. This entity used relevant calibrated measurement meters and its specialist/technicians doing the survey and measurements have MOIT certificates of energy auditing. Two Technical Advisors of TAO provided support, collaborated and supervised the implementation of baseline survey and measurement.

1.4. Results of baseline survey and measurement in schools

The results of baseline measurement indicates that the actual power of fluorescent lamps tube T8 and T10 has remarkably decreased over the time of use, remain only 77% of rated power on average. The rated power of fluorescent lamp tube T8 is 36W but the lamp power actually measured was 34.7 W (ballast included). Similarly, the actual power of fluorescent lamp tube T10 decreased to 37.7W (ballast included) as compared to its rated power of 40W (ballast excluded). Table 4 below summarises the measuring results of the power of conventional lamps in schools [7].

Table 4: Measuring results of power of conventional lamps in schools

	Lighting by Room Category	**Fluorescent lamp T8**			**Fluorescent lamp T10**			**LED lamps**			**Total power**
		Qty	**P (W)**	**Total**	**Qty**	**P (W)**	**Total**	**Qty**	**P (W)**	**Total**	
1	**Room with 100% fluorescent lamps (40 rooms)**										
	As per rated power	248	46.0	11,408	126	50.0	6,300				17,708
	As per measured power	248	34.1	8,466	126	37.1	4,675				13,141
2	**Room with 100% LED lamps (10 rooms)**										
	As per rated power							73	18	1,314	1,314
	As per measured power							73	18	1,313	1,313
3	**Room with mixed lamps (66 rooms)**										
	As per rated power	169	46.0	7,774	210	50.0	10,500	212	18	3,816	22,090
	As per measured power	169	35.3	5,965	210	38.4	8,064	212	18	3,816	17,845
	Measured average lamp power (W)		**34.7**			**37.7**			**18**		
	% the rated power		**77**			**77**			**100**		

Measuring results of average illuminance of conventional lighting systems in schools

The measurement results show that the luminous flux (lumen) of fluorescent lamps in schools has very much decreased as compared to the rated level. The average luminous flux of fluorescent tube lamps T8 and T10 has reduced to 65% of the rated amount of lumen. Similarly, conventional LED lamps of poor quality also have the average luminous flux declined to 81% of total rated lumen. All the sampled rooms categorised by use function have average illuminance, only ranged from 112 to 204 lux, which is 47.2% on average, much below the requirement of the national technical standards (QCVN 22:2016/BYT). Table 5 below summarises the outcomes of assessing the quality of conventional lighting systems in schools [7].

Table 5: Baseline assessment of the lighting quality in schools

	Room categorised by use function	**No. of sampled rooms**		**Illuminance/(lux)**		
		Qt	%	Mean	QCVN22	%
1	Classrooms	21	52.5	155	300	52
2	Computer-Foreign Languages rooms	11	27.5	142	300	47
3	Offices	0			200	
4	Practical rooms	4	10	122	500	24
5	Library	2	5	204	500	41
6	Other rooms	2	5	144	200	72
		40	100			

2. Baseline survey and measurement at selected streets

2.1 Collect relevant data of lighting systems at selected streets

Prior to the LED installation, the project had collected relevant data on the quantity, type and rated power of luminaires, and operating time in order to calculate the electric energy consumption of HP SODIUM lighting systems at 26 selected streets.

For data on the quantity, type and rated power of luminaires to be replaced, the project gathered secondary data from the proposal documents and procurement dossiers. After that, these data were verified, compared to the data aggregated in the completion report on project LED installation.

For the operating time and other factors used for calculations, the project collected periodically monitoring data from the secondary data directly supervised from the lighting monitoring and control system of HEPCO, which a networked control system with central scheduling, monitoring and/or reporting features - currently used to manage, control and operate the lighting systems of all the streets in Hue City. On a monthly basis, HEPCO's designated staff in charge of monitoring reported monitoring data on the operating time of all 26 street lighting systems to the TAO which were aggregated and filed.

The time period for collecting monitoring data of conventional street lighting systems prior to the installation of project LED lights was 06 months, from June-November 2021 for 18 streets installed project LED lights in the batch No. 1 and from January-June 2022, as compared to the minimum time period of 90 days (3 months) as required in the Methodology AMS-II.L. The data collected during these periods were used to calculate, estimate average values and extrapolate for the annual values of calculating parameters.

2.2 Measuring the average illuminance of conventional lighting systems at selected streets lightings

The assessment of average illuminance of existing lighting systems was implemented at all the selected streets prior to the project LED light installation to replace HP SODIUM luminaires. Assessing the street lighting illuminance is to measure the amount of luminous flux falling per unit area-lumens/m^2, or lux (lx), is a comparative basis for street way lighting systems based on the average maintained illuminance on a target street lighting from the baseline and project luminaires. Maintained illuminance takes into consideration the depreciation in luminous flux over time between two light sources when a LED luminaire has come to an end of its maintenance cycle.

In compliance with the guidelines in the Appendix 2 of the Methodology AMS-II.L [3], the number of calculation points are determined for each street lighting system based on the street length (m), number of baseline luminaires and space between luminaires and space between points in the longitudinal and transverse directions. According to the technical guidelines, it is not necessary to make measurement of average illuminance of entire lighting points on a street, but instead, a sample space (between lighting points/posts) should be randomly selected to be measured with the assigned number of calculation points.

The calculation in compliance with the technical guidance of the International Commission on Illumination standards -CIE 140:2000 which is detailed in the Appendix 2, the Methodology AMS-II.L[3] indicates at least 247 calculation points required to be measured at the randomly selected spaces between luminaires at 21 street lighting systems. One space between two luminaires is randomly selected for each street and there are ≥10 calculation points to be measured illuminance in the longitudinal direction. The number of calculation points in the transverse direction per street lighting system will be determined based on the width of the roadway or intersection and the number of luminaires of that street lighting system. The techniques of average illuminance complied with the Vietnam Construction Standards 259:2001: *Criteria for designing of the artificial lighting of streets and urban square*. The consultant used a calibrated meter/device to measure illuminance and these measurements were taken during non-daylight hours or at night.

Measurement results [7] indicate that the conventional lighting system of about 29% of total selected streets had the average illuminance below the standard level. The majority of conventional luminaires are HP SODIUM lights with rated power 150W and 250W used for 15-20 years; the luminaire luminous flux remarkably decreased due to exceeding the expiration time; low light level, illuminance and luminance below national technical standards. The distance between two lighting points/lamp posts is very far (more than 40m, some particular streets has the pole distance of over 50m). As a result, the lighting level was very low, creating dark areas that lead to the unlevelness of average illuminance and luminance. High trees grown along the streets shielded the light of street luminaires, leading to low

average illuminance because of low general levelness. Please refer to the results of measuring average illuminance and luminance of conventional lighting system at each street in the Annex 4.

The results of assessing the lighting quality based on average illuminance were used for the designing of LED lighting systems which are more suitable for selected streets.

3. Collect monitoring and measurement after the project LED light installation

3.1 LED lighting systems in schools

The calculation of electric energy consumption of lighting systems requires to have data of 03 key parameters, including the quantity, power of lamps and operating time of lighting system (or usage time).The rated power of LED lamps can be used to calculate the power of LED lighting systems. Therefore, the parameter of operating time of LED lighting systems is a very important variable of which data need to be collected and monitored in compliance with the technical requirements for calculation of monthly or annual electric energy consumption of a lighting system. According to the Methodology AMS-II.N, for the project on energy efficiency that do not use lighting controls, the operating time of project lamps are assumed to be the same as that of baseline/conventional lamps, and is estimated based on the values determined after the project LED installation.

In compliance with the operating hour measurement requirements in the Annex 1, Methodology AMS-II.N [2], the project used the ONSET HOBO UX90-002M Light on/off 512K data loggers to monitor the light on/off time of LED lighting systems in sampled rooms. The sample size determined from 1,343 rooms in 54 schools is 76 room, with 95% confidence level and precision/margin of error ± 5%, determined by the equation and in compliance with the UNFCCC guidelines for sampling and surveys for CDM project activities and programme of activities [6]. Refer to the details on the method of sampling and calculation of sample size, and data logger in the Annex 5.

The number of school samples representing 03 levels of education was selected on the basis of the sub-samples determined by room category and school levels. Target schools were clustered and 22 schools, including 10 primary schools, 09 secondary schools and 03 high schools were randomly selected. Room samples in each schools were randomly selected based on the sub-samples assigned by room category to install data loggers to measure the operating time through monitoring the light on/off of LED lighting systems. The data loggers were installed and launched to record data for a period of 4 weeks (01 month) as required. HOBOware Pro software was used to launch, stop, read out and plot monitoring data.

The measurement activities including installation of data loggers to measure the operating time of LED lighting systems in sampled rooms, reading out monitoring/measurement data on the set dates, store and analyse data and calculations of measurement results. TAO contracted a consultant with professional background on electricity and automation who worked closely with the MRV TA to implement measurement activities at sampled schools. During the measurement process, school management, teachers in charge of monitoring and students provided support in managing and monitoring to make sure the safety of data loggers and none of effects on the devices during the monitoring measurement.

Table 6 below aggregate the measurement results of average monthly operating time of LED lighting system by room category

Table 6: Measured results of average monthly operating time of LED lighting systems

# sampled schools	# sampled rooms	1.Classrooms	2. Computer-foreign languages rooms	3.Offices (common-private)	4. Experimental-Practical rooms	5. Library	6. Functional-service rooms
		Hours/month	Hours/month	Hours/month	Hours/month	Hours/month	Hours/month
22	**76**	**192.7**	**118.8**	**163.5**	**114.1**	**128.3**	**94.8**

The measured operating time data were used to extrapolate to the annual values for calculations after subtracting the summer holidays of students and off-work days of school staff and teachers on average in a year.

3.2 LED lighting systems at streets

For the operating time and other factors used for calculations, the project collected periodically monitoring data from the secondary data directly supervised from the lighting monitoring and control

system of HEPCO, which a networked control system with central scheduling, monitoring and/or reporting features - currently used to manage, control and operate the lighting systems of all the streets in Hue City. On a monthly basis, HEPCO's designated staff in charge of monitoring reported monitoring data on the operating time of all 26 street lighting systems to the TAO which were aggregated and filed.

Similar to the baseline data collection, monitoring data of street lighting systems after installed LED luminaires were collected from HEPCO's lighting monitoring and control system of HEPCO, which a networked control system with central scheduling, monitoring and/or reporting features. MRV TA guided HEPCO designated staff in charge of monitoring how to use templates for data collection, aggregate and reporting of monitoring data on LED lighting systems. On a monthly basis, HEPCO's staff gathers data from the company lighting monitoring and control system, aggregate and report to TAO. Total time period of collecting monitoring data for 18 streets installed LED lights in Batch 1 is 12 months, from March 2021 to February 2022 and for 08 streets installed LED light in Batch 2 is 02 month, October and November 2022. The aggregate figure of data collected for 12 months was used to calculate the electric energy consumption and electricity savings of LED lighting system each street, using the guided equations.

4. Data storage and analysis

The project used the Excel programme and SPSS (Statistical Package for the Social Sciences) to develop databases to store baseline and project data for ex-ante and ex-post calculations of results. Templates/forms for data collection, aggregation, and reporting are respectively designed in Excel spreadsheets which facilitate the data aggregation, processing and analysis of quantitative metrics and the calculations that perform basic arithmetic and mathematic functions. Data analysis mainly involves the calculations and comparison of key measurement parameters required as per Equation.

The project database system is developed into 2 components: 1) databases that store, update and process collected data and 2) databases of analysed and calculated results.

1) Databases for data storage and processing include Excel databases saving measurement data and monitoring data periodically collected, and databases in SPSS that aggregate, process and analyse data and aggregate outcomes, including SPSS databases of 1,343 rooms, database of total 54 schools and database of each school. For streets, SPSS databases are respectively established to store monitoring data of 18 streets installed LED lights in Batch 1 and of 08 streets installed LED lights in Batch 2.

2) Databases for analysed and calculated results include tables of aggregate outcomes of data analysing and calculations

IV. CALCULATION OF RESULTS

1. Calculating Methodology

Based on the equations to calculate electric energy savings and CO2 emission reductions guided in the Methodologies AMS-II.N and AMS-II.L, the project studied and determine methods of calculation to appropriately apply to actual conditions in schools and streets installed project LED lights.

1.1 School lighting systems

- The average power of fluorescent lamps tube 1,2m T8 (34.7W) and T10 (37.7W) and LED tube of poor quality (18W) actually measured in the baseline are used to calculate the electric energy consumptions of conventional lighting systems. For installed LED lights, the rated power of LED tube 1,2 T8 is used to estimate the electric energy consumption of LED lighting systems in schools;

-The average illuminance of conventional lighting systems (lux) in schools was actually very low, thereby failing to meet the lighting level requirement of the national technical standards, and therefore the design was required to increase the average illuminance of LED lighting systems up to the minimum level of national technical standards for lighting level. For that reason, the average illuminance (lux) of LED lighting systems in schools has increased to more than 50% of the actual average illuminance of conventional lighting systems on average, so as to improve the lighting quality. The aggregate data show that the number of LED lights installed in 54 schools is 5,016 lamps more than the number of conventional lamps replaced. Therefore, the monthly electric energy consumption of LED lighting systems can be equal to or greater than that of conventional lighting systems, in case the same quantity of replaced conventional lamps is used for calculations. This calculation way is not reasonable/fair for energy efficiency because it can lead to the results of no electricity savings achieved from project LED lighting systems.

-The solution for the calculation of electric energy consumption of conventional lighting systems is to compare the total luminous flux (total lumen) of replaced conventional lamps with that of installed LED lights per room. For rooms that do not any variance with increasing luminous flux as a result of comparison, the same quantity of replaced conventional lamps is used for calculations. The amount of increased luminous flux per room is then used to estimate the supplementary number of conventional lamps that is assumed to be added to the existing conventional lighting systems, to achieve the same amount of total luminous flux produced by LED lights. The Lumen Method [8,9,10], a method mostly used for interior lighting calculation, was adopted to estimate the number of conventional lamps necessarily taken in in order to produce the variant amount of total lumen per room. The following equation is used.

$$\text{number of luminaires} = \frac{E_{\text{maintained}} \times \text{workplane area}}{\text{lamps per luminaire} \times \text{lamp lumens} \times \text{CU} \times \text{LLF}} \quad \text{or} \quad N = \frac{E \times A}{F \times UF \times MF}$$

-N is the number of lamp (needs to be added). A luminaire= 1 lamp

- E is the average illuminance of room lighting system (lux); A is the room area (m2); E X A=Total luminous flux (total lumen) of room lighting system;

-F is the rated luminous flux lamp per type (lamp lumen) . For example, Dien Quang fluorescent lamp tube T10 1,2m has a rated luminous flux of 2,554 lumen/lamp. For the project, 1 luminaire=1 lamp

-UF is the utilization factor of the lamps-is the ratio of effective luminous flux to the total luminous flux of light sources. UF=0.66 is used for calculations. UF is so called coefficients of utilization (CU) [8,9,10]

-MF is the maintenance factor, the ratio of light output after a specific period of time to the intial light out of the lamp. MF is also called Light Loss Factor-LLF. MF=0.8 is used for calculations [10,11]

-The total quantity of conventional lamps used to calculate the electric energy consumption of conventional lighting systems (baseline) per room is the number of replaced conventional lamps plus the additional number of conventional lamps due to the variance of luminous flux (lumen);

-The rate of average annual technical grid losses applied for calculations (l_y) is 10%;

-The average monthly number of operating hours of LED lighting systems measured by data loggers be used to calculate the average monthly electric energy consumption of conventional lighting systems (assumed to be the same as guided)

1.2 Street lighting systems

-The Methodology AMS-II.L guides that the rated power of baseline/conventional luminaires should be used to calculate the electric energy consumption of conventional lighting systems;

-The rated power of project LED luminaires is not used for calculations. The actual power of project LED luminaires is re-calculated on the basis of the mechanism of reducing the light level of 5 dimming-level luminaires and scheduling the operating time of lighting system per street per month. The project LED luminaires installed at 18 streets in Batch 1 has the five dimming levels (100%,80%,53%, 80%, 100%) different from that of LED luminaires installed at 08 streets in Batch 2 (100%, 70%, 50%,40%, 70%). Therefore, it is substantially necessary to calculate the average power of each LED luminaire type respectively in order to correctly calculate the electric energy consumption of LED lighting system per street. Please refer to the calculations of actual average power of project LED luminaires with five dimming levels of operation and schedule of operating time period in the Annex 6;

-The monitoring data on operating time is aggregated and calculated respectively for conventional lighting and LED lighting systems per street;

-The rate of average annual technical grid losses applied for calculations ((TDy) is 10%;

-The System Outage Factor (SOF) of conventional and LED lighting systems is zero in calculating years (because the Annual Failure Rate (AFR) =0; the Outage Factor (OF)=0 as indicated by monitoring data).

2. Aggregate outcomes of electric energy savings as a result of project LED lights (MWh/year)

The outcomes of electric energy savings are calculated based on the actual start time that project LED lighting systems were considered to be officially put into operation, particularly from 15/5/2021 for LED lighting systems in schools. For street lighting systems, the official operation time of LED lighting systems at 18 streets in the first installation batch is from 1/2/2021 and of 08 streets installed in the second batch is from 1/10/2022.

In 54 schools, the project installed 18,692 LED lights to replace 13,676 conventional lamps such as fluorescent lamps T8, T10 and LED lamps of poor quality/low energy efficiency in 1,343 rooms. Up to 31/12/2022, it is estimated that the project LED lighting systems in these schools can achieve electric energy savings of 982.3 MWh, about 654.8 MWh/year on average.

Based on the actual time period of operation 1,071 project LED luminaires installed to replace HP SODIUM luminaires at 18 streets in the first batch of installation is estimated to have saved about 543.8 MWh. For 493 LED luminaires installed at 08 streets in the second batch of installation, the estimated electricity savings is roughly 42.6 MWh. Total amount of saved electric energy as a result of project LED lighting systems at 26 streets is estimated at 586.4 MWh, about 454.2 MWh/year on average. Total amount of electric energy savings achieved from project LED lighting systems in 54 schools and 26 streets is 1,568.7 MWh and roughly 1.109 MWh/year on average.

Table 7: Calculating outcomes of electric energy consumption and savings achieved from project LED lighting systems in 54 public schools and 26 streets

No	Locations of project LED installation	Qty	Qty of Rooms	Total No. of LED lights installed	Total electricity consumption of conventional lighting systems (MWh/year)	Total electricity consumption of project LED lighting systems (MWh/year)	Total electricity savings achieved from project LED lighting systems (MWh/year)	Calculating period of time
I	**Schools**	**54**	**1,343**	**18,692**	**1,551.9**	**569.6**	**982.3**	**15/5/2021 to 31/12/2022**
1	Primary school	29	627	8,341	676.8	215.8	461.0	
2	Secondary school	22	583	8,014	690.9	284.8	406.1	
3	High school	3	133	2,337	184.2	69.0	115.2	
II	**Streets**	**26**		**1,564**	**1,321.8**	**735.4**	**586.4**	
1	1st batch	18		1,071	1,244.1	700.3	543.8	**1/2/2021 to 31/12/2022**
2	2nd batch	8		493	77.7	35.1	42.6	**1/10/2022 to 31/12/2022**
	Total			**20,256**	**2,873.7**	**1,305.0**	**1,568.7**	

Please see the detailed information on calculating results per school and per street in the Annex 7 and 8.

3. Calculating outcomes of GHG emission and GHG mitigation

3.1 GHG emission reductions achieved by the project interventions

- The emission factor (EF) 2020 for national power grid (=0.8041 tCO2/MWh) [12] is used to estimate the GHG emission and GHG emission reductions of lighting systems in schools and at streets.

-Given the estimated electric energy savings achieved from the use of project LED lamps installed to replace conventional lamps in 54 schools is 982.3 MWh, the project mitigate a GHG emission of 877.69 tCO2.

- With the electric energy of about 586.4 MWh estimated to be saved by the use of project LED lighting systems at 26 streets, the project has achieved a GHG emission reduction of 524 tCO2.

Table 8: Calculating outcomes of GHG emission and emission reductions achieved from project LED lighting systems in 54 public schools and 26 streets

No	Locations of project LED installation	Qty	Total GHG emission of conventional lighting systems (tCO_2) EF 2020=0,8041 tCO2/MWh	Total GHG emission of project LED lighting systems (tCO_2) EF 2020=0,8041 tCO2/MWh	Total GHG emission reductions achieved from project LED lighting systems (tCO_2) EF 2020=0,8041 tCO2/MWh	Calculating period of time
I	**Schools**	**54**	**1,386.55**	**508.9**	**877.69**	**15/5/2021 to 31/12/2022**
1	Primary school	29	604.7	192.8	411.9	
2	Secondary school	22	617.3	254.5	362.8	
3	High school	3	164.6	61.6	103	
II	**Streets**	**26**	**1,180.93**	**657.0**	**524**	
1	1st batch	18	1,111.5	625.7	485.9	**1/2/2021 to 31/12/2022**
2	2nd batch	8	69.4	31.3	38.1	**1/10/2022 to 31/12/2022**
	Total		**2,567.5**	**1,165.9**	**1,401.6**	

-Total GHG emission reductions of conventional lighting systems in 54 schools and 26 streets (without project interventions) is estimated at **2,567.5** tCO2, average annual GHG emission of 1,781.9 tCO2/year (estimated from the average annual electricity consumption of 1,994.4 MWh/year).

-Total GHG emission reductions of project LED lighting systems in 54 schools and 26 streets is estimated at **1,165.9** tCO2, average annual GHG emission of 791 tCO2/year (estimated from the average annual electricity consumption of 885.3 MWh/year).

-The estimated total GHG emission reductions achieved from project LED lighting systems in 54 schools and 26 streets is **1,401.6** tCO2, average annual GHG emission reduction of 990.8 tCO2/year (based on the achieved electricity savings of 1,109 MWh/year).

Please see the detailed information on calculating results per school and per street in the Annex 7 and 8.

3.2 Assessment of uncertainties of project GHG emission reductions (CO2)

The estimate of percentage uncertainties is an essential element of calculations and verification of results of GHG emission reductions. Assessing the percentage uncertainties is not aiming at evaluating the accuracy of calculated GHG emission results, but is to help improve the decision making on the selection of appropriate methodologies for measurements and calculations of GHG emission in the future. The assessment of the percentage uncertainties for sources of GHG emission/absorption is required to apply the Approach 1, Chapter 3, Volume 1, IPCC 2006. According to the guidelines of IPCC, the uncertainties of GHG emission is estimated in combination with the

uncertainties of activity data (AD) and emission factor (EF), using the following 02 Equations for combining uncertainties [13,14]:

Equation 3. IPCC Equation 3.1

EQUATION 3.1
COMBINING UNCERTAINTIES – APPROACH 1 – MULTIPLICATION

$$U_{total} = \sqrt{U_1^2 + U_2^2 + \ldots + U_n^2}$$

Where:

U_{total} = the percentage uncertainty in the product of the quantities (half the 95 percent confidence interval divided by the total and expressed as a percentage);

U_i = the percentage uncertainties associated with each of the quantities.

Equation 4. IPCC Equation 3.2

EQUATION 3.2
COMBINING UNCERTAINTIES – APPROACH 1 – ADDITION AND SUBTRACTION

$$U_{total} = \frac{\sqrt{(U_1 \bullet x_1)^2 + (U_2 \bullet x_2)^2 + \ldots + (U_n \bullet x_n)^2}}{|x_1 + x_2 + \ldots + x_n|}$$

Where:

U_{total} = the percentage uncertainty in the sum of the quantities (half the 95 percent confidence interval divided by the total (i.e., mean) and expressed as a percentage). This term 'uncertainty' is thus based upon the 95 percent confidence interval;

x_i and U_i = the uncertain quantities and the percentage uncertainties associated with them, respectively.

The surveys that collected project activity data such as baseline measurements and monitoring measurements in schools have 95% confidence level and percentage uncertainty of ± 5%. The percentage uncertainty of activity data for street lighting schools is estimated at 10% and the uncertainty of the EF for national power grid is 7% [14].

-The percentage uncertainties of GHG emission of conventional lighting systems in 54 schools and 26 streets (prior to project LED light installation) is presented in Table 9a as follows:

Table 9a: The uncertainties of GHG emissions by conventional lighting systems

No	Sources of GHG emission	X. GHG emissions (tCO_2)	U. Uncertainty of GHG emission (±%)	(X*U)^2	Uncertainty of activity data (AD) (±%)	Uncertainty of emission factor (EF) (±%)
1	Schools	1,386.6	8.6	14,227.68	5	7
2	Streets	1,180.9	12.2	20,778.42	10	7
		2,567.5	**7.29**	**35,006.10**		

-The percentage uncertainties of GHG emission of project LED lighting systems in 54 schools and 26 streets is presented in Table 9b as follows:

Table 9b: The uncertainties of GHG emissions by project LED lighting systems

No	Sources of GHG emission	X. GHG emissions (tCO_2)	U. Uncertainty of GHG emission (±%)	(X*U)^2	Uncertainty of activity data (AD) (±%)	Uncertainty of emission factor (EF) (±%)
1	Schools	508.9	8.6	1,916.45	5	7
2	Streets	657.0	12.2	6,431.57	10	7
		1,165.9	**7.84**	**8,348.02**		

-The uncertainty of GHG emission reductions of project LED lighting systems in 54 schools and 26 streets estimated until 31/12/2022 is 7.56 %, which is the average of percentage uncertainties for GHG emissions of conventional and LED lighting systems.

V. THE PROJECTION OF ANNUAL RESULTS IN POST PROJECT FOLLOWING YEARS

1. Methodology for projection of project results on GHG emission reductions in 2023-2030

Total GHG emission reductions achieved by project LED lighting systems in 54 schools and 26 streets is 1,401.6 tCO2, calculated from the start date of operation until 31/12/2022. The calculations of projected electric energy consumption, electricity savings, GHG emissions and GHG emission reductions of project lighting systems in the following years from 2023 to 2030 will base on the following assumptions:

-The power of conventional and LED lighting systems used to calculate electric energy consumptions and savings for the time period of 2021-2022 is assumed to remain unchanged.

-The average annual operating hours of lighting systems in the following years from 2023-2030 is assumed to be unchanged as compared to that in the time period of 2021-2022.

The annual electricity savings from project LED lighting systems will be estimated on the basis of the electric energy consumption of conventional and LED lighting systems projected per annum.

-The emission factors for Vietnam power grid 2020 (=0.8041 tCO2/MWh) is used to project the GHG emission of lighting systems and GHG emission reductions of project LED lighting systems in the years from 2023-2030.

-The annual GHG emission and GHG emission reduction achieved per annum will be periodically re-calculated based on the annual updated emission reductions and the total project results of GHG emission reductions is aggregated by 2030.

2. The projection of power consumption and GHG emissions of conventional lighting systems in schools and streets.

-Assuming that the power and usage time of lighting systems remain unchanged, the average annual electric energy consumptions of conventional lighting systems in 54 schools is estimated at 1,034.6 MWh/year. The amount of power consumptions of conventional lighting systems in schools, estimated from 2023-2030, is 8,276.9 MWh.

-Given the power and operating time of lighting systems assumed to be unchanged, the estimated average annual electric energy consumption of conventional lighting systems at 26 streets is 959.8 MWh/year. The amount of power consumptions of conventional lighting systems at streets, estimated from 2023-2030, is 7,678.4 MWh.

-Total electric energy consumptions of conventional lighting systems in 54 schools and at 26 streets, projected for the time period of 2023-2030 is approximately 15,955.3 MWh. See more detailed information in Table 10 below.

Table 10: Projection of electric energy consumption of conventional lighting systems in 54 schools and at 26 streets from 2023-2030

No	Locations	Qty	The average annual amount of power consumption of conventional lighting systems projected in the following years (MWh/year) (with the assumption that the power and use time of conventional lighting system remain unchanged								Total power consumption of conventional lighting systems projected (MWh)
			2023	2024	2025	2026	2027	2028	2029	2030	2023-2030
I	**Schools**	**54**	1,034.6	1,034.6	1,034.6	1,034.6	1,034.6	1,034.6	1,034.6	1,034.6	**8,276.9**
II	**Streets**	**26**	959.8	959.8	959.8	959.8	959.8	959.8	959.8	959.8	**7,678.4**
1	*Package 1*	*18*	*649.1*	*649.1*	*649.1*	*649.1*	*649.1*	*649.1*	*649.1*	*649.1*	***5,192.8***
2	*Package 2*	*8*	*310.7*	*310.7*	*310.7*	*310.7*	*310.7*	*310.7*	*310.7*	*310.7*	***2,485.6***
	Total		**1,994.4**	**1,994.4**	**1,994.4**	**1,994.4**	**1,994.4**	**1,994.4**	**1,994.4**	**1,994.4**	**15,955.3**

-Assuming that the estimated average annual power consumptions in the above table remain unchanged and application of emission factor 2020 for national power grid, the average annual GHG emissions of conventional lighting systems in schools is 924.4 tCO2/years and at 26 streets is 857.5 tCO2/year. Total average annual amount of GHG emissions of conventional lighting systems in schools and at streets is estimated at 1,781.9 tCO2/year. The calculating outcomes in Table 11 below indicates that, from 2023-20330, total amount of GHG emissions of conventional lighting systems in 54 schools and at 26 streets could be approximately 14,255.1 tCO2.

Table 11: Projection of average annual amount of GHG emissions of conventional lighting systems in 54 schools and at 26 streets from 2023-2030

No	Locations	Qty	Projection of average annual GHG emission of conventional lighting systems in the following years (tCO2/year) (assumed that the power consumption of conventional lighting systems remain unchanged and emission factor 2020 for national power grid, 0.8041 tCO2/MWh, is used form estimate)								Total GHG emissions of conventional lighting systems projected (tCO2)
			2023	2024	2025	2026	2027	2028	2029	2030	2023-2030
I	**Schools**	**54**	924.4	924.4	924.4	924.4	924.4	924.4	924.4	924.4	**7,394.9**
II	**Streets**	**26**	857.5	857.5	857.5	857.5	857.5	857.5	857.5	857.5	**6,860.2**
1	*Package 1*	*18*	*579.9*	*579.9*	*579.9*	*579.9*	*579.9*	*579.9*	*579.9*	*579.9*	***4,639.4***
2	*Package 2*	*8*	*277.6*	*277.6*	*277.6*	*277.6*	*277.6*	*277.6*	*277.6*	*277.6*	***2,220.8***
	Total		**1,781.9**	**1,781.9**	**1,781.9**	**1,781.9**	**1,781.9**	**1,781.9**	**1,781.9**	**1,781.9**	**14,255.1**

For more detailed information, please refer to the Annexes 9 and 10.

3. Projection of the power consumption and GHG emission of project LED lighting systems in schools and at streets.

-With the power and usage time of lighting systems assumed to be unchanged, the average annual electric energy consumptions of project LED lighting systems in 54 schools is estimated at 379.8 MWh/year. The amount of power consumptions of project LED lighting systems in schools, estimated from 2023-2030, is 3,038.1 MWh.

-Given the power and operating time of lighting systems assumed to be unchanged, the estimated average annual electric energy consumption of project LED lighting systems at 26 streets is 505.6 MWh/year. The amount of power consumptions of project LED lighting systems at streets, estimated from 2023-2030, is 4,044.9 MWh.

-Total electric energy consumptions of project LED lighting systems in 54 schools and at 26 streets, projected for the time period of 2023-2030 is approximately 7,083.0 MWh. See more detailed information in Table 12 below

Table 12: Projection of electric energy consumption of project LED lighting systems in 54 schools and at 26 streets from 2023-2030

No	Locations	Qty	The average annual amount of power consumption of project LED lighting systems projected in the following years (MWh/year) (with the assumption that the power and use time of conventional lighting system remain unchanged								Total power consumption of LED lighting systems projected (MWh)
			2023	2024	2025	2026	2027	2028	2029	2030	2023-2030
I	Schools	54	379.8	379.8	379.8	379.8	379.8	379.8	379.8	379.8	**3,038.1**
II	Streets	26	505.6	505.6	505.6	505.6	505.6	505.6	505.6	505.6	**4,044.9**
1	*Packg. 1*	*18*	*365.4*	*365.4*	*365.4*	*365.4*	*365.4*	*365.4*	*365.4*	*365.4*	***2,923.0***
2	*Packg 2*	*8*	*140.2*	*140.2*	*140.2*	*140.2*	*140.2*	*140.2*	*140.2*	*140.2*	***1,122.0***
	Total		**885.4**	**885.4**	**885.4**	**885.4**	**885.4**	**885.4**	**885.4**	**885.4**	**7,083.0**

Applying the emission factor 2020 for national power grid, the average annual amount of GHG emissions of LED lighting systems in schools is estimated at 339.3 tCO2/year and at 26 streets is about 451.7 tCO2/year. The average annual amount of GHG emissions of project LED lighting systems in schools and at streets is 6,328.3 tCO2/year in total. The calculating outcomes in Table 13 below show that, from 2023-2030, the total GHG emissions of project LED lighting systems in 54 schools and at 26 streets is projected to be approximately 6,328.3 tCO2.

Table 13: Projection of average annual amount of GHG emissions of project LED lighting systems in 54 schools and at 26 streets from 2023-2030

No	Locations	Qty	Projection of average annual GHG emission of project LED lighting systems in the following years (tCO2/year) (assumed that the power consumption of LED lighting systems remain unchanged and emission factor 2020 for national power grid, 0.8041 tCO2/MWh, is used form estimate)								Total GHG emissions of LED lighting systems projected (tCO2)
			2023	2024	2025	2026	2027	2028	2029	2030	2023-2030
I	Schools	54	339.3	339.3	339.3	339.3	339.3	339.3	339.3	339.3	**2,714.4**
II	Streets	26	451.7	451.7	451.7	451.7	451.7	451.7	451.7	451.7	**3,613.9**
1	*Packg. 1*	*18*	*326.4*	*326.4*	*326.4*	*326.4*	*326.4*	*326.4*	*326.4*	*326.4*	***2,611.5***
2	*Packg 2*	*8*	*125.3*	*125.3*	*125.3*	*125.3*	*125.3*	*125.3*	*125.3*	*125.3*	***1,002.4***
	Total		**791.0**	**791.0**	**791.0**	**791.0**	**791.0**	**791.0**	**791.0**	**791.0**	**6,328.3**

For more detailed information, please refer to the Annexes 11 and 12

4. Projection of electric energy savings and GHG emission reductions of project LED lighting systems in schools and at streets from 2023-2030.

The aggregating outcomes in Table 14 below indicate that the project LED lighting systems are projected to continue achieving an average annual electricity savings of about 654.8 MWh/year in 54 schools and 454.2 MWh/year at 26 streets. The total amount of average annual electricity savings achieved by project LED lighting systems in schools and at streets could be 1,109 MWh/year. The projected amount of electricity savings achieved by project LED lighting systems, estimated from 2023-2030, is 8,872.3 MWh in total.

Table 14: Projection of average annual electricity savings of project LED lighting systems in 54 schools and at 26 streets from 2023 to 2030

No	Locations	Qty	A. Power consumption of conventional lighting systems (MWh/year)	B. Power consumption of LED lighting systems (MWh/year)	Projection of average electricity savings of LED lighting systems per annum in the following years (MWh/year) [=A-B]								C. Total amount of electricity savings projected (MWh)
					2023	2024	2025	2026	2027	2028	2029	2030	**2023-2030**
I	**Schools**	**54**	**1,034.6**	**379.8**	654.8	654.8	654.8	654.8	654.8	654.8	654.8	654.8	**5,238.8**
II	**Streets**	**26**	**959.8**	**505.6**	454.2	454.2	454.2	454.2	454.2	454.2	454.2	454.2	**3,633.5**
1	*Packg. 1*	*18*	*649.1*	*365.4*	283.7	283.7	283.7	283.7	283.7	283.7	283.7	283.7	**2,269.8**
2	*Packg 2*	*8*	*310.7*	*140.2*	170.5	170.5	170.5	170.5	170.5	170.5	170.5	170.5	**1,363.7**
	Total		**1,994.4**	**885.4**	**1,109**	**1,109**	**1,109**	**1,109**	**1,109**	**1,109**	**1,109**	**1,109**	**8,872.3**

Table 15 below aggregates the calculating outcomes of GHG emission reductions achieved by project LED lighting systems in the following time period of 2023-2030, with the assumption that the total amount of electricity savings from project LED lighting systems, 1,109 MWh/year, remain unchanged and the emission factor 2020 for national power grid is applied. It is estimated that project LED lighting systems can help to reduce an average of 990.9 tCO2 of GHG emission per annum and total GHG emission reductions projected to be achieved in the years from 2020 to 2030 is about 7,926.9 tCO2.

Table 15: Projection of GHG emission reductions achieved per annum by project LED lighting systems in 54 schools and at 26 streets from 2023-2030

No	Locations	Qty	A. GHG emission of conventional lighting systems per annum (tCO2/year)	B. GHG emission of LED lighting systems per annum (tCO2/year)	Projection of average GHG emission reduction per annum in the following years (tCO2/year) (EF 2020, 0.8041 tCO2/MWh is applied and total amount of average electricity savings 1.109 MWh/year assumed to be unchanged [=A-B]								C.GHG emission reductions projected to be achieved by the project (tCO2)
					2023	2024	2025	2026	2027	2028	2029	2030	**2023-2030**
I	**Schools**	**54**	**924.4**	**339.3**	585.1	585.1	585.1	585.1	585.1	585.1	585.1	585.1	**4,680.6**
II	**Streets**	**26**	**857.5**	**451.7**	405.8	405.8	405.8	405.8	405.8	405.8	405.8	405.8	**3,246.3**
1	*Packg. 1*	*18*	*579.9*	*326.4*	253.5	253.5	253.5	253.5	253.5	253.5	253.5	253.5	**2,027.9**
2	*Packg 2*	*8*	*277.6*	*125.3*	152.3	152.3	152.3	152.3	152.3	152.3	152.3	152.3	**1,218.4**
	Total		**1,781.9**	**791.0**	**990.9**	**990.9**	**990.9**	**990.9**	**990.9**	**990.9**	**990.9**	**990.9**	**7,926.9**

For more detailed information, please refer to the Annexes 13 and 14

5.Assessment of the percentage uncertainties of GHG emission by lighting systems projected to be in 2023-2030

Table 16a and 16b below presents the assessment of the uncertainty of GHG emission by lighting systems in 54 schools and at 26 streets in the time period of 2023-2030, in compliance with the IPCC Guidelines 2006 [13,14].

Table 16a: The percentage uncertainties of GHG emissions of conventional lighting systems from the time period of 2023-2030

No	Sources of GHG emission	X. GHG emissions (tCO_2)	U. Uncertainty of GHG emission (±%)	(X*U)^2	Uncertainty of activity data (AD) (±%)	Uncertainty of emission factor (EF) (±%)
1	**Schools**	7,394.91	22.36	2,734,238.04	10	20
2	**Streets**	6,860.23	22.36	2,353,140.39	10	20
		14,255.15	**15.82**	**5,087,378.43**		

-The percentage uncertainties of GHG emission by LED lighting systems in 54 schools and at 26 streers from 2023-2030 is summarized in Table 16b below.

Table 16b: The percentage uncertainties of GHG emissions of LED lighting systems from the time period of 2023-2030

No	Sources of GHG emission	X. GHG emissions (tCO_2)	U. Uncertainty of GHG emission (±%)	(X*U)^2	Uncertainty of activity data (AD) (±%)	Uncertainty of emission factor (EF) (±%)
1	**Schools**	2,714.36	22.36	368,386.65	10	20
2	**Streets**	3,613.91	22.36	653,017.15	10	20
		6,328.27	**15.97**	**8,348.02**		

-Thus, the percentage uncertainty of GHG emission reductions projected to be achieved by project LED lighting systems in 2023-2030 (7,926.9 tCO2) is 15.9%, average percentage uncertainties of GHG emission by conventional and LED lighting systems in 54 schools and at 26 streets in this time period.

.VI TOTAL PROJECT RESULTS ON GHG EMISSION REDUCTIONS TO BE REGISTERED

The calculating results indicate that the project LED lighting systems in 54 schools and at 26 streets, operated in the time period of 2021-2022, have saved an amount of electric energy consumption of 1,569 MWh. In the following years of operation from 2023-2030, it is estimated that these project LED lighting systems can save an average of 1,109 MWh/year and the total electricity savings estimated to be achieved during this period of time is about 8,872.3 MWh. Total electricity savings achieved by project LED lighting systems from 2021-2030 is estimated at 10,441.3 MWh.

The total amount of GHG emission reductions achieved by project LED lighting systems in 54 schools and 26 streets in the time period of 2021-2022 is 1,401.6 tCO2. It is projected that these project LED lighting systems would continue to achieve an average emission reduction of 990.9 tCO2/year in 2023-2030 and total GHG emission reduction to be achieved in this period of time would be 7,926.9 tCO2. The total amount of GHG emission reductions achieved by project LED lighting systems in the time period of 2021-2030 is estimated at 9,328.4 tCO2. See more information in the Table 16 below.

It should be noted that the average annual amount of GHG emission reductions projected to be achieved by project LED lighting systems in the time period of 2023-2030 will be annually re-calculated and determined again based on the updated emission factor for national power grid and in the years of biennial inspections, 2024,2026,2028 and 2030.

Table 16: Total GHG emission reductions achieved by project LED lighting systems in 54 schools and 26 streets from 2021-2030

No	Locations of project LED light installation	Qty	A. GHG emission and GHG emission reductions achieved in 2021-2022			B. GHG emission and GHG emission reductions projected to be achieved in 2023-2030			c. Total GHG emission reductions estimated to be achieved from 2021-2030		
			1. GHG emission of conventional lighting systems (tCO2)	2.GHG emission of project LED lighting system (tCO2)	3.GHG emission reductions achieved by project LED lighting systems (tCO2) [=A1-A2]	1. GHG emission of conventional lighting systems (tCO2)	2.GHG emission of project LED lighting system (tCO2)	3.GHG emission reductions achieved by project LED lighting systems (tCO2) [=B1-B2]	1. GHG emission of conventional lighting systems (tCO2) [=A1+B1]	2.GHG emission of project LED lighting systems (tCO2) [=A2+B2]	3 GHG emission reductions achieved by project LED lighting systems (tCO2) [=C1-C2]
I	**Schools**	**54**	**1,386.5**	**508.9**	**877.60**	7,394.91	2,714.36	**4,680.56**	8,781.5	3,223.3	**5,558.2**
II	**Streets**	**26**	**1,180.9**	**657.0**	**523.93**	6,860.23	3,613.91	**3,246.32**	8,041.2	4,270.9	**3,770.3**
1	*Package 1*	*18*	*1,111.5*	*625.7*	***485.86***	*4,639.45*	*2,611.51*	***2,027.94***	*5,751.0*	*3,237.2*	***2,513.8***
2	*Package 2*	*8*	*69.4*	*31.3*	***38.07***	*2,220.79*	*1,002.40*	***1,218.39***	*2,290.2*	*1,033.7*	***1,256.5***
	Total		**2,567.5**	**1,165.9**	**1,401.5**	**14,255.15**	**6,328.27**	**7,926.9**	**16,822.6**	**7,494.2**	**9,328.4**

VII. POST PROJECT MONITORING AND REPORTING

1. Implementing Agency

After the project comes to an end, the periodical monitoring, measurement and reporting of project results will be continuously done by Thua Thue Hue DONRE as delegated by the Provincial P.C under the Correspondence No. 11020/UBND-XD dated October 18th, 2022. The Project TAO will have a specific handover plan and provide technical training and guidance on periodical monitoring, measuring, calculating and reporting as planned.

2. Periodical monitoring and reporting after the project end

-In compliance with the guidance in the Methodologies AMS-II.N and AMS-II.L, the biennial monitoring inspection is applied, following the first inspection during the year of project LED light installation which is 2022.

-The reported project results are calculated based on the actual activity data of LED lighting systems in schools and at streets until 31/12/2022. Values of these calculating results are extrapolated and used for the crediting year of 2023.

-By 2030, at least 04 times of biennial monitoring inspection are required to be continuously implemented in the years 3,5,7,9. The results of biennial monitoring inspections in each of these years can be used to report for two crediting years. The following inspections are required to be implemented in the years 2024, 2026, 2028 and 2030. The results of such monitoring inspections can be applied to crediting years 2024-2025, 2026-2027, 2028-2029, and 2030.

-For street LED lighting systems, the biennial monitoring inspection will determine and update the values of measurement parameters, including the quantity of operating LED luminaires, operating time monitored in a time period of at least 90 days to extrapolate the annual value of operating time for LED lighting systems. The average power of project LED luminaires (W) estimated on the energy saving mechanism of five dimming levels will be used to calculate project results in each time of biennial monitoring.

-For school LED lighting systems, the biennial monitoring inspection will determine and update the values of measurement parameters. For LED lamps with 5 year warranty starting in 2021, it is not necessary to count the quantity of LED lamps during the time before 2025. From 2026 onward, the biennial monitoring inspections are required to monitor and check the quantity of operating LED lamps by methods of counting or survey sampling. The biennial monitoring inspections starting from 2024

onward is required to collect measurement data to calculate the average monthly operating time (hours) of LED lighting systems by using the HOBO ONSET UX90-002M light on/off data loggers. The rated power of LED lamps will be used to calculate project results in each time of biennial monitoring inspection.

-The average annual amount of GHG emission reductions are required to periodically re-calculate based on the updated emission factor issued the previous year. For example, the result of GHG emission reductions in 2023 needs to be estimated again using the EF 2022; and the recalculation of projected amount of GHG emission reductions in 2030 should use the EF 2029,

-The onward biennial monitoring inspections should adopt the sample size used in the baseline and monitoring measurements. If the sample size is required to be determined for biennial monitoring inspections, at least a 95 per cent confidence interval and ±10 % margin of error (precision) shall be achieved for the sampling parameter.

-The project results of electric energy savings and GHG emission reductions (tCO2) are required to be re-calculated on the basis of monitoring data periodically collected in each time of biennial inspections and to be reported in years 2024, 2026, 2028 and 2030.

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VIII. ANNEXES

ANNEX 1: Table of aggregate data on replaced conventional lamps and LED lights installed

No	School name	No of rooms by category installed with LED lamps							Total qty of replaced lamps	Total qty off LED lamps installed (14W &24W)	Total No, of staff and teachers	Total No. of students	Total (2021-2022)
		Clroom	IT-FL room	Office	Practical – lab room	Library	Functional-ervice room	Total rooms					
Primary schools		**498**	**31**	**40**	**0**	**17**	**41**	**627**	**6677**	**8341**	**1369**	**27037**	**28406**
1	An Đông số 1	13	1	2	0	0	0	16	154	204	60	1180	1240
2	An Cựu	18	0	2	0	0	1	21	215	261	36	750	786
3	An Hòa	23	2	2	0	1	2	30	353	380	55	914	969
4	Hương Sơ	21	2	4	0	2	7	36	295	404	41	835	876
5	Huyền Trân	10	2	0	0	1	1	14	254	196	30	549	579
6	Kim Long 1	16	4	5	0	1	7	33	325	386	32	520	552
7	Kim Long 2	12	1	1	0	1	3	18	167	248	30	522	552
8	Lý Thường Kiệt	21	1	3	0	1	0	26	262	378	65	1441	1506
9	Ngô Kha	8	2	1	0	1	2	14	159	162	29	592	621
10	Ngự Bình	15	1	0	0	1	0	17	257	240	35	775	810
11	Phường Đúc	18	0	0	0	0	0	18	168	252	54	1101	1155
12	Phước Vĩnh	14	0	0	0	0	0	14	196	196	55	1139	1194
13	Phú Bình	10	0	1	0	1	1	13	87	172	36	619	655
14	Phú Cát	19	1	0	0	0	0	20	128	284	42	905	947
15	Phú Hậu	22	1	4	0	1	4	32	249	388	34	689	723
16	Phú Hòa	17	1	3	0	1	0	22	205	296	49	886	935
17	Phú Lưu	12	2	2	0	1	2	19	132	228	20	265	285
18	Quang Trung	28	2	0	0	0	1	31	432	510	80	1523	1603
19	Tây Lộc	7	0	1	0	0	0	8	97	114	35	676	711
20	Thủy Biều	10	0	0	0	0	1	11	131	154	32	662	694
21	Thủy Xuân	8	1	1	0	0	2	12	142	144	58	850	908
22	Thuận Hòa	14	0	0	0	1	0	15	120	212	60	1267	1327
23	Thuận Lộc	21	2	0	0	0	2	25	275	330	55	1197	1252
24	Thuận Thành	16	1	2	0	1	1	21	214	254	52	877	929
25	Trần Quốc Toản	30	1	0	0	1	0	32	405	474	56	1026	1082
26	Trường An	18	0	0	0	0	0	18	195	252	60	1496	1556
27	Vỹ Dạ	27	1	1	0	0	1	30	350	416	52	1232	1284
28	Vĩnh Ninh	28	1	2	0	0	0	31	375	414	68	1403	1471
29	Xuân Phú	22	1	3	0	1	3	30	335	392	58	1146	1204
Secondary schools		**352**	**41**	**57**	**53**	**19**	**61**	**583**	**5197**	**8014**	**1112**	**18570**	**19682**
1	Chu Văn An	30	0	2	3	1	0	36	411	536	98	2127	2225
2	Duy Tân	12	3	2	3	1	5	26	194	326	42	700	742
3	Hàm Nghi	18	3	3	2	1	3	30	275	472	40	586	626

4	Hùng Vương	16	3	1	6	1	2	29	320	404	62	1144	1206
5	Huỳnh Th. Kháng	9	3	3	2	1	5	23	177	274	37	537	574
6	Lê Hồng Phong	21	1	4	3	1	3	33	330	420	49	847	896
7	Lý Tự Trọng	14	2	1	2	1	4	24	222	302	31	374	405
8	Nguyễn B. Khiêm	12	1	0	2	0	2	17	150	244	38	515	553
9	Nguyễn Cư Trinh	15	1	0	2	1	2	21	209	310	32	507	539
10	Nguyễn Chí Diểu	23	2	7	3	1	0	36	268	604	94	1957	2051
11	Nguyễn Du	7	1	0	2	0	0	10	53	144	40	537	577
12	Nguyễn Hoàng	9	2	3	3	1	4	22	230	270	41	582	623
13	Nguyễn T. M Khai	11	2	2	2	1	3	21	170	268	38	596	634
14	Nguyễn Văn Linh	16	4	4	3	1	5	33	295	480	37	475	512
15	Nguyễn Văn Trỗi	15	0	0	0	0	0	15	200	210	34	445	479
16	Phạm Văn Đồng	28	3	4	4	1	6	46	383	630	64	1137	1201
17	Phan Sào Nam	21	0	4	3	1	3	32	211	398	47	739	786
18	Tôn Thất Tùng	17	3	4	2	1	3	30	280	354	40	604	644
19	Tố Hữu	11	1	2	2	1	2	19	170	288	51	712	763
20	Thống Nhất	15	1	4	2	1	4	27	166	354	72	1356	1428
21	Trần Cao Vân	19	3	3	0	1	0	26	285	414	84	1473	1557
22	Trần Phú	13	2	4	2	1	5	27	198	312	41	620	661
High schools		**84**	**10**	**20**	**11**	**3**	**5**	**133**	**1802**	**2337**	**324**	**4127**	**4451**
1	Cao Thắng	21	4	13	2	1	2	43	380	590	84	1331	1415
2	Gia Hội	21	2	7	3	1	3	37	462	526	100	1555	1655
3	Quốc Học	42	4	0	6	1	0	53	960	1221	140	1241	1381
Total		**934**	**82**	**117**	**64**	**39**	**107**	**1343**	**13676**	**18692**	**2,805**	**49734**	**52539**

ANNEX 2: Table of aggregate data on replaced Sodium luminaires and LED luminaires installed per street

No	Street name	No of replaced SODIUM luminaires (150W-250W)	No of installed LED luminaires (120W-150W-180W)	Length (m)	Description
I	**1st package**	**1,071**	**1,071**	**25,962**	
1	Lê Duẩn (near the Huong river)	112	112	1600	Urban-level street: major street, connecting to many areas without median strip
2	Lê Duẩn QL1A GPC	137	137	2100	Urban-level street: major street, with median strip
3	Trần Hưng Đạo A (median strip)	34	34	314	Urban-level street: major street, with median strip
4	Trần Hưng Đạo B (EVN lamppost)	30	30	462	Urban-level street: major street, with median strip
5	Bạch Đằng	58	58	1758	Area-level street: the major road of an area, without median strip
6	Huỳnh Thúc Kháng	40	40	1211	Area-level street: the major road of an area, without median strip
7	Đào Duy Anh (steel lamppost)	22	22	710	Area-level street: the major road of an area, without median strip
8	Đào Duy Anh (EVN lamppost)	18	18	610	Area-level street: the major road of an area, without median strip
9	Tăng Bạt Hổ	68	68	2732	Area-level street: the major road of an area, without median strip
10	Đinh Tiên Hoàng	59	59	1692	Area-level street: the major road of an area, without median strip
11	Nguyễn Trãi	88	88	2464	Area-level street: the major road of an area, without median strip
12	Nguyễn Văn Linh	135	135	2284	Urban-level street, main street, with median strip
13	Mai Thúc Loan	30	30	850	Area-level street: the major road of an area, without median strip
14	Yết Kiêu	16	16	630	Area-level street: the major road of an area, without median strip
15	Thái Phiên	36	36	1500	Area-level street: the major road of an area, without median strip
16	Nguyễn Chí Thanh	34	34	1305	Area-level street: the major road of an area, without median strip
17	An Dương Vương	119	119	2200	Urban-level street: major street, with median strip
18	Trần Phú	35	35	1540	Area-level street: the major road of an area, without median strip
II	**2nd package**	**493**	**493**	**12,260**	
19	Lý Thái Tổ A	150	150	1450	On median strip, 2 ways, 3m wide median strip, 4m wide pavement

20	Lý Thái Tổ B	54	54	1450	1 side - 1 way, no pavement, single-rod steel lamppost
21	Cầu Chợ Dinh	66	66	980	2 sides - 2 ways, no median strip, symmetrical arrangement of lamppost, single-rod steel lamppost
22	Bùi Thị Xuân	60	60	2580	1 side- 2 ways, without median strip, two 2.5m wide pavements, single-rod EVN lamppost
23	Đặng Huy Trứ	31	31	1100	1 side- 2 ways, without median strip, two 2.5m wide pavements, single-rod EVN lamppost
24	Lê Ngô Cát	54	54	2300	1 side - 2 ways, without median strip, two 2m wide pavements, single-rod EVN lamppost
25	Minh Mạng	44	44	1600	1 side - 2 ways, without median strip, two 2m wide pavements, single-rod EVN lamppost
26	Hoàng Quốc Việt	34	34	800	2 sides - 2 ways, no median strip, symmetrical arrangement of lamppost, single-rod steel lamppost
	Total	**1564**	**1564**	**38,222**	

ANNEX 3: Methods of sampling and calculation of sample size of surveyed rooms and baseline survey

Sampling for measurement aims to collect data to calculate the mean value of parameters used in the calculations of energy savings and CO2 emission reductions such as baseline lighting demand and average illuminance of conventional lighting systems. Thus, the sampling approach is employed to select the room samples by usage groups to measure the lamp power, consumption power and average illuminance of conventional lighting fixtures per usage group in all the selected schools.

The results of the recent pilot field measurement carried out by an external consultants showed the high degree of variance in actual average power use and average illuminance of conventional lighting fixtures among sampled rooms of different types in 05 schools sampled to represent schools of three educational levels (primary, secondary and high school). The pilot data analysis indicated that the sampled rooms divided into five groups in sampled schools are not homogeneous, with great differences of actual average power use per room and average illuminance among measured rooms. Therefore, to improve the precision of the estimate of the measurement parameters for the survey population based on the data collected from a statistical valid and representative samples of rooms in selected schools, the Project will employ the Stratified Random Sampling method to sample and calculate the total sample size for the baseline survey using the mean and standard deviation values resulted from the project pilot measurement.

The quantity of 1,285 rooms at 54 schools proposed for project support, which are stratified into 05 strata, called Usage Groups. The Usage Groups are the school rooms with different functions and services, stratified into five appropriate room types for usage purposes such as 1) Classrooms, 2) Computer-Foreign Language rooms, 3) Practical-Experimental rooms, 4) Private & Common Offices and 5) Functional-Service rooms that are defined as follows:

1) Usage Group#1-Classrooms: are the rooms where a class of students is taught with lectures;
2) Usage Group#2-Computer & Foreign Language rooms: are the rooms mainly used to study and practice computer skills and foreign languages;
3) Usage Group#3- Practical-Experimental rooms: are the rooms used for practice and do experiments in the field of Physics, Chemistry, Biology, etc.
4) Usage Group#4-Private & Common Offices: Private offices are the offices of Principal/Deputy Principals and Common offices include teachers' offices/rooms, school offices, Finance-Accounting rooms, etc.;
5) Usage Group #5: Functional-Service rooms includes libraries conference halls, Pioneers/ Youth Association rooms, library, medical rooms, arts, music, etc.

The calculated sample size using the sample calculation formula as described in the Guidelines for Sampling and Survey for Project and Program Activities under the UNFCCC Clean Development Mechanism (Version 2.0). The mean and standard deviation values of the interest parameter, that is the actual power use of conventional lighting fixtures per room and average illuminance resulted from the recent project pilot measurement used for calculation of the total sample size is determined across five stratified Usage Groups in all selected schools. Then, the Probability Proportional to Size (PPS) method was used to calculate/estimate each Usage Group sample size and the sample size for schools of three educational levels (primary, secondary and high school). Based on the sample size estimated for each Usage Group, the rooms of different types will be randomly selected for measurement of actual power use and average illuminance of existing conventional lighting fixtures based on the actual conditions and convenience in each target school.

+Determination of the Sample size for baseline measurement

Following the UNFCCC guidelines for sampling, the Stratified Random Sampling Equation is used to estimate a statistical sample size for the baseline survey and measurements, using the mean and standard deviation of power use of conventional lighting per room type and average illuminance determined through the project pilot measurement. The UNFCCC standard sampling and surveys for programme of activities require that the estimate of a survey sample size shall use at least 90% confidence level and ±10% precision as the criteria for required reliability of sampling efforts for small-scale project activities. Adopted from the UNFCCC Guidelines for Sampling and Surveys for CDM project activities and programme of activities, the Equation/formula is used to calculate the total sample size for the baseline survey based on mean values of interest parameter as below:

$$n = \frac{Z^2 \times NV}{(N-1) \times e^2 + Z^2 V}$$

$$V = \left(\frac{SD}{mean}\right)^2$$

SD Is the overall standard deviation, and

$Mean$ Is the overall mean.

$$SD = \sqrt{\frac{(g_a \times SD_a^2) + (g_b \times SD_b^2) + (g_c \times SD_c^2) + \ldots + (g_k \times SD_k^2)}{N}}$$

Where:

SD Weighted overall standard deviation

SD_i Standard deviation of the i^{th} group where i=1,…,k, (note that these are all squared – so the group size is actually being multiplied by the group variance)

g_i Size of the i^{th} group where i=1,…,k

N Population total

$$mean = \frac{(g_a \times m_a) + (g_b \times m_b) + (g_c \times m_c) + \ldots + (g_k \times m_k)}{N}$$

Where:

$Mean$ Weighted overall mean

m_i Mean of the i^{th} group where i=1,…,k

where:

-n is the total sample size for the baseline survey;

-N is the survey population size (1,285 rooms in 54 selected schools)

-Z is the z-score or standard score of 1.645 for 90% confidence level or 1.96 for 95% confidence level required;

-e is the desired level of precision/error margin (sometimes called sampling error, is the range in which true value of the population is estimated to be, a relative term usually expressed in percentage points (for example: ±5 % or ±10%).

-Mean is the expected average value

-m_i is mean of the usage group *i*, of which *i*=1,…….,k

-SD is expected overall Standard Deviation

-g_i is the room number of usage group *i*, of which i *i*=1,…….,k

Table 1: The results of actual power consumption of conventional lighting fixtures per room type discovered in the pilot measurement

No	Usage Groups/Room Types	Mean (Watts)	Standard deviation (Watts)
1	Classrooms	260.8	90.3
2	Computer-foreign language rooms	192.5	46.0
3	Practical-experimental rooms (Physics, Chemistry, Biology,)	244	103.6
4	Private & Common offices	254.5	109.6
5	Functional-Service rooms	276	50.8

The determination of total sample size for baseline measurement has used the above data to calculate the values of overall mean and standard deviation (SD) in the Equation. With the 90% confidence level and ±5% desired precision, the statistically valid and representative sample size calculated for the measurement of power consumption of baseline lighting fixtures and average illuminance is **116 rooms**, which will be pro-rated to estimate the sub-sample size for each Usage group (room type) and for each target school, using the PPS method. The estimated sample size per usage group is presented Table 2 below.

Table 2: Sample size by Usage group for the baseline survey and measurements					
No	**Usage Groups/Room types**	**Primary schools**	**Secondary schools**	**High schools**	**Sample size by Usage group**
1	Classrooms	45	30	6	81
2	Computer-foreign language rooms	4	4	1	9
3	Practical-experimental rooms (Physics, Chemistry, Biology,)	0	4	2	6
4	Private & Common offices	3	5	1	9
5	Functional-Service rooms	4	5	2	11
	Total	**56**	**48**	**12**	**116**

The sample size of each Usage group continues to be estimated for each school, using the PPS method. Random sampling method was employed to select the samples for baseline measurement. Based on the total sample size and sample size assigned for each Usage group, the consultant has randomly selected the room samples to make baseline measurement of power consumption and average illuminance of conventional lighting systems.

Method of illuminance measurement: The required illuminance for different room types is different. At first, dimension of classrooms and functional rooms is measured: length, width and height (from the light bulb to the table surface). For classrooms, the first calculation point should be chosen between each student desk in a row of desks and 1 to 1.5m from the wall, depending on the room size. The space between two points must be at least 1m, in horizontal and vertical direction. As for function rooms, depending on the room area, determine a reasonable distance to check illuminance parameters, but the measurement distance between two calculation points should be in the range of 1-1.5m.

ANNEX 4: Measurement results of average illuminance and luminance of conventional lighting system at 21 streets before LED lamps installation.

No	Street name	Distance between two adjacent lamp posts (m)	Street type	(Average measured Illuminance) Ebq Lux	As per Vietnam standard QCVN 07-7:2016/BXD (Ebq Lux)	Average measured luminance Lbq Cd/m2	As per Vietnam standard QCVN 07-7:2016/BXD (Lbq Cd/m2)
1	Lê Duẩn near Huong River	30	Urban-level street: major street, connecting to many areas without median strip	25	20	1,27	2
2	Lê Duẩn QL1A GPC	40	Urban-level street: major street, with median strip	8	10	0,39	1,5
3	Trần Hưng Đạo A (GPC)	30,5	Urban-level street: major street, with median strip	22	10	1,1	1,5
4	Trần Hưng Đạo B ((EVN lamppost)	34	Urban-level street: major street, with median strip	31	10	2,2	1,5
5	Bạch Đằng	30,5	Area-level street: the major road of an area, without median strip	7	10	0,37	1,5
6	Huỳnh Thúc Kháng	35,5	Area-level street: the major road of an area, without median strip	5	10	0,23	1,5
7	Đào Duy Anh (steel lamppost)	33	Area-level street: the major road of an area, without median strip	7	10	0,36	1,5
8	Đào Duy Anh ((EVN lamppost)	35,5	Area-level street: the major road of an area, without median strip	10	10	0,72	1,5
9	Tăng Bạt Hổ	44	Area-level street: the major road of an area, without median strip	10	10	0,74	1,5
10	Đinh Tiên Hoàng	37,6	Area-level street: the major road of an area, without median strip	10	10	0,68	1,5
11	Nguyễn Trãi	33	Area-level street: the major road of an area, without median strip	14	10	1,02	1,5
12	Mai Thúc Loan	36,7	Area-level street: the major road of an area, without median strip	11	10	0,77	1,5
13	Yết Kiêu	41	Area-level street: the major road of an area, without median strip	12	10	0,88	1,5
14	Thái Phiên	40	Area-level street: the major road of an area, without median strip	11	10	0,78	1,5
15	Ông Ích Khiêm + Xuân 68	37	Area-level street: the major road of an area, without median strip	14	10	1	1,5
16	Lê Thánh Tôn	49	Area-level street: the major road of an area, without median strip	8	10	0,6	1,5
17	Nhật Lệ	42	Area-level street: the major road of an area, without median strip	14	10	1,01	1,5
18	Thạch Hãn	48.2	Area-level street: the major road of an area, without median strip	13	10	0,93	1,5
19	Nguyễn Chí Thanh	40	Area-level street: the major road of an area, without median strip	11	10	0,77	1,5
20	Hùng Vương + An Dương Vương	32	Urban-level street: major street, with median strip	17	10	0,83	1,5
21	Trần Phú	36	Area-level street: the major road of an area, without median strip	9	10	0,63	1,5

ANNEX 5: UX90-002M Methods of sampling and calculating sample size of rooms to measure the operating time of LED lighting systems in schools with HOBO UX90-002M light on/off data loggers

Method of sample size calculation

The project has applied the techniques of estimating sample size as per the Guidelines: Sampling and surveys for CDM activities and programme of activities *(UNFCCC,* CDM-EB67-A06-GUIDE, *Version 03, 2013)*.

Applying the stratified random sampling method, in which the rooms installed project LED lamps are stratified into 06 groups/categories: 1) classrooms; 2) foreign language-computer rooms; 3) Offices/working rooms; 4) Lab/experiment-practice rooms; 5) library; and 6) functional-service rooms and using the simple random formula/equation to calculate the sample size for each room group/category (stratum) presented as below (UNFCCC. EB67-A06-GUIDE, 2013);

$$n \geq \frac{Z^2 \times NV}{(N-1) \times e^2 + Z^2 V}$$

-n is the sample size for each room group/category to be measured;

-N is the total number of rooms of each room group/category that have been installed project LED lamps;

-Z (z-score) is the standard score/value indicating the number of standard deviations by which the value of a raw score is above or below the mean value of what being observed or measured. 1.645 represent the 90% confidence level and 1.96 for 95% confidence level;

-V is the squared coefficient of variation, $V=[SD/mean]^2$

-SD is the expected standard deviation of daily hour of LED lamp use;

-Mean is the expected average daily hour of LED lamp use;

-e is the desired level of precision (sometimes called margin of error) is the range in which true value of the population is estimated to be, a relative term usually expressed in percentage points (for example: ±5 % or ±10%).

The Guidelines of UNFCCC require that the estimated sample size must have at least 90% confidence level and margin of error ≤10% (or precision ≤ 0.1). Using the above sample size formula and the mean and standard deviation number of daily usage hours of LED lamps collected from a pilot monitoring in 306 rooms of 06 room groups/categories in 10 schools, and with 95% confidence level and desired margin of error ± 5% (or ±0.05), the estimated sample size for measurement of operating hours of LED lighting systems of each room category is at least 76 rooms (equivalent to 5.7% of total rooms). The sample size by school level of education (primary, secondary, high schools) is estimated using the Probability Proportional to Size (PPS) method. The total sample size for the measurement that monitors the operating hours of project LED lamps by data loggers and the sample size allocated by room group/category and school level are summarized in the Table below:

Sampe size of rooms by category to monitor the operating time of LED lights in schools						
Code	**Room categories**	**Total rooms**	**Sample size by room category and school level**			
			Primary	**Secondary**	**High**	**Sample size**
1	**Classroom**	934	16	8	4	28
2	**Computer-foreign languages**	82	3	7	2	12
3	**Offices**	117	3	8	2	13
4	**Experimenta-practical**	63	0	7	1	8
5	**Library**	40	3	4	2	9
6	**Functional-services**	107	2	2	2	6
	Total	**1,343**	**27**	**36**	**13**	**76**

Based on the estimated representative sample size by type/group of rooms and school level, the number of sample schools representing for 03 educational levels will be selected. The project will cluster and randomly select 22 representative schools, including 10 high schools, 11 secondary schools and 2 high schools. Rooms in each school will be randomly selected on the basis of sample size allocated by group/room type to measure use time of LED lighting.

Sensor device for monitoring measurement

Literature review and references show that many international projects and studies have used the HOBO UX90-002M Light on/off data logger (as shown in the device image) to measure the operating hours of ligh usage. The HOBO UX90-002M data logger will automatically record the LED light on/off data to measure the operating hours with an error of ±1 minute/month. This device uses a battery of 1-year lifespan, has the memory capacity of 512 KB, and is capable of making 346,795 measurements, with a light threshold for measurement of > 65 lux.

Before starting to measure, the data logger is connected to a computer via USB and uses HOBOware software to start and install monitoring measurement modes. After the measurement period of 4-weeks, the data logger will be recovered and connected to a computer to download data through HOBOware software for storage, synthesis and analysis. Measurement data by the device will be stored, aggregated and analyzed to determine the value of measurement parameters such as total time (hours) of using project LEDs in each category of sampled rooms in a representative period of measurement, monthly average operating time (hours) of project LEDs by room category in a representative period of measurement, total operating hours of project LEDs in each room category extrapolated.

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ANNEX 6: Table of average power of LED luminaires installed at street lightings systems calculated on five dimming level reduction strategies

	Five dimming level of power-saving for project LED luminaires 18 streets in Batch 1	**Level 1**		**Level 2**		**Level 3**		**Level 4**		**Level 5**	
		First 4 hours	P (W)	Next 2 hours	P (W)	Next 2 hours	P (W)	Next 2 hours	P (W)	Next hours	P (W)
	Diming LED lamp types										
1	Lamp MURA-LED 120W 4000K	100%	120	80%	96.0	53%	63.6	80%	96.0	100%	120
2	Lamp MURA-LED 120W 5000K	100%	120	80%	96.0	53%	63.6	80%	96.0	100%	120
3	Lamp MURA-LED 150W 5000K	100%	150	80%	120.0	53%	79.5	80%	120.0	100%	150

	Schedule of operation time in 3/2021		**Level 1**	**Level 2**	**Level 3**	**Level 4**	**Level 5**		
			100%	**80%**	**53%**	**80%**	**100%**	**Total**	**Average**
	18h00 turn on lamps until 05h45	P (W)	18-22h	22-24 h	0-2h	2-4h	4-5h45	**P (W)**	**P (W)**
	Total hours of power supply is 11h45'		**4**	**2**	**2**	**2**	**1.75**	**11.75**	
1	LAMP MURA-LED 120W 4000K		480	192	127.2	192	210	**1201**	**102.2**
2	LAMP MURA-LED 120W 5000K		480	192	127.2	192	210	**1201**	**102.2**
3	LAMP MURA-LED 150W 5000K		600	240	159	240	262.5	**1502**	**127.8**
	Schedule of operation time in 4/2021		**Level 1**	**Level 2**	**Level 3**	**Level 4**	**Level 5**		
			100%	**80%**	**53%**	**80%**	**100%**	**Total**	**Average**
	18h20 turn on lamps until 05h00	P (W)	18h20-22h20	22h20-24h20	0-2h20	2h20-4h20	4h20-5h	**P (W)**	**P (W)**
	Total hours of power supply is 10h40'		**4**	**2**	**2**	**2**	**0.67**	**10.67**	
1	LAMP MURA-LED 120W 4000K		480	192	127.2	192	80	**1071**	**100.4**
2	LAMP MURA-LED 120W 5000K		480	192	127.2	192	80	**1071**	**100.4**
3	LAMP MURA-LED 150W 5000K		600	240	159	240	100	**1339**	**125.5**
			Level 1	**Level 2**	**Level 3**	**Level 4**	**Level 5**		

	Schedule of operation time in 5/2021		**100%**	**80%**	**53%**	**80%**	**100%**	**Total**	**Average**
	18h20 turn on lamps until 05h00	P (W)	18h20-22h20	22h20-24h20	0-2h20	2h20-4h20	4h20-5h	**P (W)**	**P (W)**
	Total hours of power supply is 10h40'		**4**	**2**	**2**	**2**	**0.67**	**10.67**	
1	LAMP MURA-LED 120W 4000K		480	192	127.2	192	80	**1071**	**100.43**
2	LAMP MURA-LED 120W 5000K		480	192	127.2	192	80	**1071**	**100.43**
3	LAMP MURA-LED 150W 5000K		600	240	159	192	100	**1291**	**121.03**
	Schedule of operation time in 6/2021		**Level 1**	**Level 2**	**Level 3**	**Level 4**	**Level 5**		
			100%	**80%**	**53%**	**80%**	**100%**	**Total**	**Average**
	18h30 turn on lamps until 05h00	P (W)	18h30-22h30	22h30-24h30	0-2h30	2h30-4h30	4h30-5h	**P (W)**	**P (W)**
	Total hours of power supply is 10h30'		**4**	**2**	**2**	**2**	**0.5**	**10.50**	
1	LAMP MURA-LED 120W 4000K		480	192	127.2	192	60	**1051**	**100.1**
2	LAMP MURA-LED 120W 5000K		480	192	127.2	192	60	**1051**	**100.1**
3	LAMP MURA-LED 150W 5000K		600	240	159	240	75	**1314**	**125.1**
	Schedule of operation time in 7/2021		**Level 1**	**Level 2**	**Level 3**	**Level 4**	**Level 5**		
			100%	**80%**	**53%**	**80%**	**100%**	**Total**	**Average**
	18h30 turn on lamps until 05h10	P (W)	18h30-22h30	22h30-24h30	0-2h30	2h30-4h30	4h30-5h10	**P (W)**	**P (W)**
	Total hours of power supply is 10h40'		**4**	**2**	**2**	**2**	**0.67**	**10.67**	
1	LAMP MURA-LED 120W 4000K		480	192	127.2	192	80	**1071**	**100.4**
2	LAMP MURA-LED 120W 5000K		480	192	127.2	192	80	**1071**	**100.4**
3	LAMP MURA-LED 150W 5000K		600	240	159	240	100	**1339**	**125.5**
	Schedule of operation time in 8/2021		**Level 1**	**Level 2**	**Level 3**	**Level 4**	**Level 5**		
			100%	**80%**	**53%**	**80%**	**100%**	**Total**	**Average**

	18h15 turn on lamps until 05h10	P (W)	18h15-22h15	22h15-24h15	0-2h15	2h15-4h15	4h15-5h10	**P (W)**	**P (W)**
	Total hours of power supply is 10h55'		**4**	**2**	**2**	**2**	**0.92**	**10.92**	
1	LAMP MURA-LED 120W 4000K		480	192	127.2	192	110	**1101**	**100.9**
2	LAMP MURA-LED 120W 5000K		480	192	127.2	192	110	**1101**	**100.9**
3	LAMP MURA-LED 150W 5000K		600	240	159	240	137.5	**1377**	**126.1**
	Schedule of operation time in 9/2021		**Level 1**	**Level 2**	**Level 3**	**Level 4**	**Level 5**		
			100%	**80%**	**53%**	**80%**	**100%**	**Total**	**Average**
	17h30 turn on lamps until 05h30	P (W)	17h30-21h30	21h30-23h30	0-1h30	1h30-3h30	3h30-5h30	**P (W)**	**P (W)**
	Total hours of power supply is 12h		**4**	**2**	**2**	**2**	**2.00**	**12.00**	
1	LAMP MURA-LED 120W 4000K		480	192	127.2	192	240	**1231**	**102.6**
2	LAMP MURA-LED 120W 5000K		480	192	127.2	192	240	**1231**	**102.6**
3	LAMP MURA-LED 150W 5000K		600	240	159	192	300	**1491**	**124.3**
	Schedule of operation time in 10/2021		**Level 1**	**Level 2**	**Level 3**	**Level 4**	**Level 5**		
			100%	**80%**	**53%**	**80%**	**100%**	**Total**	**Average**
	17h15 turn on lamps until 05h30	P (W)	17h15-21h15	21h15-23h15	0-1h15	1h15-3h15	3h15-5h30	**P (W)**	**P (W)**
	Total hours of power supply is 12h15'		**4**	**2**	**2**	**2**	**2.25**	**12.25**	
1	LAMP MURA-LED 120W 4000K	120	480	192	127.2	192	270	**1261**	**103.0**
2	LAMP MURA-LED 120W 5000K	120	480	192	127.2	192	270	**1261**	**103.0**
3	LAMP MURA-LED 150W 5000K	150	600	240	159	240	337.5	**1577**	**128.7**
	Schedule of operation time in 11/2021		**Level 1**	**Level 2**	**Level 3**	**Level 4**	**Level 5**		
			100%	**80%**	**53%**	**80%**	**100%**	**Total**	**Average**

	17h10 turn on lamps until 05h40	P (W)	17h10-21h10	21h10-23h10	0-1h10	1h10-3h10	3h10-5h40	**P (W)**	**P (W)**
	Total hours of power supply is 12h30'		**4**	**2**	**2**	**2**	**2.50**	**12.5**	
1	LAMP MURA-LED 120W 4000K	120	480	192	127.2	192	300	**1291**	**103.3**
2	LAMP MURA-LED 120W 5000K	120	480	240	127.2	192	300	**1339**	**107.1**
3	LAMP MURA-LED 150W 5000K	150	600	300	159	240	375	**1674**	**133.9**
	Schedule of operation time in 12/2021		**Level 1**	**Level 2**	**Level 3**	**Level 4**	**Level 5**		
			100%	**80%**	**53%**	**80%**	**100%**	**Total**	**Average**
	17h10 turn on lamps until 05h50	P (W)	17h10-21h10	21h10-23h10	0-1h10	1h10-3h10	3h10-5h50	**P (W)**	**P (W)**
	Total hours of power supply is 12h40'		**4**	**2**	**2**	**2**	**2.67**	**12.7**	
1	LAMP MURA-LED 120W 4000K	120	480	192	127.2	192	320	**1311**	**103.5**
2	LAMP MURA-LED 120W 5000K	120	480	192	127.2	192	320	**1311**	**103.5**
3	LAMP MURA-LED 150W 5000K	150	600	240	159	240	400	**1639**	**129.4**
	Schedule of operation time in 1/2022		**Level 1**	**Level 2**	**Level 3**	**Level 4**	**Level 5**		
			100%	**80%**	**53%**	**80%**	**100%**	**Total**	**Average**
	17h30 turn on lamps until 05h30	P (W)	17h30-21h30	21h30-23h30	0-1h30	1h30-3h30	3h30-5h30	**P (W)**	**P (W)**
	Total hours of power supply is 12h		**4**	**2**	**2**	**2**	**2.00**	**12.00**	
1	LAMP MURA-LED 120W 4000K		480	192	127.2	192	240	**1231**	**102.6**
2	LAMP MURA-LED 120W 5000K		480	192	127.2	192	240	**1231**	**102.6**
3	LAMP MURA-LED 150W 5000K		600	240	159	192	300	**1491**	**124.3**
	Schedule of operation time in 2/2022		**Level 1**	**Level 2**	**Level 3**	**Level 4**	**Level 5**		
			100%	**80%**	**53%**	**80%**	**100%**	**Total**	**Average**

	17h45 turn on lamps until 05h30	P (W)	17h45-21h45	21h45-23h45	23h45-1h45	1h45-3h45	3h45-5h30	**P (W)**	**P (W)**
	Total hours of power supply is 11h45'		**4**	**2**	**2**	**2**	**1.75**	**11.75**	
1	LAMP MURA-LED 120W 4000K		480	192	127.2	192	210	**1201**	**102.2**
2	LAMP MURA-LED 120W 5000K		480	192	127.2	192	210	**1201**	**102.2**
3	LAMP MURA-LED 150W 5000K		600	240	159	240	262.5	**1502**	**127.8**

	Five dimming level of power-saving for project LED luminaires 08 streets in Batch 2		**Level 1**		**Level 2**		**Level 3**		**Level 4**		**Level 5**	
		P (W)	First 4 hours	P (W)	Next 2 hours	P (W)	Next 1 hour	P (W)	Next 3 hours	P (W)	Next 2 hours	P (W)
	Dimming LED lamp types											
1	LAMP MAGNOLIA LED-STR16B 120W 5000K, BELED	120	100%	120	70%	84.0	50%	60.0	40%	48.0	70%	84
2	LAMPS MAGNOLIA LED-STR16B 150W 5000K, BELED	150	100%	150	70%	105.0	50%	75.0	40%	60.0	70%	105

	Schedule of operation time in 10/2022			**Level 1**	**Level 2**	**Level 3**	**Level 4**	**Level 5**		
				100%	**70%**	**50%**	**40%**	**70%**	**Total**	**Average**
	17h30 turn on lights until 05h30	No of luminaires	P (W)	17h30-21h30	21h30-23h30	23H30-0h30	0h30-3h30	3h30-5h30	**P (W)**	**P (W)**
	Total hours of power supply is 12h'			**4**	**2**	**1**	**3**	**2**	**12.0**	
1	LAMP MAGNOLIA LED-STR16B 120W 5000K, BELED	343	120	480	168	60	144	168	**1020**	**85.0**
2	LAMP MAGNOLIA LED-STR16B 150W 5000K, BELED	150	150	600	210	60	180	210	**1260**	**105.0**

ANNEX 7: Table of results on electric energy consumption, savings and GHG emission reductions achieved by LED lighting systems per school

Stt	Tên trường	1.Total average annual electricity consumption of conventional lighting systems (MWh/year)	2. Total average annual tCO2 emission of conventional lighting systems (tCO2/year) EF=0,8041	3. Total average annual electricity consumption of project LED lighting systems (MWh/year)	4. Total average annual tCO2 emission of project LED lighting systems (tCO2/year) EF=0,8041	5. Total average annual electric energy savings (MWh/year)	6. Total average annual emission reductions (tCO2/year) EF=0,8041	7.Total average annual electric energy savings in 10 years (2021-2030) (MWh/10 year)	8. Total average annual emission reductions in 10 years (2021-2030) (tCO2/10 year
I	**Primary schools**	**572.9**	**511.9**	**213.8**	**191.0**	**359.2**	**320.9**	**3591.6**	**3208.9**
1	Tây Lộc CS2	7.8	6.9	3.0	2.7	4.8	4.2	47.5	42.4
2	Quang Trung	34.7	31.0	12.8	11.4	21.8	19.5	218.4	195.1
3	Ngự Bình	13.8	12.3	6.3	5.6	7.5	6.7	74.9	66.9
4	Thuỷ Biều	10.4	9.3	4.0	3.6	6.4	5.7	63.9	57.1
5	Huyền Trân	11.3	10.1	4.8	4.3	6.5	5.8	64.7	57.8
6	Hương Sơ	28.2	25.2	9.7	8.7	18.5	16.5	184.7	165.1
7	Phú Hậu	28.9	25.8	9.7	8.7	19.1	17.1	191.5	171.1
8	Ngô Kha	9.0	8.0	3.9	3.5	5.1	4.5	50.7	45.3
9	Phú Bình	14.4	12.9	4.5	4.0	9.9	8.9	99.3	88.7
10	An Hoà	23.1	20.6	9.5	8.5	13.6	12.2	136.0	121.5
11	Kim Long 1	23.3	20.8	9.1	8.2	14.1	12.6	141.5	126.4
12	Phường Đúc	19.3	17.3	6.7	6.0	12.6	11.2	125.8	112.4
13	An Đông	14.6	13.1	5.2	4.7	9.4	8.4	94.1	84.1
14	Kim Long 2	17.1	15.3	6.0	5.4	11.1	9.9	111.0	99.2
15	Lý Thường Kiệt	29.2	26.1	10.0	8.9	19.2	17.2	192.1	171.7
16	Thuận Lộc	21.8	19.5	8.5	7.6	13.3	11.9	133.2	119.0
17	An Cựu	18.1	16.1	6.9	6.2	11.1	9.9	111.2	99.4
18	Vĩnh Ninh	26.3	23.5	10.9	9.8	15.3	13.7	153.2	136.9
19	Thuỷ Xuân	7.9	7.1	3.5	3.2	4.4	3.9	43.7	39.0

20	Phú Lưu	17.1	15.3	5.6	5.0	11.5	10.3	115.2	102.9
21	Phú Cát	24.7	22.1	7.4	6.6	17.3	15.5	173.1	154.7
22	Trần Quốc Toản	32.0	28.6	12.7	11.3	19.3	17.3	193.4	172.8
23	Thuận Hoà	17.6	15.7	5.7	5.1	11.9	10.6	119.0	106.4
24	Phước Vĩnh	11.6	10.3	5.2	4.7	6.3	5.6	63.2	56.5
25	Trường An	18.3	16.4	6.7	6.0	11.6	10.3	115.8	103.4
26	Phú Hoà	22.5	20.1	7.9	7.0	14.6	13.1	146.4	130.8
27	Xuân Phú	26.0	23.2	9.9	8.9	16.1	14.3	160.5	143.4
28	Thuận Thành	16.8	15.0	6.5	5.8	10.3	9.2	102.6	91.6
29	Vỹ Dạ	27.3	24.4	10.8	9.7	16.5	14.7	164.8	147.3
II	**Secondary schools**	**581.4**	**519.4**	**197.1**	**176.1**	**384.9**	**343.9**	**3849.4**	**3439.2**
30	Chu Văn An	43.8	39.2	14.4	12.8	29.5	26.3	294.5	263.2
31	Duy Tân	21.7	19.4	7.4	6.6	14.6	13.1	146.1	130.6
32	Nguyễn Văn Linh	31.5	28.2	10.9	9.8	20.6	18.4	206.1	184.2
33	Phan Sào Nam	30.1	26.9	9.9	8.8	20.6	18.4	206.4	184.4
34	Lê Hồng Phong	27.9	24.9	10.7	9.5	17.2	15.4	172.2	153.9
35	Thống Nhất	29.0	25.9	8.7	7.8	20.3	18.1	203.1	181.4
36	Nguyễn Th M. Khai	19.4	17.4	6.5	5.8	13.0	11.6	129.6	115.8
37	Phạm Văn Đồng	44.1	39.4	15.0	13.4	29.0	26.0	290.5	259.5
38	Huỳnh Thúc Kháng	18.8	16.8	6.4	5.7	12.4	11.1	124.0	110.8
39	Tôn Thất Tùng	24.3	21.7	8.9	8.0	15.4	13.8	154.2	137.8
40	Nguyễn Bỉnh Khiêm	17.7	15.8	5.9	5.3	11.8	10.5	117.6	105.1
41	Nguyễn Du	12.3	11.0	3.5	3.1	8.8	7.9	88.4	79.0
42	Lý Tự Trọng	20.4	18.3	7.2	6.5	13.2	11.8	132.0	118.0
43	Nguyễn Văn Trỗi	12.9	11.6	5.6	5.0	7.3	6.5	73.1	65.3
44	Trần Phú	22.8	20.4	7.6	6.8	15.2	13.6	152.1	135.9
45	Nguyễn Cư Trinh	21.3	19.1	7.5	6.7	13.8	12.4	138.2	123.5

46	Trần Cao Vân	30.8	27.6	10.7	9.5	20.2	18.0	201.7	180.2
47	Nguyễn Hoàng	16.5	14.7	6.4	5.7	10.1	9.0	100.9	90.2
48	Hùng Vương	26.7	23.8	9.9	8.8	16.8	15.0	168.0	150.1
49	Hàm Nghi	35.7	31.9	11.6	10.4	24.1	21.5	240.6	214.9
50	Tố Hữu	21.7	19.4	7.0	6.2	14.7	13.2	147.2	131.6
51	Nguyễn Chí Diểu	51.7	46.2	15.5	13.8	36.3	32.4	362.7	324.0
III	**High schools**	**158.9**	**142.0**	**56.7**	**50.7**	**102.2**	**91.3**	**1021.6**	**912.7**
52	Cao Thắng	43.9	39.2	14.6	13.0	29.3	26.2	293.0	261.7
53	Gia Hội	31.7	28.3	12.6	11.3	19.1	17.0	190.7	170.4
54	Quốc Học	83.3	74.5	29.5	26.4	53.8	48.1	537.9	480.6
	Total	**1,313.2**	**1,173.3**	**467.6**	**417.8**	**846.3**	**756.1**	**8,462.5**	**7,560.8**

ANNEX 8: Table of results on electric energy consumption, savings and GHG emission reductions achieved by LED lighting systems per street

	Name of street installed project LED lights	Qty of project LED luminaires	1.Total average annual electricity consumption of SODIUM lighting systems (MWh/year) (gross)	2. Total average annual tCO2 emission of SODIUM lighting systems (tCO2/year) EF=0,8041	3. Total average annual electricity consumption of project LED lighting systems (MWh/year) (gross)	4. Total average annual tCO2 emission of project LED lighting systems (tCO2/year) EF=0,8041	Total electricity savings of LED lighting systems at 26 streets in 12 months (1 year) (MWh) (gross)	Total average GHG emission reductions per annum (tCO2)
	Installed in Batch 1	**1,071**	**681**	**608**	**365.7**	**326.7**	**315.3**	**281.7**
1	3aTrần Hưng Đạo A (trước chợ Đông Ba	24	20.9	19	13.5	12.1	7.4	6.6
1	3bTrần Hưng Đạo A (trước chợ Đông Ba	10	8.7	8	4.7	4.2	4.1	3.6
2	An Dương Vương	119	97.7	87	44.6	39.9	53.1	47.5
3	Bạch Đằng	58	29.1	26	17.4	15.6	11.7	10.4
4	Đào Duy Anh (Cột điện lực)	18	9.0	8	5.4	4.8	3.6	3.2
5	Đào Duy Anh (Cột thép)	22	11.0	10	6.6	5.9	4.4	3.9
6	Đinh Tiên Hoàng	59	29.6	26	17.7	15.9	11.9	10.6
7	Huỳnh Thúc Kháng	40	20.1	18	12.0	10.8	8.0	7.2
8	Lê Duẩn (đoạn dọc sông Hương)	112	97.6	87	44.6	39.8	53.0	47.4
9	Lê Duẩn Quốc lộ 1 (trên dải phân cách)	137	112.5	101	51.4	45.9	61.2	54.6
10	Mai Thúc Loan	30	15.1	13	9.0	8.1	6.0	5.4
11	Nguyễn Chí Thanh	34	17.1	15	10.2	9.1	6.8	6.1
12	Nguyễn Trãi	88	44.2	39	26.5	23.7	17.7	15.8
13	Nguyễn Văn Linh	135	64.5	58	40.6	36.3	23.9	21.4
14	Tăng Bạt Hổ	68	34.1	30	20.5	18.3	13.7	12.2
15	Thái Phiên	36	18.1	16	10.8	9.7	7.2	6.5
16	Trần Hưng Đạo B (cầu TT đến cầu PX)	30	26.1	23	14.1	12.6	12.0	10.8

17	Trần Phú	35	17.5	16	11.1	9.9	6.4	5.7
18	Yết Kiêu	16	8.0	7	4.8	4.3	3.2	2.9
	Installed in Batch 2	**493**	**312.0**	**278.8**	**135.5**	**121.1**	**176.5**	**157.7**
1	Bùi Thị Xuân	60	28.8	25.7	15.3	13.7	13.5	12
2	Cầu Chợ Dinh	66	32.4	28.9	16.0	14.3	16.4	15
3	Đặng Huy Trứ	31	14.4	12.9	8.3	7.4	6.1	5
4	Hoàng Quốc Việt	34	26.4	23.6	8.3	7.4	18.1	16
5	Lê Ngô Cát	54	26.4	23.6	14.5	13.0	11.9	11
6	Lý Thái Tổ A	150	118.8	106.1	47.4	42.4	71.4	64
7	Lý Thái Tổ B	54	43.2	38.6	13.8	12.3	29.4	26
8	Minh Mạng	44	21.6	19.3	11.8	10.6	9.8	9
	Total	**1,564**	**993.0**	**887**	**501.2**	**447.8**	**491.8**	**439.4**

ANNEX 9: Projection of power consumption & GHG emissions of conventional lighting systems in 54 schools in 2023-2030

No	Schools	Average power consumption of conventional lighting system g (MWh/year)	Projected power consumption of conventional lighting systems from 2023-2030 (MWh)								Total power consumption of conventional lighting systems projected to be in 2023-2030 (MWh)	Emission factor for national grid 2020 (tCO2/MWh)	Average annual technical grid losses (10%)	Projected GHG emission of conventional lighting systems in 2023-2030 (tCO2)								Total GHG emission of conventional lighting systems in 2023-2030 (tCO2)
			2023	2024	2025	2026	2027	2028	2029	2030				2023	2024	2025	2026	2027	2028	2029	2030	
I	**Primary schools**	**451.2**	**451.2**	**451.2**	**451.2**	**451.2**	**451.2**	**451.2**	**451.2**	**451.2**	**3,609.6**			**403.1**	**403.1**	**403.1**	**403.1**	**403.1**	**403.1**	**403.1**	**403.1**	**3,225.0**
1	Tây Lộc	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	56.8	0.8041	0.1	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	50.7
2	Quang Trung	24.1	24.1	24.1	24.1	24.1	24.1	24.1	24.1	24.1	192.8	0.8041	0.1	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	172.3
3	Ngự Bình	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	86.4	0.8041	0.1	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	77.2
4	Thuỷ Biều	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	63.2	0.8041	0.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	56.5
5	Huyền Trân	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	60.8	0.8041	0.1	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	54.3
6	Hương Sơ	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	168.0	0.8041	0.1	18.8	18.8	18.8	18.8	18.8	18.8	18.8	18.8	150.1
7	Phú Hậu	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	168.0	0.8041	0.1	18.8	18.8	18.8	18.8	18.8	18.8	18.8	18.8	150.1
8	Ngô Kha	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	57.6	0.8041	0.1	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	51.5
9	Phú Bình	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	84.0	0.8041	0.1	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	75.0
10	An Hoà	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	140.0	0.8041	0.1	15.6	15.6	15.6	15.6	15.6	15.6	15.6	15.6	125.1
11	Kim Long 1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	144.8	0.8041	0.1	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	129.4
12	Phường Đúc	19.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3	154.4	0.8041	0.1	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	137.9
13	An Đông	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	94.4	0.8041	0.1	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	84.3
14	Kim Long 2	15.4	15.4	15.4	15.4	15.4	15.4	15.4	15.4	15.4	123.2	0.8041	0.1	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	110.1

15	Lý Thường Kiệt	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	180.0	0.8041	0.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	160.8
16	Thuận Lộc	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	128.0	0.8041	0.1	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	114.4
17	An Cựu	14.1	14.1	14.1	14.1	14.1	14.1	14.1	14.1	14.1	112.8	0.8041	0.1	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	100.8
18	Vĩnh Ninh	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	173.6	0.8041	0.1	19.4	19.4	19.4	19.4	19.4	19.4	19.4	19.4	155.1
19	Thuỷ Xuân	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	50.4	0.8041	0.1	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	45.0
20	Phú Lưu	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	107.2	0.8041	0.1	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	95.8
21	Phú Cát	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	164.0	0.8041	0.1	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	146.5
22	Trần Quốc Toản	24.6	24.6	24.6	24.6	24.6	24.6	24.6	24.6	24.6	196.8	0.8041	0.1	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	175.8
23	Thuận Hoà	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	119.2	0.8041	0.1	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	106.5
24	Phước Vĩnh	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	94.4	0.8041	0.1	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	84.3
25	Trường An	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	146.4	0.8041	0.1	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4	130.8
26	Phú Hoà	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	144.8	0.8041	0.1	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	129.4
27	Xuân Phú	17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1	136.8	0.8041	0.1	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	122.2
28	Thuận Thành	12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.4	99.2	0.8041	0.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	88.6
29	Vỹ Dạ	20.2	20.2	20.2	20.2	20.2	20.2	20.2	20.2	20.2	161.6	0.8041	0.1	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	144.4
II	**Secondary schools**	**460.6**	**460.6**	**460.6**	**460.6**	**460.6**	**460.6**	**460.6**	**460.6**	**460.6**	**3,684.8**			**411.5**	**411.5**	**411.5**	**411.5**	**411.5**	**411.5**	**411.5**	**411.5**	**3,292.2**
30	Chu Văn An	31.3	31.3	31.3	31.3	31.3	31.3	31.3	31.3	31.3	250.4	0.8041	0.1	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	223.7
31	Duy Tân	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	148.8	0.8041	0.1	16.6	16.6	16.6	16.6	16.6	16.6	16.6	16.6	132.9
32	Nguyễn Văn Linh	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	209.6	0.8041	0.1	23.4	23.4	23.4	23.4	23.4	23.4	23.4	23.4	187.3
33	Phan Sào Nam	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	201.6	0.8041	0.1	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	180.1
34	Lê Hồng Phong	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	173.6	0.8041	0.1	19.4	19.4	19.4	19.4	19.4	19.4	19.4	19.4	155.1
35	Thống Nhất	23.2	23.2	23.2	23.2	23.2	23.2	23.2	23.2	23.2	185.6	0.8041	0.1	20.7	20.7	20.7	20.7	20.7	20.7	20.7	20.7	165.8
36	Nguyễn TM Khai	15.6	15.6	15.6	15.6	15.6	15.6	15.6	15.6	15.6	124.8	0.8041	0.1	13.9	13.9	13.9	13.9	13.9	13.9	13.9	13.9	111.5
37	Phạm Văn Đồng	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	284.8	0.8041	0.1	31.8	31.8	31.8	31.8	31.8	31.8	31.8	31.8	254.5
38	Huỳnh Thúc Kháng	16.1	16.1	16.1	16.1	16.1	16.1	16.1	16.1	16.1	128.8	0.8041	0.1	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	115.1
39	Tôn Thất Tùng	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3	82.4	0.8041	0.1	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	73.6
40	Nguyễn Bỉnh Khiêm	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	116.0	0.8041	0.1	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	103.6
41	Nguyễn Du	10.6	10.6	10.6	10.6	10.6	10.6	10.6	10.6	10.6	84.8	0.8041	0.1	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	75.8

42	Lý Tự Trọng	16.5	16.5	16.5	16.5	16.5	16.5	16.5	16.5	16.5	132.0	0.8041	0.1	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	117.9
43	Nguyễn Văn Trỗi	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	103.2	0.8041	0.1	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	92.2
44	Trần Phú	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5	148.0	0.8041	0.1	16.5	16.5	16.5	16.5	16.5	16.5	16.5	16.5	132.2
45	Nguyễn Cư Trinh	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4	131.2	0.8041	0.1	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	117.2
46	Trần Cao Vân	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	198.4	0.8041	0.1	22.2	22.2	22.2	22.2	22.2	22.2	22.2	22.2	177.3
47	Nguyễn Hoàng	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	114.4	0.8041	0.1	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	102.2
48	Hùng Vương	22.1	22.1	22.1	22.1	22.1	22.1	22.1	22.1	22.1	176.8	0.8041	0.1	19.7	19.7	19.7	19.7	19.7	19.7	19.7	19.7	158.0
49	Hàm Nghi	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5	228.0	0.8041	0.1	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	203.7
50	Tố Hữu	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	140.0	0.8041	0.1	15.6	15.6	15.6	15.6	15.6	15.6	15.6	15.6	125.1
51	Nguyễn Chí Diểu	40.2	40.2	40.2	40.2	40.2	40.2	40.2	40.2	40.2	321.6	0.8041	0.1	35.9	35.9	35.9	35.9	35.9	35.9	35.9	35.9	287.3
III	**High schools**	**122.8**	**122.8**	**122.8**	**122.8**	**122.8**	**122.8**	**122.8**	**122.8**	**122.8**	**982.4**			**109.7**	**109.7**	**109.7**	**109.7**	**109.7**	**109.7**	**109.7**	**109.7**	**877.7**
52	Cao Thắng	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	265.6	0.8041	0.1	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	237.3
53	Gia Hội	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	201.6	0.8041	0.1	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	180.1
54	Quốc Học	64.4	64.4	64.4	64.4	64.4	64.4	64.4	64.4	64.4	515.2	0.8041	0.1	57.5	57.5	57.5	57.5	57.5	57.5	57.5	57.5	460.3
	Total	**1,034.6**	***#####***	***####***	***####***	***####***	***####***	***####***	***####***	**1,034.6**	**8,276.8**			**924.4**	**924.4**	**924.4**	**924.4**	**924.4**	**924.4**	**924.4**	**924.4**	**7,394.9**

ANNEX 10: Projection of power consumption and GHG emission of conventional lighting systems at 26 streets in 2023-2030

S	Streets	Average power consumption of conventional lighting system g (MWh/year)	Projected power consumption of conventional lighting systems from 2023-2030 (MWh)								Total power consumption of conventional lighting system from 2023-2030 (MWh)	Emission factor for national grid 2020 (tCO2/MWh)	Average annual technical grid losses (10%)	Projected GHG emission of conventional lighting systems from 2023-2030 (tCO2)								Projected GHG emission of conventional lighting systems in 2023-2030 (tCO2)
			2023	2024	2025	2026	2027	2028	2029	2030				2023	2024	2025	2026	2027	2028	2029	2030	
I	**PACK 1**	**649.1**	**649.1**	**649.1**	**649.1**	**649.1**	**649.1**	**649.1**	**649.1**	**649.1**	**5,192.8**			**579.9**	**579.9**	**579.9**	**579.9**	**579.9**	**579.9**	**579.9**	**579.9**	**4639.4**
1	Lê Duẩn dọc SH	**6.5**	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	**771.8**	0.8041	0.1	86.2	86.2	86.2	86.2	86.2	86.2	86.2	86.2	689.6
2	Lê Duẩn Quốc lộ 1	**121.0**	121.0	121.0	121.0	121.0	121.0	121.0	121.0	121.0	**967.9**	0.8041	0.1	108.1	108.1	108.1	108.1	108.1	108.1	108.1	108.1	864.7
3a	Trần Hưng Đạo A (trước chợ)	**20.7**	20.7	20.7	20.7	20.7	20.7	20.7	20.7	20.7	**165.4**	0.8041	0.1	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5	147.8
3b	Trần Hưng Đạo A	**8.6**	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	**68.9**	0.8041	0.1	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	61.6
4	Trần Hưng Đạo B	**25.8**	25.8	25.8	25.8	25.8	25.8	25.8	25.8	25.8	**206.7**	0.8041	0.1	23.1	23.1	23.1	23.1	23.1	23.1	23.1	23.1	184.7
5	Bạch Đằng	**28.7**	28.7	28.7	28.7	28.7	28.7	28.7	28.7	28.7	**229.9**	0.8041	0.1	25.7	25.7	25.7	25.7	25.7	25.7	25.7	25.7	205.4
6	Huỳnh Thúc Kháng	**19.8**	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	**158.6**	0.8041	0.1	17.7	17.7	17.7	17.7	17.7	17.7	17.7	17.7	141.7
7	Đào Duy Anh thép)	**10.9**	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	**87.2**	0.8041	0.1	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	77.9
8	Đào Duy Anh	**8.9**	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	**71.4**	0.8041	0.1	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	63.8
9	Tăng Bạt Hổ	**33.7**	33.7	33.7	33.7	33.7	33.7	33.7	33.7	33.7	**269.6**	0.8041	0.1	30.1	30.1	30.1	30.1	30.1	30.1	30.1	30.1	240.8
10	Đinh Tiên Hoàng	**29.2**	29.2	29.2	29.2	29.2	29.2	29.2	29.2	29.2	**233.9**	0.8041	0.1	26.1	26.1	26.1	26.1	26.1	26.1	26.1	26.1	209.0

11	Nguyễn Trãi	**43.6**	43.6	43.6	43.6	43.6	43.6	43.6	43.6	43.6	**348.8**	0.8041	0.1	39.0	39.0	39.0	39.0	39.0	39.0	39.0	39.0	311.7
12	Mai Thúc Loan	**14.9**	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	**118.9**	0.8041	0.1	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	106.3
13	Yết Kiêu	**7.9**	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	**63.4**	0.8041	0.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	56.7
14	Thái Phiên	**17.8**	17.8	17.8	17.8	17.8	17.8	17.8	17.8	17.8	**142.7**	0.8041	0.1	15.9	15.9	15.9	15.9	15.9	15.9	15.9	15.9	127.5
15	Nguyễn Chí Thanh	**16.8**	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	**134.8**	0.8041	0.1	15.1	15.1	15.1	15.1	15.1	15.1	15.1	15.1	120.4
16	An Dương Vương	**59.0**	59.0	59.0	59.0	59.0	59.0	59.0	59.0	59.0	**471.7**	0.8041	0.1	52.7	52.7	52.7	52.7	52.7	52.7	52.7	52.7	421.5
17	Trần Phú	**18.2**	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	**145.9**	0.8041	0.1	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3	130.4
18	Nguyễn Văn Linh	**66.9**	66.9	66.9	66.9	66.9	66.9	66.9	66.9	66.9	**535.2**	0.8041	0.1	59.8	59.8	59.8	59.8	59.8	59.8	59.8	59.8	478.1
II	**PACK 2**	**310.7**	**310.7**	**310.7**	**310.7**	**310.7**	**310.7**	**310.7**	**310.7**	**310.7**	**2,485.6**			**277.6**	**277.6**	**277.6**	**277.6**	**277.6**	**277.6**	**277.6**	**277.6**	**2220.8**
1	Lý Thái Tổ	**118.4**	118.4	118.4	118.4	118.4	118.4	118.4	118.4	118.4	**946.8**	0.8041	0.1	105.7	105.7	105.7	105.7	105.7	105.7	105.7	105.7	845.9
2	Lý Thái Tổ 2 nhánh	**42.6**	42.6	42.6	42.6	42.6	42.6	42.6	42.6	42.6	**340.9**	0.8041	0.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1	304.5
3	Cầu Chợ Dinh	**31.8**	31.8	31.8	31.8	31.8	31.8	31.8	31.8	31.8	**254.5**	0.8041	0.1	28.4	28.4	28.4	28.4	28.4	28.4	28.4	28.4	227.4
4	Bùi Thị Xuân	**28.9**	28.9	28.9	28.9	28.9	28.9	28.9	28.9	28.9	**231.4**	0.8041	0.1	25.8	25.8	25.8	25.8	25.8	25.8	25.8	25.8	206.7
5	Đặng Huy Trứ	**14.9**	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	**119.5**	0.8041	0.1	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	106.8
6	Lê Ngô Cát	**26.0**	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	**208.2**	0.8041	0.1	23.3	23.3	23.3	23.3	23.3	23.3	23.3	23.3	186.0
7	Minh Mạng	**21.2**	21.2	21.2	21.2	21.2	21.2	21.2	21.2	21.2	**169.7**	0.8041	0.1	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	151.6
8	Hoàng Quốc Việt	**26.8**	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8	**214.6**	0.8041	0.1	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	191.7
	Total	**959.8**	**959.8**	**959.8**	**959.8**	**959.8**	**959.8**	**959.8**	**959.8**	**959.8**	**7,678.4**			**857.5**	**857.5**	**857.5**	**857.5**	**857.5**	**857.5**	**857.5**	**857.5**	**6,860.2**

ANNEX 11: Projection of power consumption and GHG emissions of project LED lighting systems in 54 schools from 2023-2030

		Tổng Average annual power consumption of LED lighting systems(MWh)	Projected power consumption of LED lighting systems in 2023-2030 (MWh)									Emission factor for national grid 2020 (tCO2/MWh)	Average annual technical grid losses (10%)	Projected GHG emission of project LED lighting systems from 2023-2030 (tCO2)									Projected GHG emission reductions achieve from 2023-2030 (tCO2)		
	Schools		2023	2024	2025	2026	2027	2028	2029	2030	Total power consumption of LED lighting systems from 2023-2030 (MWh)			2023	2024	2025	2026	2027	2028	2029	2030	Total GHG emission of LED lighting systems from 2023-2030 (tCO2)	Total GHG emission of conventional lighting systems 2023-2030 (tCO2)	Total GHG emission of LED lighting systems 2023-2030 (tCO2)	Total GHG emission reductions achieved by project LED lighgting systems 2023-2030 (tCO2)
I	**Primary school**	144.1	144.1	144.1	144.1	144.1	144.1	144.1	144.1	144.1	1,152.8			128.7	128.7	128.7	128.7	128.7	128.7	128.7	128.7	1,030.0	3,225.1	1,030.0	2,195.2
1	Tây Lộc	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	6.4	0.8041	0.1	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	5.7	50.9	5.7	45.2
2	Quang Trung	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	88.8	0.8041	0.1	9.9	9.9	9.9	9.9	9.9	9.9	9.9	9.9	79.3	172.5	79.3	93.1
3	Ngự Bình	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	28.0	0.8041	0.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	25.0	77.4	25.0	52.4
4	Thuỷ Biều	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	10.4	0.8041	0.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	9.3	56.8	9.3	47.5
5	Huyền Trân	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	15.2	0.8041	0.1	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	13.6	54.4	13.6	40.8
6	Hương Sơ	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	57.6	0.8041	0.1	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	51.5	150.3	51.5	98.9
7	Phú Hậu	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	52.8	0.8041	0.1	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	47.2	149.8	47.2	102.7
8	Ngô Kha	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	12.8	0.8041	0.1	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	11.4	51.7	11.4	40.2
9	Phú Bình	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	13.6	0.8041	0.1	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	12.2	74.8	12.2	62.6
10	An Hoà	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	56.0	0.8041	0.1	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	50.0	124.9	50.0	74.9
11	Kim Long 1	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	58.4	0.8041	0.1	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	52.2	129.3	52.2	77.1
12	Phường Đúc	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	36.0	0.8041	0.1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	32.2	138.1	32.2	105.9
13	An Đông	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	16.8	0.8041	0.1	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	15.0	84.6	15.0	69.6
14	Kim Long 2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	25.6	0.8041	0.1	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	22.9	109.9	22.9	87.0
15	Lý Thường Kiệt	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	69.6	0.8041	0.1	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	62.2	160.6	62.2	98.5
16	Thuận Lộc	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	43.2	0.8041	0.1	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	38.6	114.1	38.6	75.5

17	An Cựu	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	29.6	0.8041	0.1	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	26.4	100.9	26.4	74.5
18	Vĩnh Ninh	9.9	9.9	9.9	9.9	9.9	9.9	9.9	9.9	9.9	79.2	0.8041	0.1	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	70.8	154.8	70.8	84.0
19	Thuỷ Xuân	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	8.8	0.8041	0.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.9	45.2	7.9	37.3
20	Phú Lưu	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	20.0	0.8041	0.1	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	17.9	95.9	17.9	78.0
21	Phú Cát	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	36.8	0.8041	0.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	32.9	146.2	32.9	113.3
22	Trần Quốc Toản	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	114.4	0.8041	0.1	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	102.2	175.6	102.2	73.4
23	Thuận Hoà	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	24.8	0.8041	0.1	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	22.2	106.4	22.2	84.2
24	Phước Vĩnh	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	21.6	0.8041	0.1	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	19.3	84.3	19.3	65.0
25	Trường An	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	36.0	0.8041	0.1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	32.2	130.9	32.2	98.8
26	Phú Hoà	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	43.2	0.8041	0.1	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	38.6	129.1	38.6	90.5
27	Xuân Phú	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	52.0	0.8041	0.1	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	46.5	122.5	46.5	76.0
28	Thuận Thành	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	25.6	0.8041	0.1	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	22.9	88.7	22.9	65.9
29	Vỹ Dạ	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	69.6	0.8041	0.1	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	62.2	144.6	62.2	82.4
II	**Secondary**	**189.9**	**189.9**	**189.9**	**189.9**	**189.9**	**189.9**	**189.9**	**189.9**	**189.9**	**1,519.2**			**169.7**	**169.7**	**169.7**	**169.7**	**169.7**	**169.7**	**169.7**	**169.7**	**1,357.3**	**3,292.2**	**1,357.3**	**1,934.9**
30	Chu Văn An	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	172.0	0.8041	0.1	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	153.7	224.0	153.7	70.3
31	Duy Tân	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	49.6	0.8041	0.1	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	44.3	133.1	44.3	88.8
32	Nguyễn Văn Linh	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	89.6	0.8041	0.1	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	80.1	186.9	80.1	106.9
33	Phan Sào Nam	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	87.2	0.8041	0.1	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	77.9	180.0	77.9	102.1
34	Lê Hồng Phong	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	97.6	0.8041	0.1	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	87.2	155.2	87.2	68.0
35	Thống Nhất	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	68.8	0.8041	0.1	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	61.5	165.9	61.5	104.5
36	Nguyễn TM Khai	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	40.8	0.8041	0.1	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	36.5	111.8	36.5	75.3
37	Phạm Văn Đồng	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	176.0	0.8041	0.1	19.7	19.7	19.7	19.7	19.7	19.7	19.7	19.7	157.2	254.3	157.2	97.1
38	Huỳnh Thúc Kháng	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	43.2	0.8041	0.1	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	38.6	114.9	38.6	76.3
39	Tôn Thất Tùng	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	68.0	0.8041	0.1	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	60.8	73.3	60.8	12.5
40	Nguyễn Bỉnh Khiêm	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	32.8	0.8041	0.1	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	29.3	103.8	29.3	74.5

41	Nguyễn Du	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	12.0	0.8041	0.1	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	10.7	75.6	10.7	64.9
42	Lý Tự Trọng	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	48.8	0.8041	0.1	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	43.6	118.1	43.6	74.5
43	Nguyễn Văn Trỗi	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	44.8	0.8041	0.1	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	40.0	92.4	40.0	52.4
44	Trần Phú	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	48.8	0.8041	0.1	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	43.6	132.3	43.6	88.7
45	Nguyễn Cư Trinh	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	45.6	0.8041	0.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	40.7	117.6	40.7	76.8
46	Trần Cao Vân	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	70.4	0.8041	0.1	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	62.9	177.4	62.9	114.5
47	Nguyễn Hoàng	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	44.0	0.8041	0.1	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	39.3	102.0	39.3	62.6
48	Hùng Vương	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	64.8	0.8041	0.1	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	57.9	157.7	57.9	99.9
49	Hàm Nghi	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	74.4	0.8041	0.1	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	66.5	203.4	66.5	136.9
50	Tố Hữu	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	44.8	0.8041	0.1	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	40.0	125.2	40.0	85.2
51	Nguyễn Chí Diểu	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	95.2	0.8041	0.1	10.6	10.6	10.6	10.6	10.6	10.6	10.6	10.6	85.1	287.3	85.1	202.2
III	**High schools**	**46.1**	**46.1**	**46.1**	**46.1**	**46.1**	**46.1**	**46.1**	**46.1**	**46.1**	**368.8**			**41.2**	**41.2**	**41.2**	**41.2**	**41.2**	**41.2**	**41.2**	**41.2**	**329.5**	**877.6**	**329.5**	**548.1**
52	Cao Thắng	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	91.2	0.8041	0.1	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	81.5	237.6	81.5	156.1
53	Gia Hội	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	81.6	0.8041	0.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	72.9	179.9	72.9	107.0
54	Quốc Học	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	196.0	0.8041	0.1	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	175.1	460.1	175.1	285.0
	Total	**380.1**	**380.1**	**380.1**	**380.1**	**380.1**	**380.1**	**380.1**	**380.1**	**380.1**	**3,040.8**			**339.6**	**339.6**	**339.6**	**339.6**	**339.6**	**339.6**	**339.6**	**339.6**	**2,716.8**	**7,394.9**	**2,716.8**	**4,678.1**

ANNEX 12: Projection o power consumption and GHG emissions of project LED lighting systems in at 26 streets from 2023-2030

	Streets	Average annual power consumption of LED lighting systemsm (MWh/year)	Projected power consumption of project LED lighting systems from 2023-2030 (MWh)									Emission factor for national grid 2020 (tCO2/MWh)	Average annual technical grid losses (10%)	Projected GHG emission of project LED lighting systems from 2023-2030 (tCO2)									Projected GHG emission reductions achieve from 2023-2030 (tCO2)		
			2023	2024	2025	2026	2027	2028	2029	2030	Total power consumption of LED lighting systems from 2023-2030 (MWh)			2023	2024	2025	2026	2027	2028	2029	2030	Total GHG emission of project LED lighting systems from 2023-2030 (tCO2)	Total GHG emission of conventional lighting systems 2023-2030 (tCO2)	Total GHG emission of conventional lighting systems 2023-2030 (tCO2)	Total GHG emission of conventional lighting systems 2023-2030 (tCO2)
I	**Pack1**	**365.2**	**365.2**	**365.2**	**365.2**	**365.2**	**365.2**	**365.2**	**365.2**	**365.2**	**1,435.5**			**326.3**	**326.3**	**326.3**	**326.3**	**326.3**	**326.3**	**326.3**	**326.3**	**2,610.3**	**4,639.4**	**2,610.3**	**2,029.2**
1	Lê Duẩn (đoạn dọc sông	**44.6**	44.6	44.6	44.6	44.6	44.6	44.6	44.6	44.6	356.8	0.8041	0.1	39.8	39.8	39.8	39.8	39.8	39.8	39.8	39.8	318.8	689.6	318.8	370.8
2	Lê Duẩn Quốc lộ 1	**51.3**	51.3	51.3	51.3	51.3	51.3	51.3	51.3	51.3	410.4	0.8041	0.1	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8	366.7	864.7	366.7	498.1
3a	Trần Hưng Đạo A	**13.5**	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	108.0	0.8041	0.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	96.5	147.8	96.5	51.3
3b	Trần Hưng Đạo A lực)	**4.7**	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	0.8041	0.1	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	33.6	61.6	33.6	28.0
4	Trần Hưng Đạo B	**14.1**	14.1	14.1	14.1	14.1	14.1	14.1	14.1	14.1	112.8	0.8041	0.1	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	100.8	184.7	100.8	83.9
5	Bạch Đằng	**17.4**	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	139.2	0.8041	0.1	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	124.4	205.4	124.4	81.1
6	Huỳnh Thúc Kháng	**12.0**	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	96.0	0.8041	0.1	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	85.8	141.7	85.8	55.9
7	Đào Duy Anh	**6.6**	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	0.8041	0.1	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	47.2	77.9	47.2	30.7

8	Đào Duy Anh (Cột	**5.4**	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	0.8041	0.1	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	38.6	63.8	38.6	25.2
9	Tăng Bạt Hổ	**20.4**	20.4	20.4	20.4	20.4	20.4	20.4	20.4	20.4	20.4	0.8041	0.1	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	145.8	240.8	145.8	95.0
10	Đinh Tiên Hoàng	**17.7**	17.7	17.7	17.7	17.7	17.7	17.7	17.7	17.7	17.7	0.8041	0.1	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8	126.5	209.0	126.5	82.5
11	Nguyễn Trãi	**26.4**	26.4	26.4	26.4	26.4	26.4	26.4	26.4	26.4	26.4	0.8041	0.1	23.6	23.6	23.6	23.6	23.6	23.6	23.6	23.6	188.7	311.7	188.7	123.0
12	Mai Thúc Loan	**9.0**	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	0.8041	0.1	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	64.3	106.3	64.3	41.9
13	Yết Kiêu	**4.8**	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	0.8041	0.1	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	34.3	56.7	34.3	22.4
14	Thái Phiên	**10.8**	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	0.8041	0.1	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	77.2	127.5	77.2	50.3
15	Nguyễn Chí Thanh	**10.2**	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	0.8041	0.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	72.9	120.4	72.9	47.5
16	An Dương Vương	**44.6**	44.6	44.6	44.6	44.6	44.6	44.6	44.6	44.6	44.6	0.8041	0.1	39.8	39.8	39.8	39.8	39.8	39.8	39.8	39.8	318.8	421.5	318.8	102.7
17	Trần Phú	**11.1**	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	0.8041	0.1	9.9	9.9	9.9	9.9	9.9	9.9	9.9	9.9	79.3	130.4	79.3	51.1
18	Nguyễn V. Linh	**40.6**	40.6	40.6	40.6	40.6	40.6	40.6	40.6	40.6	40.6	0.8041	0.1	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3	290.2	478.1	290.2	187.9
II	**Pack 2**	**140.2**	**140.2**	**140.2**	**140.2**	**140.2**	**140.2**	**140.2**	**140.2**	**140.2**	**1,122.0**			**125.3**	**125.3**	**125.3**	**125.3**	**125.3**	**125.3**	**125.3**	**125.3**	**1,002.4**	**2,220.8**	**1,002.4**	**1,218.4**
1	Lý Thái Tổ	**49.1**	49.1	49.1	49.1	49.1	49.1	49.1	49.1	49.1	392.5	0.8041	0.1	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	350.6	845.9	350.6	495.3
2	Lý Thái Tổ 2 nhánh	**14.3**	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	114.3	0.8041	0.1	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	102.2	304.5	102.2	202.4
3	Cầu Chợ Dinh	**16.6**	16.6	16.6	16.6	16.6	16.6	16.6	16.6	16.6	132.5	0.8041	0.1	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	118.4	227.4	118.4	109.0
4	Bùi Thị Xuân	**15.9**	15.9	15.9	15.9	15.9	15.9	15.9	15.9	15.9	127.1	0.8041	0.1	14.2	14.2	14.2	14.2	14.2	14.2	14.2	14.2	113.5	206.7	113.5	93.2
5	Đặng Huy Trứ	**8.6**	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	69.0	0.8041	0.1	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	61.7	106.8	61.7	45.1
6	Lê Ngô Cát	**15.0**	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	120.3	0.8041	0.1	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	107.5	186.0	107.5	78.6
7	Minh Mạng	**12.2**	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	98.0	0.8041	0.1	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	87.6	151.6	87.6	64.0
8	Hoàng Q Việt	**8.5**	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	68.3	0.8041	0.1	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	61.0	191.7	61.0	130.8
	Tổng	**505.4**	**505.4**	**505.4**	**505.4**	**505.4**	**505.4**	**505.4**	**505.4**	**505.4**	**2,557.5**			**451.6**	**451.6**	**451.6**	**451.6**	**451.6**	**451.6**	**451.6**	**451.6**	**3,612.7**	**6,860.2**	**3,612.7**	**3,247.5**

ANNEX 13: The projection of average annual electric energy savings and total amount of GHG emission reductions in 54 schools from 2021-2030

		A. AVERAGE ANNUAL GHG EMISSION REDUCTIONS FORM PROJECT LED LIGHTING SYSTEMS (tCO2/year)						B. GHG EMISSION REDUCTIONS ESTIMATED TO BE ACHIEVED FROM 2021-2030									
	School name	1.Average annual power consumption of conventional lighting systems (MWh/year)	2. Average annual power consumption of project LED lighting systems (MWh/year)	3. Average annual electricity savings from project LED lighting systems (MWh/year)	4. Emission Factor for national grid 2020 (tCO2/MWh)	5. Average annual technical grid loss(10%)	6. Average annual GHG emission reduction (tCO2/year)) =[(A3*A4)/(1-A5)]	1. GHG emission reductions achieved by project LED lighting systems (tCO2)	2. PROJECTED GHG EMISSION REDUCTIONS ACHIEVED PER ANNUM (tCO2/year) (Use EF 2020 =0.8041 tCO2/MWh and average annual electricity savings assumed to be unchanged)								3. Total GHG emission reduction achieved by project LED lighting systems (tCO2)
								2021-2022	2023	2024	2025	2026	2027	2028	2029	2030	2021-2030
1	Tây Lộc	7.12	0.75	6.37	0.8041	0.1	**5.69**	8.53	5.69	5.69	5.69	5.69	5.69	5.69	5.69	5.69	54.04
2	Quang Trung	24.13	11.06	13.07	0.8041	0.1	**11.7**	17.52	11.68	11.68	11.68	11.68	11.68	11.68	11.68	11.68	110.94
3	Ngự Bình	10.83	3.55	7.28	0.8041	0.1	**6.5**	9.76	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	61.79
4	Thuỷ Biều	7.95	1.26	6.69	0.8041	0.1	**6.0**	8.96	5.97	5.97	5.97	5.97	5.97	5.97	5.97	5.97	56.76
5	Huyền Trân	7.61	1.90	5.71	0.8041	0.1	**5.1**	7.65	5.10	5.10	5.10	5.10	5.10	5.10	5.10	5.10	48.44
6	Hương Sơ	21.03	7.21	13.82	0.8041	0.1	**12.3**	18.52	12.34	12.34	12.34	12.34	12.34	12.34	12.34	12.34	117.27
7	Phú Hậu	20.96	6.64	14.32	0.8041	0.1	**12.8**	19.19	12.79	12.79	12.79	12.79	12.79	12.79	12.79	12.79	121.54
8	Ngô Kha	7.23	1.58	5.64	0.8041	0.1	**5.0**	7.56	5.04	5.04	5.04	5.04	5.04	5.04	5.04	5.04	47.89
9	Phú Bình	10.46	1.65	8.81	0.8041	0.1	**7.9**	11.81	7.87	7.87	7.87	7.87	7.87	7.87	7.87	7.87	74.80
10	An Hoà	17.48	6.97	10.51	0.8041	0.1	**9.4**	14.08	9.39	9.39	9.39	9.39	9.39	9.39	9.39	9.39	89.20
11	Kim Long 1	18.08	7.34	10.75	0.8041	0.1	**9.6**	14.40	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	91.20
12	Phường Đúc	19.32	4.53	14.79	0.8041	0.1	**13.2**	19.82	13.21	13.21	13.21	13.21	13.21	13.21	13.21	13.21	125.52

13	An Đông	11.84	2.07	9.77	0.8041	0.1	**8.7**	13.09	8.73	8.73	8.73	8.73	8.73	8.73	8.73	8.73	82.93
14	Kim Long 2	15.37	3.22	12.15	0.8041	0.1	**10.9**	16.28	10.85	10.85	10.85	10.85	10.85	10.85	10.85	10.85	103.10
15	Lý Thường Kiệt	22.47	8.70	13.77	0.8041	0.1	**12.3**	18.46	12.31	12.31	12.31	12.31	12.31	12.31	12.31	12.31	116.90
16	Thuận Lộc	15.96	5.35	10.61	0.8041	0.1	**9.5**	14.22	9.48	9.48	9.48	9.48	9.48	9.48	9.48	9.48	90.07
17	An Cựu	14.12	3.68	10.44	0.8041	0.1	**9.3**	13.99	9.33	9.33	9.33	9.33	9.33	9.33	9.33	9.33	88.60
18	Vĩnh Ninh	21.66	9.89	11.77	0.8041	0.1	**10.5**	15.78	10.52	10.52	10.52	10.52	10.52	10.52	10.52	10.52	99.93
19	Thuỷ Xuân	6.32	1.07	5.26	0.8041	0.1	**4.7**	7.04	4.70	4.70	4.70	4.70	4.70	4.70	4.70	4.70	44.61
20	Phú Lưu	13.41	2.51	10.90	0.8041	0.1	**9.7**	14.61	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	92.55
21	Phú Cát	20.45	4.60	15.86	0.8041	0.1	**14.2**	21.25	14.17	14.17	14.17	14.17	14.17	14.17	14.17	14.17	134.59
22	Trần Quốc Toản	24.57	14.25	10.32	0.8041	0.1	**9.2**	13.83	9.22	9.22	9.22	9.22	9.22	9.22	9.22	9.22	87.58
23	Thuận Hoà	14.89	3.08	11.81	0.8041	0.1	**10.6**	15.83	10.55	10.55	10.55	10.55	10.55	10.55	10.55	10.55	100.25
24	Phước Vĩnh	11.80	2.74	9.05	0.8041	0.1	**8.1**	12.13	8.09	8.09	8.09	8.09	8.09	8.09	8.09	8.09	76.85
25	Trường An	18.32	4.53	13.79	0.8041	0.1	**12.3**	18.48	12.32	12.32	12.32	12.32	12.32	12.32	12.32	12.32	117.04
26	Phú Hoà	18.06	5.43	12.63	0.8041	0.1	**11.3**	16.93	11.29	11.29	11.29	11.29	11.29	11.29	11.29	11.29	107.21
27	Xuân Phú	17.14	6.48	10.66	0.8041	0.1	**9.5**	14.28	9.52	9.52	9.52	9.52	9.52	9.52	9.52	9.52	90.46
28	Thuận Thành	12.42	3.16	9.26	0.8041	0.1	**8.3**	12.41	8.27	8.27	8.27	8.27	8.27	8.27	8.27	8.27	78.57
29	Vỹ Dạ	20.23	8.68	11.54	0.8041	0.1	**10.3**	15.47	10.31	10.31	10.31	10.31	10.31	10.31	10.31	10.31	97.97
30	Chu Văn An	31.34	21.49	9.85	0.8041	0.1	**8.8**	13.20	8.80	8.80	8.80	8.80	8.80	8.80	8.80	8.80	83.61
31	Duy Tân	18.63	6.19	12.44	0.8041	0.1	**11.1**	16.67	11.11	11.11	11.11	11.11	11.11	11.11	11.11	11.11	105.57
32	Nguyễn Văn Linh	26.15	11.19	14.97	0.8041	0.1	**13.4**	20.06	13.37	13.37	13.37	13.37	13.37	13.37	13.37	13.37	127.02
33	Phan Sào Nam	25.19	10.87	14.32	0.8041	0.1	**12.8**	19.20	12.80	12.80	12.80	12.80	12.80	12.80	12.80	12.80	121.57
34	Lê Hồng Phong	21.72	12.16	9.56	0.8041	0.1	**8.5**	12.81	8.54	8.54	8.54	8.54	8.54	8.54	8.54	8.54	81.12
35	Thống Nhất	23.22	8.65	14.57	0.8041	0.1	**13.0**	19.52	13.01	13.01	13.01	13.01	13.01	13.01	13.01	13.01	123.63
36	Nguyễn TM Khai	15.64	5.11	10.53	0.8041	0.1	**9.4**	14.11	9.41	9.41	9.41	9.41	9.41	9.41	9.41	9.41	89.39
37	Phạm Văn Đồng	35.58	22.05	13.53	0.8041	0.1	**12.1**	18.14	12.09	12.09	12.09	12.09	12.09	12.09	12.09	12.09	114.87
38	Huỳnh Thúc Kháng	16.08	5.38	10.70	0.8041	0.1	**9.6**	14.33	9.56	9.56	9.56	9.56	9.56	9.56	9.56	9.56	90.78

39	Tôn Thất Tùng	10.25	8.48	1.77	0.8041	0.1	**1.6**	2.37	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	15.01
40	Nguyễn Bỉnh Khiêm	14.52	4.09	10.44	0.8041	0.1	**9.3**	13.99	9.33	9.33	9.33	9.33	9.33	9.33	9.33	9.33	88.59
41	Nguyễn Du	10.57	1.54	9.04	0.8041	0.1	**8.1**	12.11	8.07	8.07	8.07	8.07	8.07	8.07	8.07	8.07	76.70
42	Lý Tự Trọng	16.52	6.09	10.43	0.8041	0.1	**9.3**	13.97	9.32	9.32	9.32	9.32	9.32	9.32	9.32	9.32	88.51
43	Nguyễn Văn Trỗi	12.93	5.62	7.31	0.8041	0.1	**6.5**	9.80	6.53	6.53	6.53	6.53	6.53	6.53	6.53	6.53	62.04
44	Trần Phú	18.51	6.13	12.38	0.8041	0.1	**11.1**	16.60	11.06	11.06	11.06	11.06	11.06	11.06	11.06	11.06	105.10
45	Nguyễn Cư Trinh	16.45	5.74	10.70	0.8041	0.1	**9.6**	14.34	9.56	9.56	9.56	9.56	9.56	9.56	9.56	9.56	90.85
46	Trần Cao Vân	24.81	8.76	16.05	0.8041	0.1	**14.3**	21.51	14.34	14.34	14.34	14.34	14.34	14.34	14.34	14.34	136.24
47	Nguyễn Hoàng	14.26	5.46	8.81	0.8041	0.1	**7.9**	11.80	7.87	7.87	7.87	7.87	7.87	7.87	7.87	7.87	74.74
48	Hùng Vương	22.07	8.11	13.96	0.8041	0.1	**12.5**	18.71	12.47	12.47	12.47	12.47	12.47	12.47	12.47	12.47	118.50
49	Hàm Nghi	28.46	9.27	19.19	0.8041	0.1	**17.1**	25.72	17.15	17.15	17.15	17.15	17.15	17.15	17.15	17.15	162.89
50	Tố Hữu	17.51	5.64	11.87	0.8041	0.1	**10.6**	15.91	10.61	10.61	10.61	10.61	10.61	10.61	10.61	10.61	100.75
51	Nguyễn Chí Diểu	40.19	11.89	28.31	0.8041	0.1	**25.3**	37.94	25.29	25.29	25.29	25.29	25.29	25.29	25.29	25.29	240.27
52	Cao Thắng	33.24	11.35	21.89	0.8041	0.1	**19.6**	29.33	19.55	19.55	19.55	19.55	19.55	19.55	19.55	19.55	185.76
53	Gia Hội	25.17	10.17	15.00	0.8041	0.1	**13.4**	20.11	13.40	13.40	13.40	13.40	13.40	13.40	13.40	13.40	127.34
54	Quốc Học	64.37	24.47	39.90	0.8041	0.1	**35.7**	53.48	35.65	35.65	35.65	35.65	35.65	35.65	35.65	35.65	338.70
	Total	**1,034.6**	**379.76**	**654.85**			**585**	**877.6**	**585**	**585**	**585**	**585**	**585**	**585**	**585**	**585**	**5,558.2**

ANNEX 14 : The projection of average annual electric energy savings and total amount of GHG emission reductions at 26 streets from 2021-2030

	Streets	Length(m)	I. Qty and power of LED luminaires installed		A. AVERAGE ANNUAL ELECTRICITY SAVING (MWh/year)			B. AVERAGE ANNUAL GHG EMISSION REDUCTION ACHIEVED BY PROJECT LED LIGHTING SYSTEMS (tCO2/year)				C. GHG EMISSION REDUCTIONS ESTIMATED TO BE ACHIEVED BY PROJECT LED LIGHTING SYSTEMS FORM 2021-2030									
			1. Qty	2. Rated power (W)	1. Average annual power consumption of conventional lighting systems (MWh/year)	2. Average annual power consumption of LED lighting systems (MWh/year)	3.Average annuam electricity savings achieved by project LED lighting systems (MWh/yyear) [=(A1-A2)]	1.Average annual electricity savings by project LED lighting systems (MWh/year)	2. Emission Factor for national grid 2020 (tCO2/MWh)	3. Average annual technical grid loss(10%)	4. Average annual GHG emission reductions by project LED lighting systems (tCO2/year) =[(B1*B2/(1-B3)]	1. GHG emission reductions achieved by project LED lighting systems (tCO2)	2. PROJECTED GHG EMISSION REDUCTIONS ACHIEVED PER ANNUM (tCO2/year) (Use EF 2020 =0.8041 tCO2/MWh and average annual electricity savings assumed to be unchanged)								3. Total GHG emission reduction achieved by project LED lighting systems (tCO2)
I	Pack I											2021-2022	2023	2024	2025	2026	2027	2028	2029	2030	2021-2030
1	Lê Duẩn (đoạn dọc sông Hương	1,600	112	150	96.48	44.56	**51.92**	51.92	0.8041	0.1	**46.4**	88.9	46.4	46.4	46.4	46.4	46.4	46.4	46.4	46.4	460.0
2	Lê Duẩn Quốc lộ 1	2,100	137	150	120.98	51.33	**69.65**	69.65	0.8041	0.1	**62.2**	119.3	62.2	62.2	62.2	62.2	62.2	62.2	62.2	62.2	617.1
3a	Trần Hưng Đạo A (trước chợ	314	24	180	20.67	13.54	**7.13**	7.13	0.8041	0.1	**6.4**	12.2	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	63.2
3b	Trần Hưng Đạo A (		10	150	8.61	4.66	**3.96**	3.96	0.8041	0.1	**3.5**	6.8	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	35.1
4	Trần Hưng Đạo B	462	30	150	25.84	14.11	**11.74**	11.74	0.8041	0.1	**10.5**	20.1	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	104.0

5	Bạch Đằng	1,758	58	120	28.74	17.43	**11.31**	11.31	0.8041	0.1	**10.1**	19.4	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	100.2
6	Huỳnh Thúc Kháng	1,211	40	120	19.82	12.02	**7.80**	7.80	0.8041	0.1	**7.0**	13.4	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	69.1
7	Đào Duy Anh (Cột th	710	22	120	10.90	6.61	**4.29**	4.29	0.8041	0.1	**3.8**	7.3	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	38.0
8	Đào Duy Anh	610	18	120	8.92	5.41	**3.51**	3.51	0.8041	0.1	**3.1**	6.0	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	31.1
9	Tăng Bạt Hổ	2,732	68	120	33.70	20.44	**13.26**	13.26	0.8041	0.1	**11.8**	22.7	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	117.5
10	Đinh Tiên Hoàng	1,692	59	120	29.24	17.73	**11.50**	11.50	0.8041	0.1	**10.3**	19.7	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3	101.9
11	Nguyễn Trãi	2,464	88	120	43.61	26.45	**17.16**	17.16	0.8041	0.1	**15.3**	29.4	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	152.0
12	Mai Thúc Loan	850	30	120	14.87	9.02	**5.85**	5.85	0.8041	0.1	**5.2**	10.0	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	51.8
13	Yết Kiêu	630	16	120	7.93	4.81	**3.12**	3.12	0.8041	0.1	**2.8**	5.3	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	27.7
14	Thái Phiên	1,500	36	120	17.84	10.81	**7.03**	7.03	0.8041	0.1	**6.3**	12.0	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	62.3
15	Nguyễn Chí Thanh	1,305	34	120	16.85	10.21	**6.64**	6.64	0.8041	0.1	**5.9**	11.4	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	58.8
16	An Dương Vương	2,200	119	150	58.97	44.59	**14.38**	14.38	0.8041	0.1	**12.8**	24.6	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	127.4
17	Trần Phú	1,540	35	120	18.24	11.08	**7.16**	7.16	0.8041	0.1	**6.4**	12.3	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	63.5
18	Nguyễn Văn Linh	2,284	135	120	66.89	40.57	**26.32**	26.32	0.8041	0.1	**23.5**	45.1	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	233.2
	Sub-total	**25,962**	**1,071**		**649.10**	**365.37**	**283.7**	**283.72**			**253.5**	**485.9**	**253.5**	**253.5**	**253.5**	**253.5**	**253.5**	**253.5**	**####**	**253.5**	**2,513.8**
II	**ĐỢT 2**											**1/10-31/12/2022**									
19	Lý Thái Tổ	1,450	150	150	118.35	49.06	**69.3**	69.30	0.8041	0.1	**61.9**	15.48	61.9	61.9	61.9	61.9	61.9	61.9	61.9	61.9	510.8
20	Lý Thái Tổ 2 nhánh	1,450	54	120	42.61	14.29	**28.3**	28.31	0.8041	0.1	**25.3**	6.32	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	208.7
21	Cầu Chợ Dinh	980	66	120	31.81	16.57	**15.2**	15.25	0.8041	0.1	**13.6**	3.41	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	112.4
22	Bùi Thị Xuân	2,580	60	120	28.92	15.88	**13.0**	13.04	0.8041	0.1	**11.7**	2.91	11.7	11.7	11.7	11.7	11.7	11.7	11.7	11.7	96.1

23	Đặng Huy Trứ	1,100	31	120	14.94	8.63	**6.3**	6.31	0.8041	0.1	**5.6**	1.41	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	46.5
24	Lê Ngô Cát	2,300	54	120	26.03	15.03	**11.0**	11.00	0.8041	0.1	**9.8**	2.46	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	81.1
25	Minh Mạng	1,600	44	120	21.21	12.25	**9.0**	8.96	0.8041	0.1	**8.0**	2.00	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	66.0
26	Hoàng Quốc Việt	800	34	120	26.83	8.53	**18.3**	18.29	0.8041	0.1	**16.3**	4.09	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3	134.8
	Sub-total	**12,260**	**493**		310.71	140.24	**170.5**	**170.5**			**152.3**	**38.07**	**152.3**	**152.3**	**152.3**	**152.3**	**152.3**	**152.3**	**####**	**152.3**	**1,256.5**
	TỔNG	**38,222**	**1,564**				**454.2**	**454.2**			**405.8**	**523.93**	**405.8**	**405.8**	**405.8**	**405.8**	**405.8**	**405.8**	**####**	**405.8**	**3,770.3**