



**Viet Nam Academy of Science and Technology (VAST)
Global Environment Facility (GEF)
United Nations Development Programme (UNDP)**

TERMINAL PROJECT REPORT

(For a project financed from ODA)

**Project: Local Development and Promotion of LED Technologies for
Advanced General Lighting in Viet Nam**

UNDP PIMS no.: 5192 GEF PMIS no.: 5555; UNDP Project Id.: 00092227

GEF-5; GEF Climate Change Mitigation; CC1-Promote the demonstration,
deployment, and transfer of innovative low-carbon technologies

Hanoi, April 2020

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ABBREVIATIONS AND ACRONYMS

ADB	Asian Development Bank
AWP	Annual Work Plan
BaU	Business as Usual
BRH	Bangkok Regional Hub
CFL	Compact fluorescent lamp
CEO	Chief Executive Officer
CEO ER	CEO Endorsement Request
CHTD	Center for High Technology Development (of VAST)
CO	Country Office
CO ₂	Carbon dioxide
EA	GEF Executing Agency (UNDP Implementing Partner)
EE	Energy efficiency
EoP	End of project
ESCO	Energy service company
GEF	Global Environment Facility
GHG	Greenhouse gas
GWh	Gigwatt-hour (= 1 billion Watt-hour)
HCMC	Ho Chi Minh City
HACT	Harmonized Approach to Cash Transfers
HID	High-intensity discharge
HPPMG	Harmonized Programme and Project Management Guidelines
IA	GEF Implementing Agency
INDC	Intended National Development Contribution
ISPONRE	Institute of Strategy & Policy on Natural Resources & Environment
ISTA	International Senior Technical Adviser
IPR	Intellectual property rights
JSC	Joint Stock Company
ktCO ₂	Kilotons of CO ₂

kW	Kilowatt
LED	Light-emitting diode
LED UV	Ultraviolet light-emitting diode
LEEC	Law on Energy Efficient and Conservation
M&E	Monitoring and evaluation
MPES	Minimum energy performance standard
MoC	Ministry of Construction
MoIT	Ministry of Industry and Trade
MoNRE	Ministry of Natural Resources and Environment
MPI	Ministry of Planning and Investment
MtCO ₂	Millions of tons of CO ₂
MRV	Monitoring, reporting, validation
MSP	Medium-sized Project
MW	Megawatt (= 1 million Watt)
NA	North America
NIM	National implementation modality
NPD	National Project Director
NTA	National Technical Adviser
PA cum Adm.	Project Accountant cum Administrator
PIF	Project Identification Form
PIR	Project Implementation Review
PM	Project Manager
PMU	Project Management Unit
PPP	Public-private partnership (Modality)
QA / QC	Quality Assurance/Quality Control
Ralaco	Rang Dong Light Source and Vacuum Flask JSC
RE	Renewable energy
REDS	Renewable Energy Development Strategy
RTA	Regional Technical Advisor
SDG	Sustainable Development Goal
SME	Small and medium-sized enterprise

STAMEQ	Directorate for Standards, Metrology, and Quality (of MoST)
TCVN	Viet Nam Standard
TE	Terminal Evaluation
ToR	Terms of Reference
tCO ₂	Ton of carbon dioxide
UNDP	United Nations Development Programme
UNDP CO	Country Office of the United Nations Development Program
USD	United States dollar
UNFCCC	United Nations Framework Convention on Climate Change Committee
VAST	Vietnam Academy of Science and Technology
VCD	Village Development Committee
VEEPL	Vietnam Energy Efficient Public Lighting project
VLA	Vietnam Lighting Association
VND	Vietnamese Dong
VNEEP	Vietnam National Energy Efficiency Programme
WB	World Bank

General Information

1.1. General information on the project

- Title and code of the project (in English): Local Development and Promotion of LED Technologies for Advanced General Lighting (LED Lighting Project); Code: UNDP PIMS no.: 5192, GEF PMIS no: 5555, UNDP Project Id.: 00092227.
- Project location(s): Viet Nam.
- Donor(s): Global Environment Facility (GEF)/United Nations Development Programme (UNDP).
- National Implementing Partner: Viet Nam Academy of Science and Technology (VAST).
- Project Owner: Center for High Technology Development (CHTD) under VAST
- Duration:
 - Date of GEF approval: 04/02/2015;
 - Date of Vietnam Government approval: 03/06/2015;
 - Duration: 4 years (2015 – 2019), the project started in June 2015 with the signature of the Project Document and scheduled to end operationally in time by December 2019.
- Funding sources: Total project budget; ODA budgets, counterpart contributions (specify budget revisions if any and dates of such revisions): 8.146.794USD (GEF = 1.517.400USD; Co-financing = 6.629.394USD)

1.2. Project description

1.2.1. Project objectives and scope

- The objective of the Project is to mitigate GHG emissions through transformation of the lighting market in Viet Nam towards greater usage of locally produced LED lighting products. This objective is to be achieved by removing barriers to increased production and utilization of locally produced LED lighting products in Viet Nam through two project components: i) the transfer of skills, knowledge and technology for the manufacture of LED lamps in Viet Nam; and ii) the demonstration of cost-effective local commercial production of LED lighting devices. The Project is to be implemented over a 4-year period and is expected to achieve GHG emission reductions through the reduction of electricity generation from fossil-fuelled power plants.
- To address the above-mentioned barriers to the more widespread diffusion of LED into the Vietnamese lighting market, the project Local Development and Promotion of LED Technologies for Advanced General Lighting in Viet Nam, was formulated, hereafter shortly referred to “LED Project”. The main source of financing is the Global Environmental Facility (GEF) with a USD 1,517,400 contribution and with planned co-financing (from UNDP, government, and private sector) of USD 6,629,394.
- The United Nations Development Programme (UNDP), as mandated by GEF, is the GEF Implementing Agency and Viet Nam Academy of Science and Technology (VAST), assigned

by the Government, is the national GEF Executing Partner, implemented by VAST's Center for High Technology Development (CHTD).

- To achieve these objectives, the Project is comprised of two components:
- **Component 1: the transfer of skills, knowledge and technology for the manufacture of LED lamps in Viet Nam** addresses the absence of supporting LED lamp standards and regulations, insufficient professional expertise and technical skills to support the enforcement of new LED lamp standards and regulations, insufficient capacity of testing and R&D facilities, and insufficient local knowledge to implement scaled-up local production of LED lamps. This component also includes supportive policy and regulatory measures to improve the quality and promote the adoption of LED lamp technologies.
- **Component 2: the demonstration of cost-effective local commercial production of LED lighting devices** addresses barriers related to low public awareness about LED lighting product benefits. This will be achieved through demonstrations on the use of high-quality LED lighting products manufactured in Viet Nam in a variety of applications from outdoor street and industrial lighting to indoor lighting for commercial and residential applications.

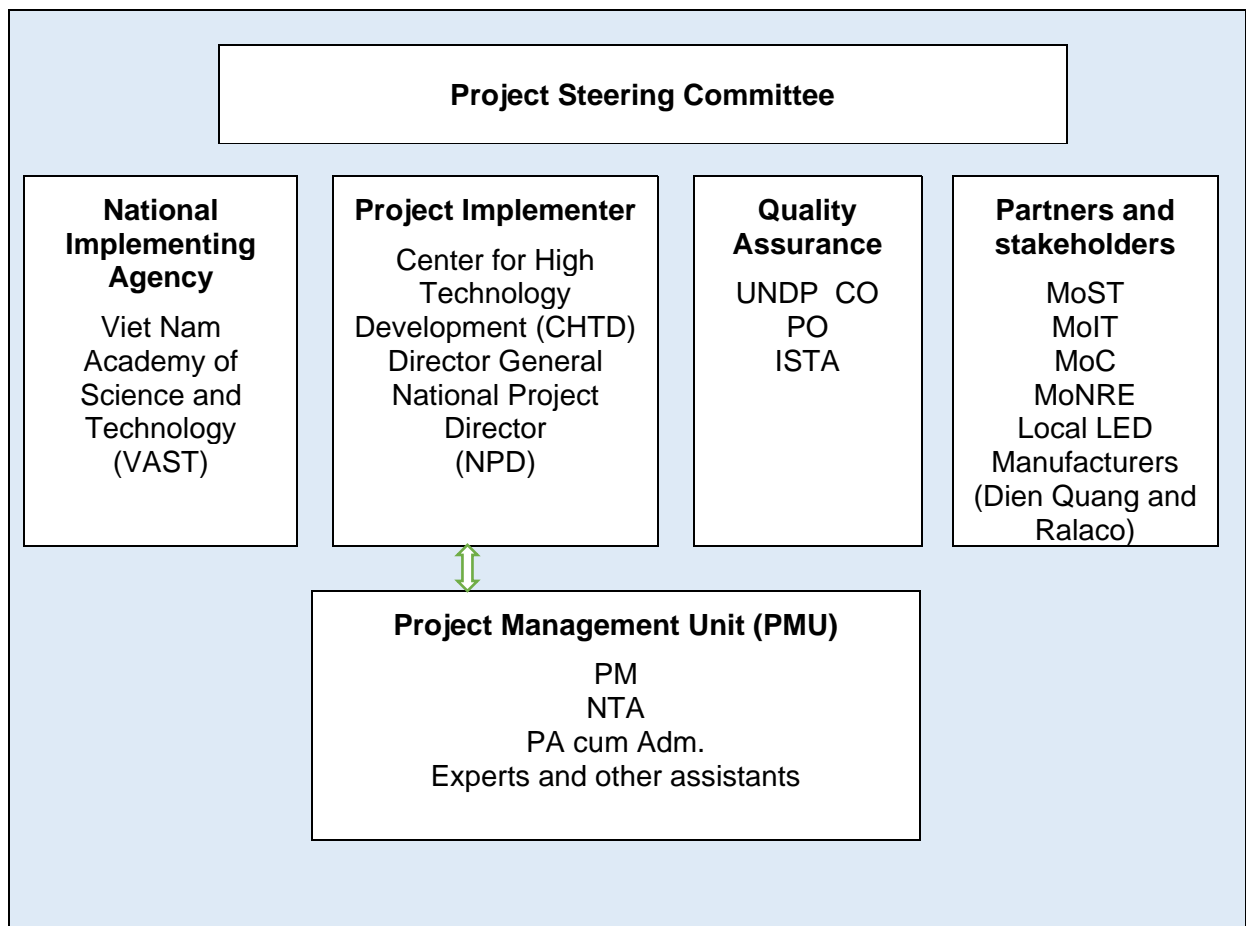
1.2.2. Management arrangements

- The Project is executed under Harmonized Approach to Cash Transfers to Implementing Partners (HACT) framework and National Implementation Modality (NIM) in project management implementation guidelines agreed by UNDP and the Government of Viet Nam. UNDP is the GEF Implementing Agency (IA) for the Project, and the Viet Nam Academy of Science and Technology (VAST) the GEF Implementing Partner.
- The Center for High Technology Development (CHTD) under VAST has the overall responsibility for the achievement of project results. At the request of CHTD, VAST President decided to establish a Project Management Unit (PMU) and appoint a senior official as the National Project Director (NPD) for the Project. PMU members include: 1) National Project Director (NPD), National Project Deputy Director (DNPD), Project Manager (PM), National Technical Advisor (NTA), Accountant cum Administrator (PA cum Adm.), Counterpart Fund Accounting and Office Assistant to support PMU in Project implementation and management..
- UNDP CO in Hanoi, based on the guidelines of the regional UNDP in Bangkok (BRH), is responsible for monitoring and evaluation as well as quality assurance for project implementation. UNDP CO has nominated a program officer (PO) and recruited an international senior technical advisor (ISTA) to assist UNDP CO in ensuring the quality of its activities and project results; responsible for recruiting international experts / consultants for the Project. UNDP CO has been responsive to the proposed changes when needed. For example, UNDP CO assisted the PMU with procurement, when the process needed to be speeded up. Also, two packages on e-learning and financial mechanism study were added to the original list of project activities). When the bidding following Government procedures was taking too much time, UNDP CO did the procurement PMU to assist those packages in order to be able implement these within the project timeframe. On the other hand, other

activities were taken out of the Work Plan, such as consulting package of assessment on transformation to LED market (when it was concluded that carrying the study out in 2016, when the LED market was just establishing itself, would have been too early). These are examples of adaptive management exercised by both PMU and UNDP in this project.

- A Project Management Unit (under CHTD), based at VAST, has been responsible for implementing the Project, planning activities and budgets, recruiting specialists, conducting training workshops and other activities to ensure the Project is executed as per approved work plans. The PMU reports to VAST, UNDP CO and the Project Steering Committee.

The project management structure is shown in the following chart:



- The primary functions of the PSC have been to provide the necessary direction that allows the Project to function and achieve its policy and technical objectives, to oversee the PMU, and to approve the annual Project plans and M&E reports. Chaired by VAST President, members are:
 - United Nations Development Programme (UNDP)
 - Ministry of Construction (MoC)
 - Ministry of Industry and Trade (MoIT)
 - Ministry of Science and Technology (MoST)
 - LED manufacturers (Dien Quang and Ralaco)

- The Project Management Unit (PMU) is located at 2C, VAST building, 18 Hoang Quoc Viet Street, Cau Giay District, Hanoi. The Project Manager (PM) operates the Project under the direction of the National Project Director (NPD). PM is supported by the National Technical Advisor (NTA), International Senior Technical Advisor (ISTA - part-time), Project Accountant and Administrator (PA cum Adm.), Financial co-financing accounting and administrative assistant.
- UNDP CO also has a role of project assurance. This role will be exercised by the UNDP Programme Officer (PO) responsible for the project, based in the UNDP Country Office (CO) and the Regional Technical Advisor (RTA) based in the UNDP Bangkok Regional Hub (BRH).

- Project personnel :

PMU:

- NPD: Mr. Nguyen Van Thao,
- Deputy NPD: Ms. Hoang Thi Thu Linh,
- PM (7/2015- 1/2017): Ms. Nguyen Thi Bac Kinh (she passed away at the end of January 2017)
- PM (2/2017 – 12/2019): Mr. Nguyen Kien Cuong
- NTA: Mr. Phan Hong Khoi
- PA cum Adm.: Ms. Nguyen Thi Thanh Thuy

UNDP:

- PO: Ms. Vu Thi Thu Hang
- RTA: Ms. Milou Beerepoot



Mr. Bakhodir Burkhanov, Representative of UNDP CO and Prof. Duong Ngoc Hai, VAST's Vice President delivered their welcoming address at the Inception Workshop, Ha Noi, November 18, 2015



Dr. Nguyen Van Thao, CHTD's Director General & NPD delivered opening speech at the Inception workshop of the Project, Ha Noi, November 18, 2015.

The inception workshop was held in Hanoi on November 18, 2015 with the participation of representatives from UNDP, VAST, CHTD, MoC, MoST, MoIT, MoNRE, manufacturers and The co-financiers agreed on the five-year plan and the 2016 plan with a few terms and targets that were adapted to a more realistic situation at the start of implementation (from 2016). The Log frame has been revised in accordance with the proposal of the Inception Workshop and the PMU's proposal during implementation, approved by PSC, VAST, UNDP CO as well as the regional UNDP (see **Annex 5.1.**)

2. Results Achieved

2.1. Implementation of the project objectives

Being medium-sized project (MSP), the LED Vietnam Project consists of only 2 components but managed to maximize results and served as a catalyst in facilitating the lighting market transformation towards higher-efficiency lighting products with associated avoidance of greenhouse gas (GHG) emission reduction.

An important non-technical barrier, namely higher cost of the technology in comparison with conventional options, still acts as a deterrent in the purchase decision in many sectors, notably the public sector and the poorer segment in the residential sector. As an MSP and with a limited budget size, the Vietnam LED project did not include a specific component for financial issues, although the Project has commissioned a study on “*financial investment schemes for the wide-scale implementation of LED projects for public lighting*”, because financial investment in LED lighting is one of the key steps to transform the lighting market

The results of the Project as well as the end-of-project evaluation of international consultants, Mr. Jan Van den Akker and Ms. Dang Ngoc Dung showed that in terms of manufacturing and selling LED lighting products in Vietnam, the Project has clearly exceeded its goals. However, in this regard, the project has benefited from the development of global and domestic market, LED lighting products have rapidly developed over the past few years and become an affordable technology affordable. In this general context, with a relatively short time frame, the Project has an activating effect, acting as a catalyst in recognizing significant changes in the lighting market in Vietnam, especially regarding the production (and sale) of quality LED lighting products in compliance with the mandatory national (and international) standards (See

Appendix 5.4 *Terminal Evaluation Report, Local Development and Promotion of LED Technologies for Advanced General Lighting in Vietnam, Hanoi December 2019).*

The Project Management Unit (PMU) has implemented mechanisms to ensure on-going stakeholder participation and effectiveness. This was helped by conducting regular stakeholder meetings, issuing a regular project electronic newsletter, conducting feedback surveys, implementing strong project management practices in close cooperation with UNDP Viet Nam as the GEF implementing agency.

Unlike many other UNDP/GEF project, the project implementation has not met any delays, while project expenditures have been closely monitored and proceeded as planned (see **Annex 5.4.**)

Direct impact from 10 demonstration projects (energy saving and reducing greenhouse gas emissions):

Items	Results achieved	According to the Project design
Direct impact from 10 demonstration projects (energy saving and reducing greenhouse gas emissions) at EoP		
Cumulative energy savings:	1.460 kWh	1.000 kWh
Cumulative CO ₂ reduction:	1,264 tons CO ₂	623 tons CO ₂
Indirect impacts from technical support of the Project (energy saving and reducing greenhouse gas emissions) after project termination in 10 years (2019 – 2028)		
Cumulative energy savings:	150,534 MWh	3,000 MWh.
Cumulative CO ₂ reduction:	130,197 ktonnes CO ₂	1,000 ÷ 5,154 ktonnes CO ₂

As estimated in the chart below, during the indirect impact period of the Project (2019-2028), the transition to LED lighting will help the lighting sector save from 7% in 2019 to 52% in 2028 the total energy consumption for lighting. The LED Project contributes about 3% in 2019 to 21% in 2028 to this saving of the lighting sector.

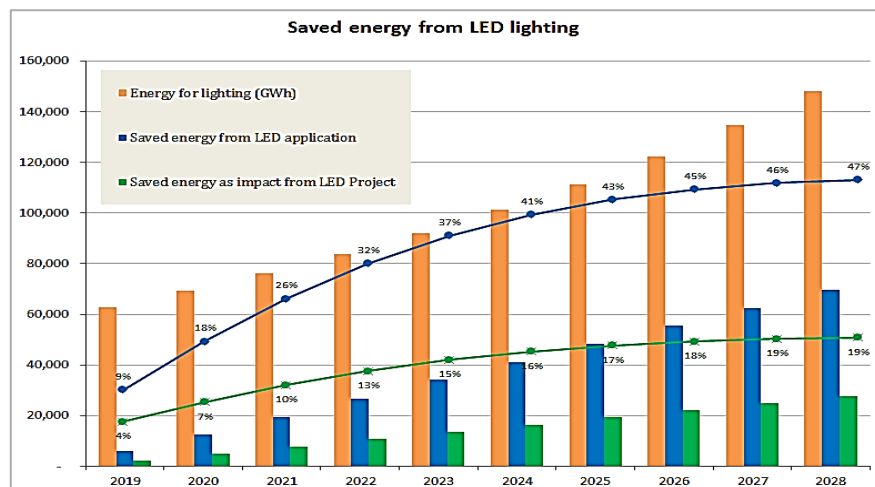
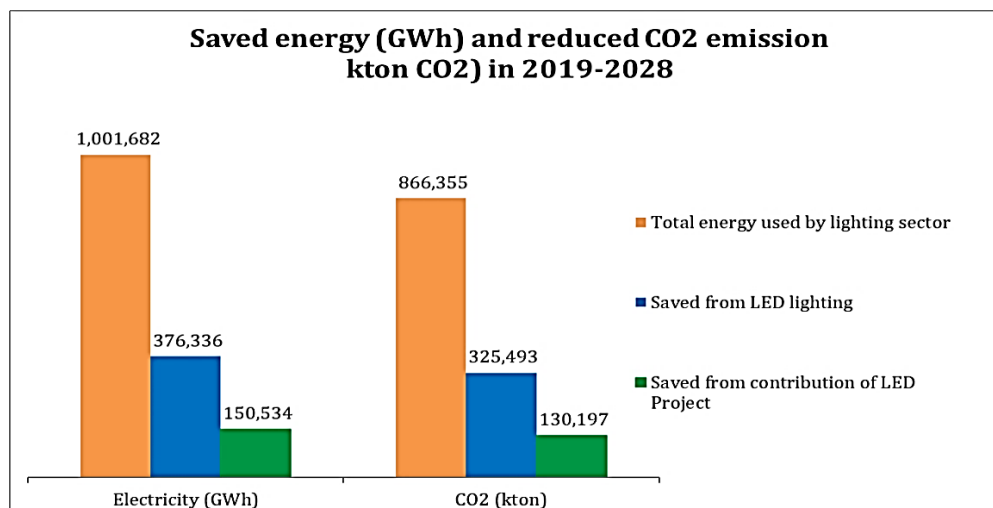


Chart of total energy savings and emission reductions from conversion to LED lighting and the contribution of LED Project.

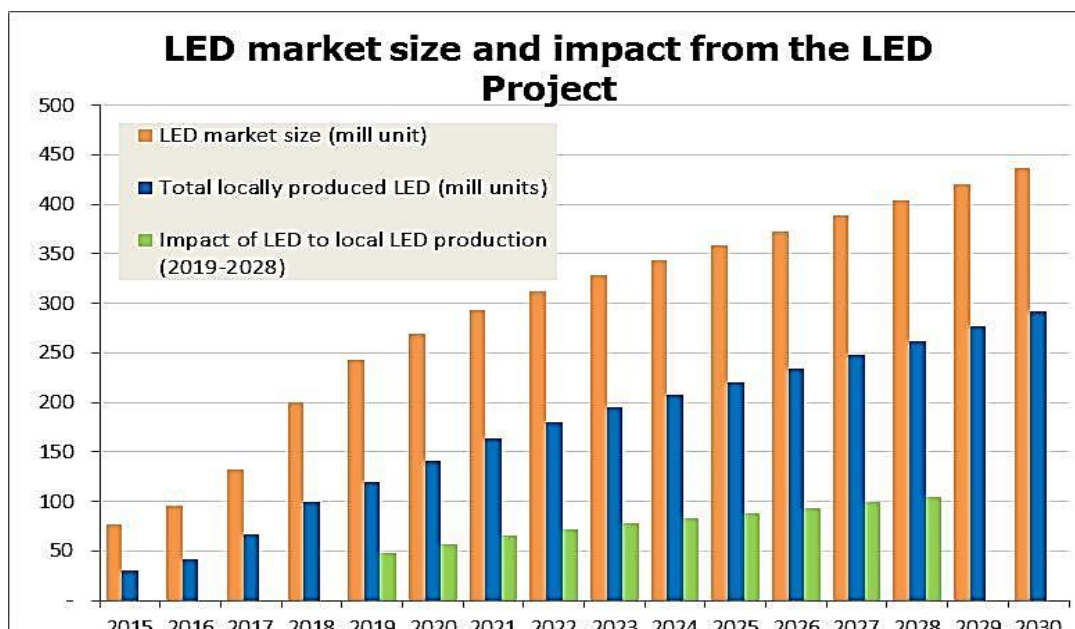
The contribution of LED Project to the growth of domestic LED production is estimated in the 10-year period after the Project ends at about 870 million products, starting from 47.7 million products in 2019 to 104.6 million in 2028. .

Below is the graph of total saved energy and reduced emission from the transition to LED lighting and the contribution of the LED Project.



Note: The emission factor used to calculate the project design is 0.8649 tons CO₂/MWh according to the Notice No. 315/KTTVBKHX GSPT dated March 29, 2019 of the Department of Meteorology, Hydrology and Climate Change - Ministry of Natural Resources and Environment)

As estimated in the chart below, during the indirect impact period of the Project (2019-2028), the conversion to LED lighting will save Vietnam's lighting industry from 7% in 2019 to 52%. by 2028 the total energy consumption for lighting. LED projects contribute about 3% in 2019 to 21% in 2028 for saving on this lighting industry.



The size of the LED market and the impact of the Project

The contribution of the LED Lighting Project to the growth of domestic LED production is estimated in the 10-year period after the Project finishes about 870 million products, starting from 47.7 million products in 2019 to 104.6 million. in 2028.

During a period after the Project's (2019-2028), the transition to LED lighting will help the lighting sector save from 7% in 2019 to 52% in 2028 on total energy consumption for lighting of about 376,336 GWh. This is equivalent to 37.6% of the total energy used by the lighting sector. The indirect contribution of the LED project is 150,534 GWh, equivalent to 15% of the total energy used by the lighting sector. Correspondingly, the total emission reduction from the transformation to LED lighting in these 10 years is 325,493 kilotons of CO₂, of which the contribution from the LED Project is estimated at 130,197 kilotons. The other achieved targets of the Project compared with the targets set out are shown in **Annex 5.3**.

2.2. Implementation of the components and outputs

2.2.1. Component 1: the transfer of skills, knowledge and technology for the manufacture of LED lamps in Viet Nam

a) Technical support to building & enforcing policies, standards & regulations to sustainable development of LED lighting technology

- A roadmap for LED lighting industry development in Viet Nam up to 2025 was developed: The Roadmap was developed based on an elaborate research conducted by a group of scientists, manufacturers and operators of lighting equipment and inputs were provided by policymakers. It has made predictions about the advancement of LED technology, the development of the global and domestic LED lighting market and provided recommendations on ways to develop LED technology for general lighting. The roadmap forecasts annual LED lamp sales revenues in Viet Nam to grow at an average of 25% per year to 2,068 million USD by 2025.

Elements of the Roadmap of Vietnam's LED lighting up to 2025

No.	Item	Milestone 2020	Milestone 2025	Note
1	LED revenue (million USD)	854	2608	With annual average growth rate of 25%
2	LED technology			
	- LED Wafer & LED Package	- Do not develop owing to hi-tech requirement - Should import LED chips - Considering to invest special LED packages in agriculture, aquaculture, in sterilizing devices using uV LED		
	- LED lamp production	- Researching and fabricating parts: optical part, heat sink, driver and lamp body (increasing localization rate to 60%-70%)		Vietnam has over 200 companies at present

		- Producing general lighting products meeting EU and NA markets' requirements - Concentrating on applications in general lighting and commercial lighting due to their energy consumption (31% and 43%, respectively).	
3	Lighting service	- Developing ESCO (energy service company) services - Developing smart lighting (indoor, outdoor, special lighting) - Vietnam lighting association has enough competence to issue lighting consulting certificate	

- 04 Vietnamese standards (TCVN) for LED lighting products were developed with technical support by the project and issued by the Ministry of Science and Technology: (i) TCVN 11842:2017 (IES TM-21-11) - Projecting Long Term Lumen Maintenance of LED Packages; (ii) TCVN 11843:2017 (CIE S 025:2015) - Test Method for LED Lamps, LED Luminaires and LED Module; (iii) TCVN 11844:2017 - LED lamps - Energy Efficiency; and (iv) LED road and street lighting luminaires – Energy efficiency.



03 Vietnamese Standards (TCVN) for LED lighting products drafted and transferred by the Project to Vietnam Standards Institute, Vietnam Standards, Quality and Salary Center and was issued by the Ministry of Science and Technology on December 31, 2017.

The proposal “LED road and street lighting luminaires – Energy efficiency.” has been submitted to MoST by STAMEQ for review and issuance.

- Capacity of laboratories were strengthened to measure, test and evaluate the quality of LED lighting products (QUATESTs and VILAS):
 - (i) Infrastructure, equipment, methods, techniques for measuring and evaluating the quality of LED products of QUATEST-1, QUATEST-3 and 02 VILAS were strengthened;
 - (ii) 02 theoretical and practical training courses on measurement, inspection and evaluation of quality of LED lighting products were organized for more than 18 technical staff of 03 Quality Testing Centers in Ha Noi (North), Da Nang (Central) and Ho Chi Minh city (South) (QUATEST-1, QUATEST-2 and QUATEST-3).



Dr. Indika Perera (United States) and Dr. Gareth Jones (United Kingdom), project consultants, provide technical guidance on LED measurement and evaluation for lab staff QUATEST-1.



Dr. Indika Perera (United States) and Dr. Gareth Jones (United Kingdom), project consultants, provide technical guidance on LED measurement and evaluation for VILAS labs of Rang Dong Company and Dien Quang Company.

- The LED Lighting Labeling and Certification Program was developed and implemented by the Ministry of Industry and Trade with technical support by the project: (i) "Labeling and Certification Program for LED lighting products (L&CP)" was promulgated by the government in the Prime Minister's Decision No. 04/2017 / QD-TTg; (ii) The Energy Labeling Program for LED lighting products is being implemented by the Ministry of Industry and Trade as follows: from 2018 to December 31, 2019 - Voluntary labeling. From 1/1/2020 – Mandatory labelling; (iii) Until 2019, 05 companies registered in the labeling programme with the Ministry of Industry and Trade, with 16 types of LED lights and 72 models.



Vietnamese Energy saving labels

- 02 Vietnamese lighting technical standards for using LED technology in road & tunnel traffic works were developed and submitted to the Ministry of Construction for approval and promulgation in 2019:
 - (i) Standard on urban street lighting design using LED light source; and
 - (ii) Standard on urban tunnel lighting design using LED light source.
- Financial investment schemes for implementing large-scale LED lighting projects for Public Lighting in Viet Nam have been studied and suggestions were provided for selecting a suitable financial mechanism and contracting method.

b) Training & workshop activities

- The Project has developed a R&D training programme on LED technologies. Two national consultants and an international consultant have been involved to carry out a training needs assessment and, based thereon, to set up a training module that consisted of four modules: i) Basics of LEDs, ii) Advanced core technologies for LED lighting products manufacturing, iii) Quality assurance of LED lighting products manufacturing, and iv) Impact of LED lighting. These modules were presented to trainees in 3-day training workshops organised in Hanoi and Ho Chi Minh City in the second quarter of 2017. Some 109 people were participated coming from lamp producers, testing facilities and lighting companies. Participants were introduced to the advanced and latest LED technologies (including international experiences and best practices in EE lighting technology), to the impact of LED Lighting on energy saving, as well as on developing LED lighting technologies for export markets of Europe, Middle East and the USA.
- Thereafter, more training courses and workshops were organised on basic and advanced LED Lighting Technologies; the design, installation, operation and maintenance of lighting systems using LED Technologies, and on LED lighting products testing methods, procedures and protocols. In June 2019 a training workshop on "Solutions for Smart Lighting and Financial Investment for Vietnam Urban Lighting" was held in Ho Chi Minh City with 103 participants from lamp manufacturing and testing facilities as well as lighting companies.

- Training course on "Test methods for LED lighting products according to existing standards" organized for more than 20 engineers of 03 Quality Measurement Technical Centers (Quatest-1, Quatest-2, Quatest-3), 02 VILAS laboratories. The program had the participation of international experts.
- An overview of training courses and workshops organised by the LED Vietnam Project is given in the following box. Totally, about 970 people (18% are female) from lamp producers, testing facilities and lighting companies, testing labs, lighting service companies, etc. participated in and benefitted from the training courses and workshops and thus will help boost improvements in local design and production and application of LED lamps.

Summary of the Training and workshops organized and participation

No	Training, Workshop, Events	Number of participants	Gender		Sex ratio (%)	
			Male	Female	Male	Female
1	Inception kick-off workshop, 18/11/2015	61	36	25	59%	41%
2	Training course on basic and advanced LED lighting technology, Hanoi, 28-30/3/2017	86	72	14	84%	16%
3	Training course on basic and advanced LED lighting technology, Ho Chi Minh city, 23-25/5/2017	70	66	5	93%	7%
4	Workshop on building LED lighting roadmap, Ba Vi, Hanoi, 14/6/2017	42	33	9	79%	21%
5	Workshop on developing Vietnam national standards, labeling and certification program for LED lighting products, Hanoi, 24/8/2017	58	44	14	76%	24%
6	Workshop on GEF / UNDP Technical Assistance for LED lighting industry in Vietnam, Ho Chi Minh, 16/11/2017	51	47	4	92%	8%
7	Workshop on GEF / UNDP Technical Assistance for LED lighting industry in Vietnam, Ha Noi, 25/11/2017	54	40	14	74%	26%
8	Workshop on Vietnamese standards using LED technology for transport construction (streets and tunnels), Hanoi 16/3/2018	26	19	7	73%	27%
9	Workshop on LED lighting technology application for urban transport construction, Hanoi 28/8/2018	59	48	11	81%	19%

10	Training course on lighting design, installation, operation and maintenance with LED technology, Hanoi, 24-26/9/2018	69	58	11	84%	16%
11	Workshop on certification and labelling pilot program for LED lighting products, Hanoi, 27/9/2018	69	54	15	78%	22%
12	Workshop on certification and labelling pilot program for LED lighting products, Da Nang city, 01/10/2018	57	51	6	89%	11%
13	Workshop on certification and labelling pilot program for LED lighting products, Ho Chi Minh city, 06/11/2018	73	63	10	86%	14%
14	Training course on lighting design, installation, operation and maintenance with LED technology, Ho Chi Minh city, 7-9/11/2018	91	83	8	91%	9%
15	Training course on smart lighting solutions and financial investment Schemes for Vietnam, Ho Chi Minh city, 19-20/11/2018	105	91	14	87%	13%
Total		971	804	170	83%	17%

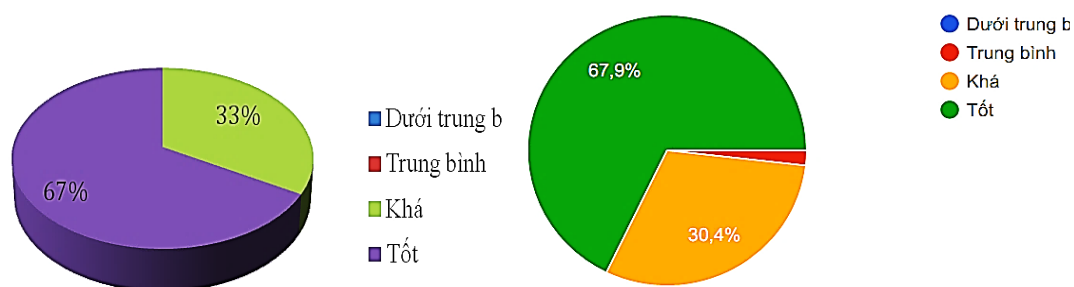
Note: A survey was carried out of the participants before and after the workshop in Hanoi to learn about the results, knowledge augmentation impact and satisfaction to learn from the first workshop to improve on content and delivery in the next workshops.



02 training courses on "basic and advanced LED lighting technology in general lighting", Hanoi, March 2016 and Ho Chi Minh City, May 2016.



02 training courses on "Design, installation, operation, maintenance and management of LED lighting systems", Hanoi, September 2018 and Ho Chi Minh City, November 2018.

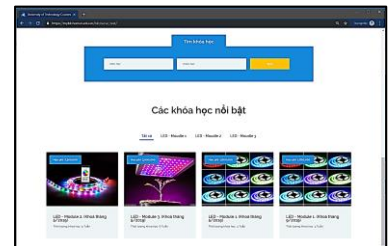
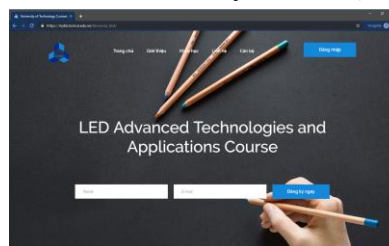
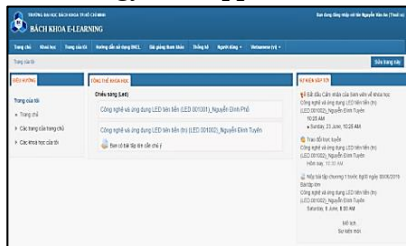


Quality assessment chart of 2 training courses held in Hanoi, September 2018 and Ho Chi Minh City, November 2018.

- To provide knowledge of LED technology to more students, an e-learning program on advanced LED technologies and applications in lighting (in collaboration with Ho Chi Minh City University of Technology) was built, has been implemented. The e-learning facility contains lectures on a) Basic concepts of Light Emitting Diodes (LEDs) and LED lights; b) Core technologies for LED lighting products manufacturing; c) LED Chip Packaging; e) Measurement & testing of LED Lights; f) LED Indoor Lighting Design and Installation; g) LED Outdoor Lighting Design and Installation; h) Smart LED lighting - Design and Installation; i) LED lighting systems operation and maintenance; j) LED Lighting systems management.



Dr. Nguyen Van Thao - General Director of Center for High Technology Development, National Project Director and Assoc. Dr. Tran Thien Phuc - Vice Rector of Ho Chi Minh City University of Technology spoke at the opening ceremony of an online training course on "Advanced LED Technology and Application" held in Ho Chi Minh City. June 21, 2019.



BACH KHOA-E-learning homepage and course registration page (opening the course)

c) Technical assistance for transferring knowledge, skills & technology

- Provided hands on training on the use of 02 software for designing critical parts of the LED, such as heat sinks (ANSYS Icepak thermal management software) and LED drivers.
- Provided advisory and consulting support to improve the quality of LED lighting products to meet national and international standards, including improvements to the measurement and quality control of LED lighting products.



Left photo: Handover of thermal management software "ANSYS Icepak", Right photo: working with international consultants, Mr. Gareth Jones (UK), Mr. Younghoon An (South Korea) and consultants in water to evaluate the results of technical assistance for Rang Dong Lamps and Thermos Joint Stock Company.

- Provided advisory and consulting support on the production of LED lighting products, including on further automation and the use of information technology.

For Ralaco, the project supported the procurement of Ansys Icepak software for heat sink design, provided on-the-job training on it for 29 technical staff, and developed a database for heat sink design and guideline on its use. Technical assistance was also provided through engagement of international and national consultants to support the improvement of production management, quality improvement as per EC standards, product testing capacity and the Quality Assurance and Quality Control (QA/QC) procedures for three LED products¹⁾.

For Dien Quang, the project supported the further development and deployment of the software being developed for the design of LED Drivers²⁾, improvement of production management, testing capacity and quality control. This has resulted in improvements for products in terms of colour rendering, luminous efficacy, LED driver quality, as well as reduction in the use of packaging materials.



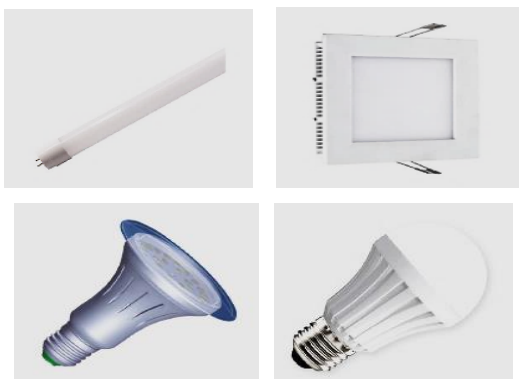
Left photo: Mr. Gareth Jones, International Consultant (UK) of the Project working with technical staffs of Dien Quang Lamp Joint Stock Company; Right photo: Evaluation meeting of Technical Assistance for Dien Quang Company.

Indicator with end-of-project (EoP) target	Actual value or status of the indicator
Number of LED lamp manufacturing plants that have advanced manufacturing to produce LED lamps that meet new VN standards for LED lamps <i>Target: 2-3¹</i>	The two largest local LED lighting companies with advanced manufacturing facilities include the project partners Ralaco and Dien Quang. In addition, there are mid-range companies and several smaller companies
Number of retailers that sell locally labelled LED lighting products <i>Target: 200</i>	According to Ralaco and Dien Quang, they have their LED products sold by about 15,000 retailers. The high number of retailers is mainly due to the fast development of the LED market that has led to a significant number retailers and stores selling LED lights

¹ The Project Document target of "3" was reset at project Inception to "2", after Vietnam Schreder was not included anymore

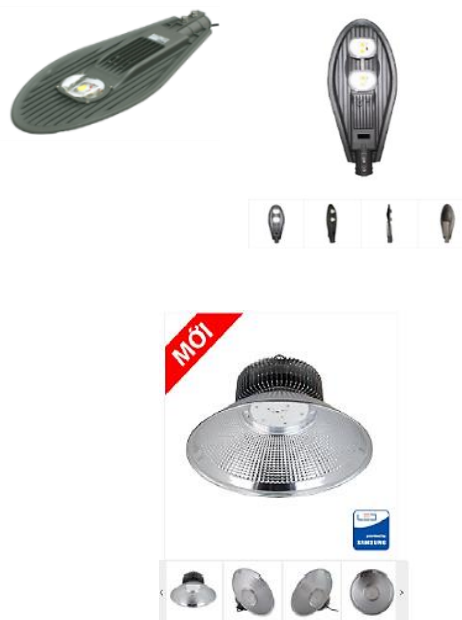
<p>Number of LED lighting products that are standardized</p> <p><i>Target 6</i></p>	<p>16 LED light types include 9 for indoor and 7 for outdoor, covering 210 LED light models. Again, this is a much higher number and targeted due to the rapid development of the local LED market.</p>
<p>Number of new LED lighting products that are labelled</p> <p><i>Target: 4</i></p>	<p>The labeling programme for LED was adopted in 2017 with an initial voluntary labeling period from Jan 2018 to Dec 2019 with a mandatory regime from January 2020 onwards. The before-mentioned 16 LED lamp types (covering 72 different models) have been labelled with MoIT approval</p>

Sample of Dien Quang LED products



LED tube, LED panel, LED Down-light, and LED bulb manufactured by Dien Quang Lamp Joint Stock Company with technical support of the Project.

Sample of Ralaco LED products



LED street lamps models D CSD03L / 30W, D CSD1L / 35W and D CSD02L- 120W and LED High Bay lamps models D HB02L 430 / 100W produced by Rang Dong Light Source and Vacuum Flask JSC with the support Technical of the Project.

2.2.2. Component 2: the demonstration of cost-effective local commercial production of LED lighting devices.

- Component 2 aims to address barriers related to low public awareness about the benefits and quality of LED lighting products, especially those produced domestically. Through demonstration projects using high-quality LED lighting products made in Vietnam in various

application fields, from public lighting (streets, alleys, eco-zones, etc.).), industrial lighting (workshop, factory) to indoor lighting (commercial area, residential area, school, office etc.)

- The PMU has contracted with consultants to conduct feasibility assessment, quality assessment and energy efficiency (energy saving), environmental impact (reduction of CO₂ emissions, handling replacement lamps ...) of some demonstration projects. The project completed 10 LED lighting demonstration projects (8 according to the original Project design), including LED replacement and installation produced by two local companies (Ralaco and Dien Quang) and Vietnam - Schredér. Company.
- A summary of the demonstration projects is listed in the table below:

List of 10 LED demo-projects

STT	Demonstration project	Number of lights replaced	Power replaced (kW)	Number of LED lights installed	Installed capacity (kW)	Energy savings (KWh)/year
1	Saigon Cigarette Ltd. (LED tube)	1.188 FL	47,520	1.122 LED	40,392	21.384
2	Tran Thanh Ltd. - Location 1 – North of Tu Liem (LED HighBay)	129 MH, CFL	10,320	43 LED	5,160	24.768
	Tran Thanh Ltd. - Location 2 - Tien Son - Bac Ninh (LED HighBay)	624 FL	49,920	208 LED	24,960	119.808
3	Ecopark – Hung Yen (LED street lights)	335 HPS	28,189	335 LED	15,862	53.253
4	Trinh Ba street- Thai Nguyen (LED street lights)	54 HPS	9,450	42 LED	5,040	17.464
5	National road 22 –Ho Chi Minh – Tay Ninh (LED street lights)	1.276 HPS	295,075	1.276 LED	207,131	379.918
6	Alleys 22 & 28 of Cam Gia Ward, Thai Nguyen City	100 HPS, CFL	4,000	60 LED	1,800	8.712
7	Technology incubation building in Hanoi, VAST (LED panel, tube, downlight, and LED bulb)	1,038 FL	29,095	967 LED	12,000	53.335
8	Le Ngoc Han primary school in HCM city (LED tube, LED downlights)	654 FL	18,332	595 LED	7,652	39.986

9	8 class rooms of secondary schools in Tay Ho District and Thanh Oai District , Hanoi (LED tube + Occupancy sensors)	119 FL	3,97	132	2,65	4. 942
10	Smart LED lighting system on campus of Ho Chi Minh City University of Technology, Ho Chi Minh City National University (LED street lights)	50 High pressure mercury	12,5	50 LED	8,000	19.440
Total		5.567	508,371	4.830	330,647	743.009

Some typical images of demonstration projects:



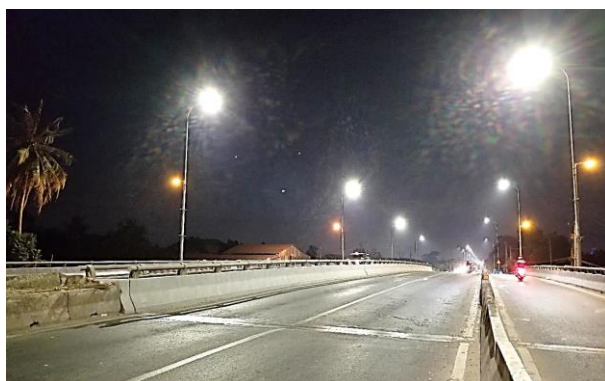
Lighting system of Tran Thanh packaging factory, Bac Tu Liem, Hanoi before and after replacing compact fluorescent lamps with LED High-bay lights manufactured by Rang Dong Light Source and Vacuum Flask JSC. Total power of fluorescent lamps: 10,320 kW, total power of LED lamps: 5,160 kW; The amount of electricity saved per year: 24,768 kWh.



The lighting system uses LEDs (manufactured by Dien Quang Lamp Joint Stock Company) at the technology incubator building of Vietnam Academy of Science and Technology, 18 Hoang Quoc Viet, Cau Giay District, Hanoi. Total power of fluorescent lamps: 29.095 kW, total power of LED lamps: 12.000 kW; The amount of electricity saved per year: 53.335 kWh.



Street light system in the Thai Nguyen city before and after replacing HPS lamp with LED lamps produced by Rang Dong Light Source and Vacuum Flask JSC (replaced 150W HPS with 120W LED lamps). Total power of HPS lamps: 9.450 kW, total power of LED lamps: 5.040 kW; The amount of electricity saved per year: 17.464 kWh.



LED lighting system supplied and installed by Vietnam-Schreder & SAPULICO companies on Highway 22 Tp. Ho Chi Minh - Tay Ninh. Total power of HPS lamps: 295.075 kW, total power of LED lamps: 207.131 kW; The amount of electricity saved per year: 379.918 kWh.

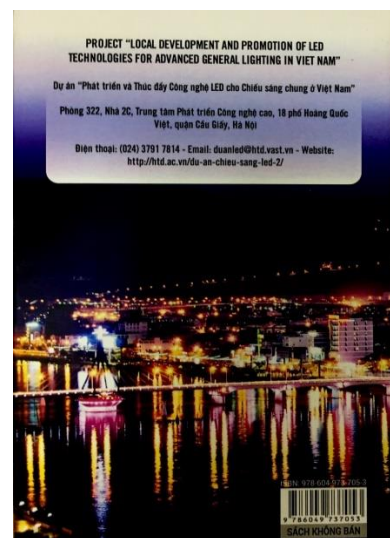
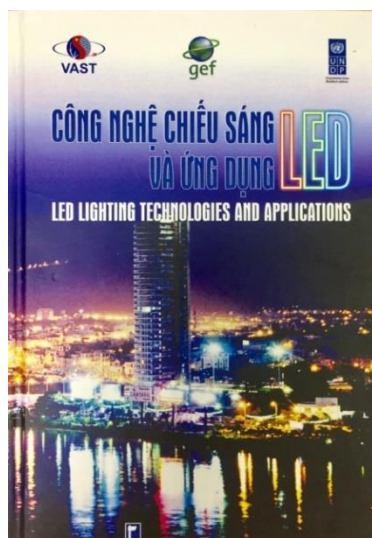


Smart LED system on campus of Ho Chi Minh City University of Technology, Ho Chi Minh National University (LED street light). Total power of high pressure mercury lamps: 12,5 kW, total power of LED lamps: 8,0 kW; The amount of electricity saved per year: 19.440 kWh.



The lighting system uses LED lights produced by Dien Quang Lamp Company at Le Ngoc Han Primary School in Ho Chi Minh City. Total power of fluorescent lamps: 18,332 kW, total power of LED lamps: 7,652 kW; The amount of electricity saved per year : 39.986 kWh.

- Measurement, Reporting and Verification (MRV) system was developed for LED lighting, including software. Based on data for 3 years from 2015 to 2017, the MRV system has been used to calculate the impact of LED lighting technology in Viet Nam in terms of energy savings, reduction of greenhouse gas emissions and few Project target indicators.
- Communication and awareness raising activities for the community include:
 - 24 articles, news about activities and some results of the Project implementation are regularly updated on the website and “Light & Life” magazine.
 - Participate and present the presentations at 03 national lighting conferences held by Vietnam Lighting Association in collaboration with the Project (2017, 2018 and 2019), 03 International Fairs / Workshops LEDTEC ASIA (2015, 2016, 2017).
 - 11 video clips and more 500 leaflets introducing production technology, LED market, LED application in lighting, results and impact of technical support of the Project.
 - Published a book "LED lighting technology and applications" Youth Publishing House, December 2018;
 - 02 Proceeding of the National Proceedings in the National Symposium on Lighting Science and Technology 2017 on “Smart Urban Lighting in Response to the Fourth Industrial Revolution (I 4.0)” and National Symposium on Lighting Science and Technology 2019 on “Vietnam Lighting in the Digital Era - Opportunities and Challenges” (co-organized with Viet Nam Lighting Association); and
 - Project's website: <http://htd.vn/du-an-chieu-sang.html>; <http://htd.vn/led-lighting-projects.html>



LED Project Summary
Local Development and Promotion of LED Technologies for Advanced General Lighting in Viet Nam

Viet Nam Context

- Population:** The population of Viet Nam in 2019 is 96.66 Million.
- Economic Growth (GDP):** Increased by 7.06% in 2018.
- Lighting:** accounts for 25% of all electricity used in Viet Nam.
- Energy Efficient Lighting:** LED lights reduce energy use by 50% – 80%, compared to Fluorescent Lights (FLs), HED lights and traditional incandescent lamps.
- Local Production Capacity:** 119 million LED lights were produced in 2019, accounting for 49% of the national LED market.
- Smart Lighting and Smart Cities:** Only LEDs are compatible with smart lighting technology. (Viet Nam is at the 5th of 5 phases of smart lighting development).

Challenges at Project Outset (2015)

- Technology:** Local LED manufacturers have insufficient design and manufacturing capacity to improve their production lines. Companies lack cutting edge design software to compete with international LED manufacturers.
- Quality Assurance:** LEDs lighting products were not consistently assessed to ensure they were high quality and met competitive efficiency standards.
- Awareness:** The public does not know the economic and social benefits of using LED lights. Demand for LED products is low.

LED Project Solutions

- Technology Transfer and Training:** new design software and on-the-job technical trainings on production management and quality control are offered at local LED factories. Six training courses and an e-learning program on lighting technology and installation are offered. They are attended by 333 engineers and technical managers from lamp production facilities, testing labs and lighting companies.
- LED Labelling and Standards:** Decision n.4/2017 on labeling (voluntary labeling: 1st January 2018 and mandatory labeling: 1st January 2020). Three Standards of the LED lighting products are promulgated.
- 10 sites that demonstrate LED light installation** are created to raise awareness about the benefits and quality of locally produced LED lights.

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Project Objectives

To reduce GHG emissions by promoting greater use of locally produced LED lights. The project has: 1) Promoted the transfer of skills, knowledge and technology for the manufacturing of LED lamps in Viet Nam; and 2) Demonstrated the cost-effective local commercial production of LED lighting devices. The project is expected to directly reduce CO2 emissions by 0.623 tonnes, and is projected to reduce CO2 emissions by 69.36 tonnes over the 10 years following its completion.

Baseline in 2015

- There is untapped potential to save energy by using LED lighting products.
- National Standards are insufficient to certify that LED products are up to code. No labelling system exists.
- LED production plants have limited access to advanced technology and cannot compete with international manufacturers.
- Vietnamese companies hold less than 1% of the national market share of LED production.
- Less than 200 local retail stores sell LED lighting products.
- Less than 1% of households and commercial establishments purchase locally produced LED lights.

Achievements in 2019

- Reduced CO2 emissions (tonnes): 1,263 (direct), 204.931 (indirect). Energy saving (MWh): 1,460 (direct), 2,370.160 (indirect).
- 16 LED Product Types meet national standards, including 210 models are standardized and 72 models are labelled.
- Local LED lamp manufacturers are actively producing high quality, certified LED products at competitive prices.
- Vietnamese companies hold 49% of the national market share in LED production.
- 15,000 local retail stores are selling LED products manufactured locally.
- 75% of households and commercial establishments have purchased locally manufactured LED products.

General Project Information

Implementing Partner: Viet Nam Academy of Science and Technology, Centre for High Technology Development
Primary Funders: Global Environment Facility (GEF) and United Nations Development Program (UNDP)
Total Budget: USD \$8,146,794 (GEF = USD \$1,517,400; Co-financing = USD \$6,629,394)
Project Duration: 2015 to 2019

Vietnamese partners participating in project implementation: Ministry of Science and Technology (Viet Nam Quality Standards Institute (STAMEQ), Quality Measurement Center (QUATEST), Ministry of Industry and Trade, Ministry of Construction, Viet Nam Lighting Association, Lighting equipment manufacturers (Rang Dong Thermo Light Bulb Joint Stock Company, Dien Quang Lamp Joint Stock Company, and others).

Relevant Policies: Law on Economical and Efficient Use of Energy, Decree on Urban Lighting Management, the National Strategy of Urban Lighting Development, a Plan for the Implementation of the Paris Agreement, and the Nationally Determined Contributions (NDCs).

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Some photos and media publications of the Project

2.3. Financial performance

- The GEF budget planned for disbursement USD 1,517,400 for whole 4-year project life in which most budget was allocated for Outcome 1 (67% of GEF budget), 5% of budget for project management, and the remainder for Outcome 2. As of 07/11/2019 the project disbursed USD 1,365,954, i.e. accounting for 90% and the remaining 10% is the commitments at the project closing (such as the Completion Workshop, Terminal Evaluation, and audit/spot check).
- The estimated co-financing as indicated in the Project Document was USD 6,629,394 with contributions from different stakeholders (VAST, MOIT, Quatest, CHTD, Ralaco, Dien Quang, Schreder and UNDP). Co-financing consists of in-kind contribution from government institutions (working offices, office equipment), water and electricity costs for PMU office, staff salary of VAST supporting staff (see Section 4.1) as well as acquisition of laboratory equipment, technology transfer, capacity development, input materials, advanced LED testing equipment, the LED production process equipment, the cost of indoor and outdoor LED lamps and their installation in the 10 demonstration projects. At the end of the project, the level of co-financing achieved is an estimated USD 6,698,773. Co-financing from was not realized as they closed their representative office in Viet Nam (Schreder does maintain a regional office in China), but other co-financiers, such as Quatest, CHTD and Dien Quang, contributed more than planned. The level of co-financing met the target, achieving about 101%.

Project Title	Local Development and Promotion of LED Technologies for Advanced General Lighting in Viet Nam			
GEF Project ID:	5555		<i>at endorsement</i> (USD)	<i>at completion</i> (USD)
UNDP PIMS ID:	5193	GEF financing:	1,517,400	1,365,954 ^{*)}
Country:	Vietnam	IA/EA own:	100,000	100,000
Region:	South East Asia	Government:	440,000	884,000
Focal Area:	Climate Change Mitigation	Other:	6,129,294	5,714,773
FA Objectives, (OP/SP):	CC1-Promote the demonstration, deployment, and transfer of innovative low-carbon technologies	Total co-financing:	6,629,394	6,698,773
Executing Agency:	Viet Nam Academy of Science and Technology (VAST)	Total project Cost:	8,146,794	8,064,727 ^{*)}
Other Partners	Ministries of Construction	ProDoc Signature		11 June 2015

involved:	(MoC), Science and Technology (MoST), Natural Resources and Environment (MoNRE), Industry and Trade (MoIT), Planning and Investment (MPI), Local manufacturer (Ralaco, Dien Quang)	(date project began):		
		Operational closing date	Proposed: 30 June 2019	Actual: 30 Dec 2019

- *) As of 07 Nov 2019; the balance of USD 151,445 was committed for Terminal Evaluation, Completion Workshop, and other pending last payments for project activities
- The annual audits (2017, 2018 and 2019) were done by an international auditing firm and the final project evaluation was completed on December 2019 by the international expert team.
 - Project review conference/debrief on the project implementation and experiences exchange was successfully organized in Hanoi on December 11, 2019.



Prof. Phan Ngoc Minh, VAST's Vice President and Ms. Caitlin Wiesen UNDP CO Resident Representative in Viet Nam delivered their speech at the Project review conference/debrief, Ha Noi, December 11, 2019



Dr. Nguyen Van Thao, CHTD's Director General & NPD presented the Project Review Report and representatives participated in dialogue at the Conference/Debrief, Hanoi, December 11, 2019

2.4. Factors that affected the implementation of the project

2.4.1. Legal and policy environment

- **Government policy**

- Energy efficiency and government policies*

For decades Vietnam has been one of the fast-growing economies in the region and in the world. While economic growth is a high priority for the Vietnamese government, governmental strategies emphasize that fast development needs to uphold sustainability at the same time.

The Government of Vietnam has several key policies for sustainable energy development with the four main pillars of energy efficiency (EE), renewable energy (RE), energy market and climate change. Regarding sustainable energy, the following policies and legislation are of importance²:

- + *Law on Energy Efficiency and Conservation* (LEEC; Law 50/2010/QH12): promoting energy efficiency and conservation through regulations, standards, and incentives;
- + *Vietnam Green Growth Strategy* (VGGS; Decision 1393/2012/QD-TTg): introducing greenhouse gas emission (GHG) reduction targets aiming to reduce fossil fuel and promoting renewable energy.
- + *National Program on Energy Efficiency and Conservation* for the period 2019-2030 (VNEEP3; Decision No. 280/2019/QD-TTg): setting targets for reducing the final energy consumption compared to a business-as-usual baseline;
- + *Intended Nationally Determined Contributions* (INDCs): submitted to the Secretariat of the United Nations Framework Convention on Climate Change (UNFCCC);
- + *Renewable Energy Development Strategy* (REDS; Decision No. 2068/2015/QD-TTg): setting RE targets in energy and power sectors; supporting schemes for RE development Renewable Portfolio Standard (RPS), net-metering etc.).
- + The Vietnam National Energy Efficiency Programmes were implemented by MoIT in the period 2006-2015 (VNEEP1 and VNEEP2) and comprised many activities ranging from legal framework, capacity building, obligations for designated energy users, support for energy audits, soft loans, standards and energy labeling, as well as non-financial and financial incentives. VNEEP1 and VNEEP2 achieved energy saving ratios of 3.39% and 5.65% respectively. Compulsory labelling and minimum energy performance standard (MEPS) programmes under VNEEPs have been implemented for many appliances in the residential, commercial, industrial and transport sectors. These include lighting products, such as CFLs, fluorescent lamps, electronic and magnetic ballasts. VNEEP3 (2019-2030) was approved in March 2019 with targets for reducing the total final energy consumption by 5-7% in 2025 and 8-10% in 2030 compared to the baseline development. The major supporting schemes under the VNEEP3 include: enhancement of legal framework and enforcement, promulgation of EE standards, establishment of energy service companies (ESCO), technical and financial support, capacity building, creating energy information systems, and establishing an Energy Efficiency Fund².

² Vietnam Energy Outlook Report 2019, Electricity and Renewable Energy Authority (EREA); MoIT

Specific targets in energy and climate policy, Vietnam		
Target	2030	2050
<i>Renewable energy</i>		
1) RE share in primary energy supply (REDS)	32%	44%
2) RE share in total energy generation (REDS)	32%	43%
<i>Energy efficiency (compared to BaU)</i>		
3) Final energy demand savings (VNEEP3)	8-10%	
<i>GHG emissions (compared to BaU)</i>		
5) INDCs	8-25%	
6) REDS (energy sector as a whole)	25%	
See Table 1 in Vietnam Energy Outlook Report 2019 (EREA; MoIT)		

Under the VNEEP umbrella, the Government has shown commitment to energy efficiency in general and to energy-efficient lighting. The voluntary LED standards and labelling (S&L) were defined and will move into a mandatory scheme for several LED lighting products, starting in January 2020. Testing laboratories (of Quatest and LED manufacturers) have been upgraded, which is an essential condition for product certification by authorized agencies and self-certification by manufacturers. Experience with the mandatory system will show to what extent the certification authority will be able to carry its functions such as sampling products in the market, testing of samples for certification, and evaluating the capacity of enterprises.

- **Sustainable Development Goals**

The project document (ProDoc) does not explicitly refer to the SDGs, maybe because it was not a requirement to do so at the time of ProDoc formulation. However, the project addresses several SDGs both directly as well as indirectly, as indicated as follows:

Sustainable Development Goals with relevance to the Project	
Sustainable Development Goals	Linkage with energy efficiency
<i>Sustainable energy</i>	
7.2 Increase substantially the share of renewable energy in the global energy mix 7.3 Double the global rate of improvement in energy efficiency	7a. Enhance international cooperation to facilitate access to clean energy research and technologies, including renewable energy, energy efficiency, and advanced and cleaner fossil fuel technologies, and promote investment in energy infrastructure and clean energy technologies 7b. Expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries
<i>Other SDGs:</i>	
8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all	Energy efficiency and conservation influence the country's energy intensity and carbon content of economic growth

9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	Resilient infrastructure and public-private partnerships are required to ensure access to energy for all and to maximise energy efficiency
11. Make cities and human settlements inclusive, safe, resilient and sustainable	Municipalities require careful electricity planning and efficient power distribution
12. Ensure sustainable consumption and production patterns	The residential and buildings sector is a key part of a future in which there is sustainable consumption of energy and products
Compiled from <i>Transforming our World: the 2030 Agenda for Sustainable Development</i> (UN, 2015), <i>Indicators and a Monitoring Framework for the Sustainable Development Goals</i> , Sustainable Development Solutions Network (SDSN)	

- **Donor policy**

GEF and UNDP

The LED Vietnam project results framework in the ProDoc refers to the following Outcome as defined in the Country Programme: “By 2016, key national and sub-national agencies, in partnership with the private sector and communities, have established and monitor multi-sectorial strategies, mechanisms, and resources to support implementation of relevant multilateral agreements and effectively address climate change adaptation, mitigation and disaster risk management” with the corresponding Outcome Indicator “CO₂ emissions, total, per capita and per USD 1 GDP (PPP)”.

The project falls within the GEF-5 programme area “GEF Climate Change Mitigation; Strategic Programme SP-1 “Promote the demonstration, deployment, and transfer of innovative low-carbon technologies” with Outcome 1.1, “Technologies successfully demonstrated, deployed, and transferred”, and Outcome 1.2 “Enabling policy environment and mechanisms created for technology transfer”, as well as “tonnes of CO_{2-eq} avoided”.

Stakeholder involvement

The project has maintained successful collaboration and coordination between PMU and other stakeholders including the relevant ministries (MoIT, MoC, MoST), education sector (HCM University of Technology, HCM National University, schools) private sector manufacturers (e.g., Dien Quang, Ralaco) and UNDP (see Box 7 for an overview of the various stakeholders and their role in the LED Vietnam project). The project has regularly worked with and consulted intensively with these stakeholders on the labelling and certification of LED lights and the LED market trends during the implementation of the project activities in the reporting period. The Project has worked with LED lights producers through providing technical support and guidance to the companies in preparation for their products and application for their products to be labelled. In general, the stakeholders interviewed during the mission expressed their satisfaction with the Project's assistance and the interventions by the Project Management Unit.

List of project stakeholders

Category	Stakeholders
Viet Nam Academy of Science and Technology (VAST)	VAST is the government agency responsible for developing technologies as directed by the State that includes LED lighting technologies. VAST is the Executing Entity for UNDP/GEF this Project. VAST's Centre for High Technology Development (CHTD) is the Implementing Entity of the project on behalf of the VAST. It is worth mentioning that VAST also implemented the UNDP/GEF "VEEPL (Vietnam Energy Efficient Public Lighting)" project during 2005-2011.
Ministry of Construction (MoC)	<p>MoC's Technical Infrastructure Agency (TIA) gives advises and assists the Ministry in enforcing various policies on urban infrastructure development that would include LED lighting policies (including standards for street lighting)</p> <p>The Department of Science, Technology, and Environment (DoSTE) of MoC is responsible for scientific, technological and environmental perspectives on construction. DoSTE's involvements in the LED Vietnam project is in the area of promotion of LEDs in transport infrastructure and incorporation of efficient lighting aspects in the Energy Efficient Building Code (EEBC).</p>
Ministry of Science and Technology (MOST)	<p>The Directorate of Standards, Metrology and Quality (STAMEQ) of MoST assists in the setting of standards for new technologies including LED technologies for energy performance and service life.</p> <p>The Viet Nam Standard and Quality Institute (VSQI) under STAMEQ is responsible for the issuance of national standards identified under the abbreviation TCVN (standing for <i>Tiêu chuẩn Việt Nam</i>) followed by a number, a colon, and the year issued.</p> <p>The Quality Assurance and Testing Center 1 (Quatest 1) is the science-technological organization under STAMEQ is responsible for State management on standards, measurements, quality, and other service activities. Quatest has cooperated with the LED Vietnam project on upgrading and operating the system of lighting (LED and luminaires) testing equipment</p>
Ministry of Industry and Trade (MoIT)	MoIT's Energy Efficiency and Sustainable Development Department implements the National Program on Energy Efficiency (VNEEP). MoIT is involved in the LED Viet Nam project are in the area of market analysis on trends in the LED market in Viet Nam and through its labelling programme for LED lighting.
Ministry of Natural Resources and Environment (MoNRE)	The Director of MoNRE's Environment protection Fund is the GEF Operational Focal Point. MoNRE's Institute of Strategy and Policy on Natural Resources and Environment (ISPONRE) has been executing the UNEP/GEF project "Phasing out Incandescent Lamps through Lighting Market Transformation in Viet Nam" during 2010-2017.

Private and public companies	Local private sector LED lamp manufacturers (such as Ralaco, Dien Quang) that are producing LED products for indoor and outdoor general lighting and have partners with Project. Other public and private entities have hosted the indoor LED lighting applications (e.g., Tran Thanh Co. and Saigon Tobacco Fiber Co.) and outdoor applications of LEDs (e.g., indoor lighting in public buildings and street lighting), such as the Ho Chi Minh City Public Lighting Company, Le Ngoc Han Primary School (in HCMC).
Civil society organisations (CSOs)	Civil social service organizations (such as the Viet Nam Lighting Association (VLA) and the Energy Efficiency and Conservation Association of Viet Nam (VEECA) play a role in raising the profile of local LED products, their usage, and its national environmental and social benefits through advocacy, awareness-raising and training.

2.4.2. Project management

- **Implementation arrangements for the project**

Management arrangements

The Project is executed under Harmonized Approach to Cash Transfers to Implementing Partners (HACT) framework and National Implementation Modality (NIM) in project management implementation guidelines agreed by UNDP and the Government of Viet Nam. UNDP is the GEF Implementing Agency (IA) for the Project, and the Vietnam Academy of Science and Technology (VAST) the GEF Implementing Partner.

As stated in section 1.2.2, the CHTD established a Project Management Unit (PMU) and appointed a senior official as the National Project Director (NPD) and another official as the National Project Deputy Director (DNPD). Based on the bidding laws of the Vietnamese government, the regulations of HPPMG and UNDP CO, the announcement of the selection of three key members for PMU has been published in the bidding newspaper and websites of CHTD and UNDP. Based on the results of the bid evaluation, the General Director of CHTD cum NPD recommended VAST President to appoint the following 3 main PMU members: Project Manager (PM), National Technical Advisor (NTA), Accountant cum Administrator (PA cum Adm.). CHTD and NPD also appointed an accountant in charge of counterpart fund and an office assistant to assist PMU in project implementation and management.

UNDP has provided overall management and guidance from its Country Office in Hanoi and the Bangkok Regional Hub (BRH) in Bangkok, and has been responsible for monitoring and evaluation as well as quality assurance for the project. UNDP has been responsive to the proposed changes when needed. For example, UNDP assisted the PMU with procurement, when the process needed to be speeded up. Also, two packages on e-learning and financial mechanism study were added to the original list of project activities). When the bidding following Government procedures was taking too much time, UNDP did the procurement PMU to assist those packages in order to be able implement these within the project

timeframe. On the other hand, other activities were taken out of the Work Plan, such as consulting package of assessment on transformation to LED market (when it was concluded that carrying the study out in 2016, when the LED market was just establishing itself, would have been too early). These are examples of adaptive management exercised by both PMU and UNDP in this project.

- ***Implementation capacity for the project***

VAST, CHTD are experienced, competent and reputable to organize successful implementation of national and international projects. PMU members have good experience in implementing international projects, including ODA projects funded by GEF, UNDP, participated in project management training courses organized by UNDP CO. bidding laws of the State of Vietnam, etc. VAST and CHTD are reputable and have good relations with government agencies, ministries, branches, universities, local governments and especially with the Vietnam Lighting industry (Vietnam Lighting Association, Lighting equipment manufacturers, lighting companies..).

- ***Compliance with reporting requirements and M & E requirements during the project implementation process***

M&E: design at entry

At Inception, a total of USD 122,000 was allocated, about 5% of the total GEF budget, which is more than enough given the Project. In the M&E plan as formulated in the project documentation, the performance of the Project is monitored and assessed according to the goals defined and agreed in the AWP, with outcome indicators (which are based on the logframe of the Project Document) and outputs. The ProDoc also gives a 'standard-type' of M&E Plan of which the main elements are:

- Project Inception Workshop and Project Implementation Workplan:
- Quarterly monitoring of project progress (and update of risk logs in ATLAS); AWP and expenditure reports
- Project Implementation Report (PIR) and PMU Progress Report
- Project Steering Committee (PSC) meetings
- Mid-Term Review and Project Terminal Evaluation
- Learning and knowledge sharing: results from the Project to be disseminated within and beyond the project intervention zone through existing information sharing networks and forums.

M&E implementation; reporting

An Inception Report has been prepared, and as a result of the Inception Workshop, has foreseen slight changes in the project outputs and activities formulated in an updated Results Framework. Regular quarterly progress reports have been prepared since Q3 of 2015 up to Q2 2019. Annual Project Progress Report were prepared for 2015, 2016, 2017 and 2018. The annual Project Implementation Reviews (PIR) for 2017, 2018, and 2019 have been prepared. A project Completion Report (in both English and Vietnamese) has been prepared.

PSC meetings have been used to monitor project progress and results, approve the next year workplan and provide the orientation on the project implementation. PSC meetings have been held on 24.12.2015, 20.12.2016, 21.12.2017 and 26.12.2018), of which the

Minutes of Meeting including discussion points and agreements have been made available. At the meetings, usually five to seven PSC members have been present³.

The Mid-Term Review was not conducted, because (i) the LED project is a medium-sized one therefore no mandatory to undertake the review; (ii) the project implementation results achieved over the years were deemed satisfactory enough with no need for a MTR (thus also saving on the project budget). PMU staffs and UNDP officials did not make separate field visits to monitor progress on a periodic basis, but to save cost the monitoring activities have been combined with or accompanying the project activities. The performance of the Project is monitored and assessed according to the goals defined and agreed in the AWP, with outcomes and outcome indicators (which are based on the logframe of the Project Document) and reported in the before-mentioned annual progress reports or PIRs.

The Project produces two reporting systems, one for UNDP and another one for the Government. With UNDP reporting requirements, the Project produces quarterly and annual reports⁴. The reporting requirements for the Government of Vietnam entail the same in parallel, quarterly and annual reports using separate templates which are regulated by Decree No. 16/2016/ND-CP and Circular No. 12/2016/TT-BKHDT that are applicable to all projects in Vietnam.

- **Risk and change**

Risks identified in the implementation of the project and mitigation measure are summarized in the Table below.

Risk Description	Mitigation Measure	Level of Risk
Political Risk		
The government may shift program priorities unexpectedly, leading to a lack of committed resources for the development and implementation of LED lighting projects.	This risk will be mitigated by engagement of government and other stakeholders to facilitate actions such as S&L and testing programmes. Their commitment will be established and confirmed during project preparation and the inception phase.	Low
Technical Risk		
Given support on technology transfer, the local manufacturers may still not be able to develop products that meet quality and	This risk will be managed by applying an integrated approach in technology transfer and exposing the largest Vietnamese lighting manufacturers to the latest technological	Medium

³ Apart from the Vice Chairman of VAST, representatives of MOIT, MOC, VLA, Dien Quang and Ralaco manufacturers as well as UNDP Head of Sustainable development cluster and the responsible Programme officer. Other staffs from PMU, CHTD, VAST, Universities, as well as consultants and experts have participated.

⁴ Generally, the annual workplan was prepared in October or November each year. The annual workplan then was submitted to UNDP in January and VAST for an approval in February of next year, followed by submission of the Procurement Plan for an approval in March to be followed by implementation of activities in April

Risk Description	Mitigation Measure	Level of Risk
performance levels set by local and international markets.	developments and training local professionals in technology and quality assurance.	
Market Risk		
Market demand for LED lighting technology may be low, mainly due to high initial costs compared to conventional lighting technologies in addition to market distortions due to the presence of substandard products in the market and the reluctance of foreign technology suppliers to enter a market where there may be issues with Intellectual property rights (IPR) infringement.	<p>This risk will be managed by locally producing LED lighting lamps with the largest lighting manufacturers in Viet Nam who will meet international quality standards, while reducing the production costs and the price of LED lamps. Enhancing consumer awareness of the benefits of LEDs as well as the long-term financial benefits will help to boost the confidence of consumers in LED lighting products.</p> <p>In addition, the largest lighting manufacturers have already expressed a willingness to pay or have paid for licensing fees for the use of patented LED technologies, and have the production capacity that would bring LED prices down. The Project, however, will <u>not</u> assist in human resource capacity building to improve IPR enforcement oversight.</p>	Medium
Social Risk		
Poor and marginal income households may not benefit from increased access to LED lighting due to higher prices.	This risk can be mitigated through the continued promotion of locally-produced LEDs, continued production of quality LEDs and maximizing the reduction of LED prices through increasing scales of economy of LED production	Low

- ***Bidding and procurement***

During implementation, the Project Management Unit completely complied with HPPMG procurement regulations, Vietnam's Bidding Laws No 43/2013/QH13 dated on 26, November 2013, Decree No. 30/2015 / ND-CP of March 17, 2015 detailing the implementation of a number of articles of the Bidding Law regarding investor selection and joint circulars No. 07/2015 / TTLT-BKHDT-BTC promulgated by the Minister of Planning and Investment and the Minister of Finance detailing the provision, posting of information on bidding and selecting contractors online. The list of main technical reports created during the Project implementation is in **Annex 5.4**.

- ***Technical assistance, training and capacity building***

The Project has a successful cooperation and coordination between PMU and other stakeholders including the related ministries (MoIT, MoC, MoST), education sector (HCMC University of Technology, Vietnam National University, Ho Chi Minh City, schools) private sector

manufacturers (eg, Dien Quang, Ralaco) and UNDP. The Project has regularly worked and consulted in-depth with stakeholders on LED labeling and certification (L&C) and LED market trends during the implementation of Project activities.

The project has worked with LED manufacturers through providing technical support and guidance to manufacturing LED lighting products and applications of their certified products. In general, stakeholders expressed satisfaction with the support of the Project and the intervention of the Project Management Unit.

- ***Clearance and resettlement***

CHTD has arranged the premises and renovated the lanes rooms to ensure good working conditions for the project's activities, including two (2) 24m2 rooms for PMU to work and a 24 m2 meeting room on the 3rd floor, 2C building Technology Park, 18 Hoang Quoc Viet, Hanoi, ensuring electricity, water, network, telephone, sanitation and security.

- ***Environmental Management***

Environmental management is carried out within the common framework of CHTD and VAST. During the implementation of the Project, no incidents of environment and fire occurred.

- ***Gender issues***

Gender as such is not reflected in the results framework, because at the time of project conceptualisation (2014) there were no clear guidelines on including gender-relevant indicators in the results framework. Only the most recent UNDP/GEF ProDoc template now includes a separate section dedicated to gender issues, while a gender action plan needs to be annexed). This does not mean that the Project has ignored gender issues during implementation, e.g., the reporting on participation in the Project's training course and workshop gives a breakdown per gender.

With the support of the UNDP-GEF LED Vietnam project the production of lighting products has been significantly improved and with this the potential for employment. This will increase the chance for women to participate more in all stages of the production line with higher incomes and the equivalent of men, although the Project does not provide data to corroborate this.

The Project Management Unit has given details on women's participation in the training courses and workshops organized. we learn that participation by women was an overall 18% with higher participation in more general workshops (e.g. inception, policy and regulations) and less in the more technical events, indicating that the sector is still pretty much male-dominated.

- ***Technology and know-how***

The project recruited international experts, Mr. An Young Hoon (South Korea), Mr. Takeo Tatematsu (Japan), Mr. Yuji Segawa (Japan), Mr. Gareth Jones (United Kingdom), Mr. Indika Perera (United States).) and national experts, Mr. Le Minh Phuong (Ho Chi Minh City University of Technology), Mr. Nguyen Viet Hung (Hanoi University of Technology), Mr. Phan Quoc Dung (Ho Chi Minh City University of Technology) on LED lighting technology and trainers organized by the Project to provide technology solutions and know-how to LED lighting manufacturers and users. At the request of Ralaco and Dien Quang, the project has provided and built 2 software to design radiators and control sources for LED lights.

The following table lists the technology solutions and know-how transferred by the Project to manufacturers of LED lighting products, together with justifying the difficulties of domestic manufacturers before the Project. and the effectiveness of receiving technological solutions and know-how.

Technology solutions and know-how and transfer modality	Businesses receiving	Difficulties before Project Support	The effectiveness of technological solutions and know-how
SMT technology for LED chips to produce lights (Technical training and guidance on SMT technology)	Ralaco and Dien Quang	No equipment and no grasp of SMT technology to produce LED lights	There are automatic SMT systems. Mastering SMT technology to produce over 200 different types of LED lights
Software for designing LEDs heat sinks There is a license to use (The Project bought and supplied software, provided consultants to train and guide the use of the software)	Ralaco	Design of LED heat sinks was manual, backward, slow with poor quality	Using software to design LED heat sinks for different types of LEDs with accurate, fast, quality control.
Software for designing LED power supplies (LED drivers) (The Project provided domestic experts in building software, training, manuals, and confidential software)	Dien Quang	Design of LED drivers was manual, slow with poor quality.	Using software to design LED power source drivers of different capacity accurately, quickly with quality control
Solutions for measuring, testing and evaluating LED lamp quality (Training, technical guidance)	Ralaco, Dien Quang, Quatest 1,2,3	Not yet qualified and knowledgeable to measure, evaluate and manage LED measurement	Measurement and evaluation Quality management of LEDs is guaranteed.
Solutions to protect LEDs from damage due to accidental electrical impulses of the grid and lightning strikes (Training, technical guidance)	Ralaco, Dien Quang and some others	LED lights were often broken during use, the cause is unknown.	Thanks to a protective solution, it is possible to avoid lamps damage due to accidental electrical impulses of the grid and lightning strikes.

3. Analysis of Socio-Economic Benefits

3.1. Analysis of the results achieved against the project objectives and design

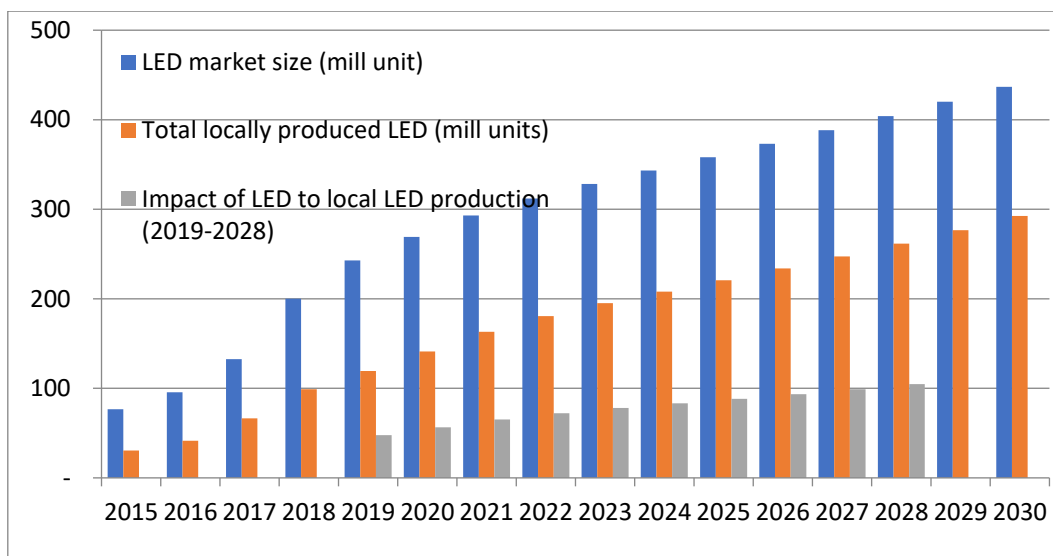
The lighting products market in Vietnam has been growing very fast in the past years with an increasing share of LED products. There has been a concern about the presence of substandard foreign and domestic LED lighting products in the market. With support from the Project, a voluntary energy labeling scheme was implemented to prepare for the mandatory labeling starting from January 2020. With the mandatory labeling, the quality of LED lights penetrating to the market will be controlled thus preventing the low-quality LED lights from access to the market. This also gives a clear indication to LED product manufacturers to what standards their products should adhere and what additional investments are needed to manufacture quality LED devices for the Viet Nam market.

Eventually, the promotion of locally-produced LEDs, continued production of quality LEDs and global trend in reduction of LED prices (through improved production efficiency and increasing economies of scales) will imply that increasingly more and more households will be able to afford the purchase of LED lighting devices. However, such a market transition may be delayed if the economic growth of the Vietnamese economy would slow down in the coming years and/or if subsidized energy prices will continue to lower the incentives for consumers to save on their electricity bill. In particular, lower-income households may not benefit at first from LED lighting in comparison with higher-income sectors.

3.2. Impact on sectorial and regional development

The development of the Roadmap and the support provided for the national quality system such as the TCVN standards, the energy labeling program and capacity building of the testing laboratories, provides both the policy and regulatory framework and the tools to help state management agencies, manufacturers, operators, users, monitor quality and develop the market not only for domestically produced LED lighting products but also for imported products.

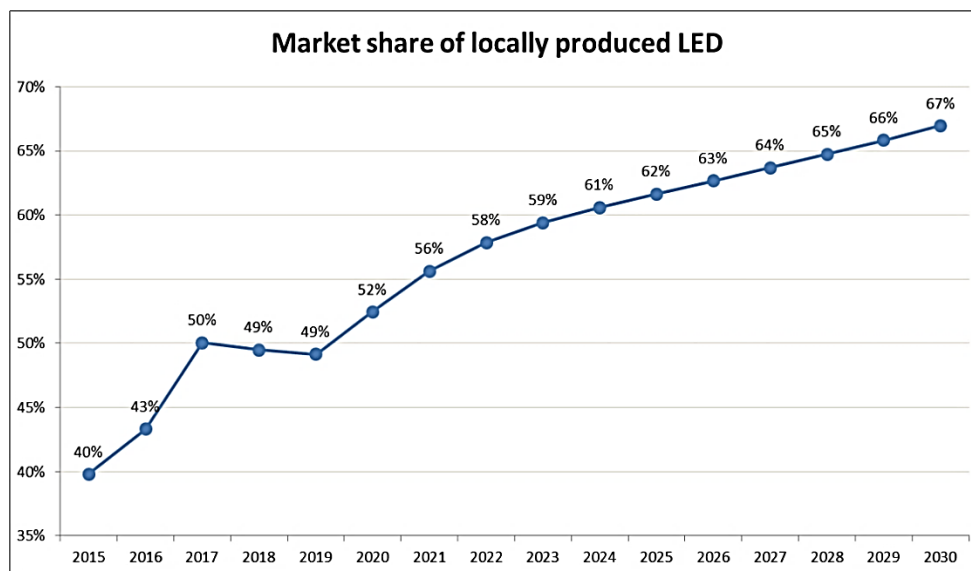
Thanks to the technical assistance provided by the Project and the significant efforts investment made on R&D and production of LED lighting products by the central & local governments, manufacturers/companies, the LED domestic manufacturers have been able to improve their capacity to produce a variety of good quality LED lamps meeting TCVN standards, with 16 types of LED lighting products of 72 models being labeled and certified. The LED domestic manufacturers are also making efforts to have some types of lamps that meet international standards and can be exported to European and American markets. The price LED of lights is decreasing quickly, for example, the average price of LED lamps locally manufactured has reduced 3 times in 2019 in comparison to 2016. The calculation result based on the survey data as in the chart below shows that local LED market will increase about 5 times in 15 years, from about 76.6 million lamps in 2015 to nearly 450 million in 2030. The quantity of locally produced LED lamps will tentatively increase from 30.5 million lamps in 2015 to nearly 300 million in 2030.



LED market size and impact from the LED Project

Contribution of LED Project to the growth of local LED production is estimated in the period of 10 years after EOP about 870 million totally, starting from 47.7 million lamps in 2019 to 104.6 million in 2028.

The growth of LED production of local enterprises will tentatively increase the market share of locally produced LED products from 40% in 2015 to about 67% in 2030, as shown in the following chart:



Market share of locally produced LED lights

As the above calculation result, the market share of locally produced LED products is expected to increase strongly in the first 10 years period (2015 – 2024), from 40% in 2015 to more than 60% in 2024, then will level off in about 60-70%.

3.3. Sustainability

Sustainability is generally considered to be the likelihood of continued benefits after the project ends. Consequently, the assessment of sustainability considers the risks that are likely to affect the continuation of project outcomes. In fact, many risks are in one way or another related to the “barriers” mentioned in the Project Document). The occurrence of the “risks” and failure to implement risk mitigation, implies that it will be more difficult to lower corresponding “barriers” substantially, thus negatively affecting the likeliness of “sustainability” of the project’s interventions. The critical “assumptions” then is that the “internal risks” (i.e. risks that can be mitigated or managed by Project management), and ‘external risks’ have a low incidence and/or impacts, in such a way that sustainability remains (moderately) likely. The quality of adaptive management is determined by the mitigation response of Project management to these external and internal risk factors as these manifests themselves more intensely and/or more frequently than expected.

To assess the sustainability of the Project, Mr. Jan Van den Akker and Ms. Dang Ngoc Dung, the experts of final project evaluation team, have based on a simple ranking method as follows

- :
- Likely (L): negligible risks to sustainability;
- Moderately Likely (ML): moderate risks to sustainability;
- Moderately Unlikely (MU): significant risks to sustainability; and
- Unlikely (U): severe risks to sustainability.

Five main areas are considered and then rated as to the likelihood and extent that risks will impede sustainability. The evaluation results of the expert evaluation team at the end of the project period are as follows:

- ***Socio-economic sustainability (likely)***

The lighting products market in Vietnam has been growing very fast in the past years with an increasing share of LED products. There has been a concern about the presence of substandard foreign and domestic LED lighting products in the market. With support from the Project, a voluntary energy labeling scheme was implemented to prepare for the mandatory labeling starting from January 2020. With the mandatory labeling, the quality of LED lights penetrating to the market will be controlled thus preventing the low-quality LED lights from access to the market. This also gives a clear indication to LED product manufacturers to what standards their products should adhere and what additional investments are needed to manufacture quality LED devices for the Viet Nam market.

Eventually, the promotion of locally-produced LEDs, continued production of quality LEDs and global trend in reduction of LED prices (through improved production efficiency and increasing economies of scales) will imply that increasingly more and more households will be able to afford the purchase of LED lighting devices. However, such a market transition may be delayed if the economic growth of the Vietnamese economy would slow down in the coming years and/or if subsidized energy prices will continue to lower the incentives for consumers to save on their electricity bill. In particular, lower-income households may not benefit at first from LED lighting in comparison with higher-income sectors.

- ***Governance and institutional sustainability (likely)***

Under the VNEEP umbrella, the Government has shown commitment to energy efficiency in general and to energy-efficient lighting. The voluntary LED standards and labelling (S&L) were defined and will move into a mandatory scheme for several LED lighting products, starting in January 2020. Testing laboratories (of Quatest and LED manufacturers) have been upgraded, which is an essential condition for product certification by authorized agencies and self-certification by manufacturers. Experience with the mandatory system will show to what extent the certification authority will be able to carry its functions such as sampling products in the market, testing of samples for certification, and evaluating the capacity of enterprises.

- ***Financial sustainability (likely)***

There are more than 200 LED manufacturers in Vietnam. Around 3% of the LED manufacturers are larger local companies that have many years of experience in producing lighting products and 84% are smaller enterprises (see Box 21). Most of these smaller enterprises on assemble LED products with imported components, mainly using imported LED product assembly and packaging equipment, that is low in price but not always delivers good quality. Hence, there has been a proliferation of poor-quality LED products which has been a barrier for the further development of the LED market in Vietnam. The new mandatory LED S&L scheme is expected to weed out low-quality LED products from the market. However, producing LED products that are good in quality but remain affordable requires high-technology and automated manufacturing capability, supported by the company's internal research and development. In order to be able to compete in the market, these smaller companies will have to upgrade their products and production lines. The availability of soft loans (e.g. through development banks or funds) will help the small to improve their production lines and quality management system while shifting the range of products from LED equipment to offering model lighting solutions.

Public lighting systems offer a high potential for energy saving. For example, Hanoi currently consumes 57 million kWh of electricity annually for public lighting and the electricity cost accounts for 65% of the annual budget for maintenance of the lighting system; in Ho Chi Minh City (HCMC), the lighting system currently consumes more than 162 million kWh of electricity per year, of which public lighting accounts for about 90 million kWh per year. Most lamps currently used for public lighting in Hanoi and HCMC as well as in the other cities are high-pressure sodium lamps (HPS) and metal halide (MH). In fact, these conventional lamps are used widely with LEDs currently accounting for only about 5% of public lighting products.

A challenge to develop and implement such LED public lighting projects in Vietnam is the limited availability of public finance. The ESCO (energy service company) mechanism has been proposed as a remedy, but this can be practiced only if the public lighting sector could be organised and operated more according to market-based mechanisms (see Box 21). The before-mentioned cities, Hanoi, HCMC and Halong city to implement LED lighting in public lighting through the ESCO model, supported by an active People's Committee. However, performance contracting does not fit easily with standard procurement procedures, raising issues around asset ownership (of installed equipment) and requiring financial arrangements very different from the 'pay-on-delivery-of-a-specified-service' model. Local government finances tend to be tightly controlled by the national governments and the smaller or poorer ones may not have enough budget to invest in public LED lighting.

- ***Environmental sustainability (likely)***

LED lights are up to 80% more efficient than traditional lighting such as fluorescent and incandescent lights, i.e. 95% of the energy in LEDs is converted into light and only 5% is wasted as heat. A longer life span means lower carbon emissions. LEDs have a better quality of light distribution and focus light in one direction as opposed to other types of lighting (which waste energy by emitting light in all directions, often illuminating areas where light is not required). This means that fewer LED lights are needed to achieve the same level of brightness given off by fluorescents and incandescent lights. LED lights contain no toxic elements, unlike (compact) fluorescent lamps that contain noxious chemicals such as mercury. This will contaminate the environment when disposed of in landfill waste.

- ***Replication and scaling up (likely)***

LED lighting will witness a higher penetration in the Vietnamese market due to growing urbanization in the country, due to the rising per capita income in Vietnam and growth in the building and infrastructure sector and the (global) trend towards lower prices. The LED market in Viet Nam was USD 95 million in 2016, but reaching USD 249 million in 2018, and according to a recent estimate, the market will increase to USD 818 million by 2024. Thus, the Evaluation Team rates overall 'sustainability' as 'likely' with the observation that for the local LED industry to thrive in the long run, they also need to gradually access the large and lucrative global and regional (ASEAN) export markets.

The sustainability of the project is summarised with key products that have been utilized and scaled up by national stakeholders as follows:

- The lighting roadmap had been built and transferred by the project to domestic lighting management, operation and research units which are one of the first steps to orient the domestic lighting industry in the direction of usage of LED lights.

- Vietnam standards (TCVN) for LED lighting products have been developed with the support of the project were approved and issued by MOST for implementation. These are the basis for evaluating LED products in the market in order to develop and orient the market of LED lighting in Vietnam, supporting the production and distribution of domestic quality LED products, eliminate poor quality (imported) products.

- The standards for urban street and tunnel lighting that were supported by the project were submitted to the MoC for approval as a tool to support the implementation of urban lighting projects in the trend of transition to use LED lights.

- The labeling and certification program (L&CP) of LED lighting products has been approved by MOIT and this is the first steps to institutionalize the management the domestic lighting market.

- Thermal design software and driver design software have been applied very effectively by Ralaco and Dien Quang manufacturers. These are important software that supports the production of LED lighting products in order to achieve LED lighting products that meet national and international standards. This is also an important factor to improve the quality of domestic products, towards export Viet Nam LED products to regional and international markets.

- The training programs of the project have contributed to improving the capacity of employees in the lighting industry in Vietnam. The online training program has been developed by the project to continue training a team of qualified staff in the lighting industry in the near future, after the project ends.

4. Lessons Learned and Recommendations

4.1. Lessons Learned

Some lessons learnt from the implementation of the LED Vietnam project are:

- Clearly define the project objectives, tasks & related activities; identify correctly and successfully mobilize co-financing partners and stakeholders to participate in project implementation.
- Having an effective policy-regulatory framework is an important condition to achieve a market towards more efficient consumer technology, such as LED lighting. In such a framework, energy labels help shift the market from less efficient to more energy-efficient market ('market pull'). Defining minimum energy performance standards (MEPS) has the aim of eliminating obsolete equipment from the market ('market push'). A mandatory system needs to be accompanied by an effective monitoring, verification and enforcement system, including adequate test facilities, organized market checks and sanctions for offenders.
- Much importance is given in GEF projects on project indicators. These are given in the results framework and their progress is reported in the annual Project Implementation Reviews (PIRs). In development projects, 'results' are the describable or measurable development change resulting from a cause-and-effect relationship. These results include project outputs, short- to medium-term outcomes, and global environmental and development impacts. One such developmental impact is market transformation.
- Respect and comply with the instructions and needs of the central, city, provincial governments and their agencies, particularly the executing entity (Viet Nam Academy of Science and Technology) and the implementing entity (Center for High Technology Development (CHTD) under VAST), and try to get their support.
- Ensure commitment and active participation of the lamp manufacturers: the active involvement and commitment of the domestic manufacturers was needed to improve their own business practices and production management system, and their data, inputs and consensus were needed for strengthening the policy and regulatory framework to accelerate the transition to LEDs.
- Secure leadership and political support of the Government ministries and agencies (MOIT, MOST, MOC): The development, promulgation and implementation of various support policies and standards required leadership from the Ministries in terms of defining the scope, ensuring all relevant stakeholders are heard, smooth inter and intra-ministerial coordination and a commitment to improve internal systems. And finally
- Closely monitor and provide technical support by UNDP and smooth coordination between the Project Management Unit, UNDP Programme Officer & other UNDP Country Office staff, and international & national project technical advisors/consultants has enable the successful implementation of the project.

4.2. Recommendations

Based on lessons learnt from the project implementation and recommendation by the terminal evaluation reviewer, following are recommendations suggested to successfully further develop LED lighting technology for general lighting and its market in Viet Nam:

- With the LED development trend, MOST and MOC should continue the development and promulgation of TCVNs for LED lighting products, especially those for smart lighting and to improve the capacity of testing laboratories (including physical and human resources) as well as LED related lighting standards/codes and regulations for suitability and sustainability of LED lighting and smart lighting development;
- There is a need to continue efforts by MOIT to complete the registration and verification procedures for product registration and energy efficiency labelling, especially from the second phase (stage mandatory labelling) of the "Labelling and Certification Program for LED lighting products (L & CP)" will begin from January 01, 2020;
- MOIT and VLA should support small and medium enterprises to upgrade their production lines to produce high quality lighting equipment: MoIT can consider how smaller LED companies can take advantage of SME Law incentives, whether they are sufficient and if there are additional incentives necessary for small LED companies to upgrade their production lines;
- There is a need to stimulate LED lighting demand in public and residential areas: The LED project has conducted a small survey on the LED lighting market. While providing valuable information about the LED lighting market, due to budget constraints, the survey has been limited in scope, so MOIT and VLA should conduct a more comprehensive supply and demand survey (collective focus on more cities and regions, and with a statistically relevant minimum number of users interviewed. Accurate market information will help redefine standards and labelling according to the products available, market availability and appropriate strategies to promote the replacement of less energy efficient lighting technologies with LEDs.
- The LED lighting market has grown rapidly over the past decade in terms of market volume, production methods and application of LED technology. It is therefore recommended that VLA continue to seek cooperation with national and regional lighting associations in Asia, Europe and North America to keep up with technology application, production and production, and latest products.
- There is a need to identify financing options and removing barriers for investment to upgrading lighting systems nationwide, which will accelerate the flows of investments towards lighting upgrades.
- The domestic LED industry in Viet Nam will soon find itself lagging with reference to international competition, if it does not take into consideration the role of LEDs in the changes happening globally in terms of the energy transition towards cleaner, modern, decentralised energy systems and their links with Information and Communication Technology, Smart Systems and Artificial Intelligence. Being a low energy solid state device that can be linked with sensors and ICT systems, LED has the potential to be a key part of such systems, but for this to happen in Viet Nam this aspect needs to be proactively considered in both the public and corporate planning and policy making and requires coordination between various governmental and private sector stakeholders influencing LED production, sales and application. This in fact could be a key part of the next phase of development that the LED industry in Viet Nam, and this might need the support of international partners as this is a fast paced and evolving field.

- A more ambitious awareness raising and communication campaign is needed to introduce the benefits of LED lighting products, the selection of good quality products and the phasing out of less efficient and environmentally damaging lighting products and about the safe disposal of lighting products.
- Further research is needed on effective solutions for the proper management and safe disposal of waste from lighting systems and the solutions need to be disseminated and implemented nationwide.

5. Annexes

Annex 5.1: The Log frame

- **Revised Project Results Framework (by the Inception Phase – November 2015)**

Primary applicable Key Environment and Sustainable Development Key Result Area (same as that on the cover page, circle one): 1. <u>Mainstreaming environment and energy</u> OR 2. Catalyzing environmental finance OR 3. Promote climate change adaptation OR 4. Expanding access to environmental and energy services for the poor.
Applicable GEF Strategic Objective and Program: GEF-5 CCM Strategic Program SP1: Promote the demonstration, deployment, and transfer of innovative low-carbon technologies
Applicable GEF Expected Outcomes: Technologies successfully demonstrated, deployed, and transferred; enabling policy environment and mechanisms created for technology transfer; and GHG emissions avoided
Applicable GEF Outcome Indicators: Percentage of technology demonstrations reaching its planned goals; extent to which policies and mechanisms are adopted for technology transfer; and tonnes of CO ₂ equivalent avoided

Outcomes	Indicator	Baseline	Targets	Means of Verification	Critical Assumptions
Project Objective: ⁵ Mitigation of GHG emissions through transformation of the lighting market towards greater usage of locally-	<ul style="list-style-type: none"> ▪ Cumulative direct and indirect CO₂ emission reductions resulting by EOP, tonnes CO₂ ▪ Cumulative direct and indirect energy saving (MWh) by EOP 	<ul style="list-style-type: none"> ▪ negligible⁶ ▪ negligible⁷ 	<ul style="list-style-type: none"> ▪ 623 ⁹ ▪ 69,382 ¹⁰ ▪ 1,000 ¹¹ ▪ 3,000 ¹² 	<ul style="list-style-type: none"> ▪ Project final report as well as annual surveys of LED energy consumption ▪ Project final report as well as annual surveys of energy 	<ul style="list-style-type: none"> ▪ Economic recovery of the country will continue that would enhance the ability of most households to afford the purchase of LED lighting devices

⁵ Objective (Atlas output) monitored quarterly ERBM and annually in APR/PIR

⁶ Negligible due to poor quality LEDs resulting in few if any emission reductions

⁷ Ibid 2

⁹ Direct ERs from direct investments and generated during the Project period

¹⁰ Post-project direct ERs (cumulative 10 yrs after EOP) from direct investments + ERs (cumulative 10 yrs after EOP) from locally manufactured LED lamps installed after EOP that received TA during Project period in Yrs 3 and 4

¹¹ Includes direct energy savings of 705 MWh from indoor demos and 293 MWh from outdoor demos

¹² Assumes a replication factor of 3 to be realized during the Project duration

Outcomes	Indicator	Baseline	Targets	Means of Verification	Critical Assumptions
produced LED lighting products in Viet Nam	<ul style="list-style-type: none"> % urban households and commercial establishments with reduced electricity bills from the use of LED lamps by EOP 	<ul style="list-style-type: none"> negligible⁸ 	<ul style="list-style-type: none"> 5 	<ul style="list-style-type: none"> consumption & reductions for LED usage EOP market surveys of LED usage and electricity bills segregated into residential and commercial establishments 	
Outcome 1: ¹³ Development of a local LED industry that provides locally produced quality LED lamps that are increasingly in demand by local consumers	<ul style="list-style-type: none"> Number of LED lamp manufacturing plants that have advanced manufacturing to produce LED lamps that meet new VN standards for LED lamps by EOP Number of retailers that sell locally labeled LED lighting products by EOP 	<ul style="list-style-type: none"> 0 0 	<ul style="list-style-type: none"> 2¹⁴ 200 	<ul style="list-style-type: none"> Official documentation on LED lighting policies Official study that overviews the current LED manufacturing operations and Required actions to improve LED production with new 	<ul style="list-style-type: none"> Continued government support for strengthening current LED legal framework as well as regulations, standards and codes Sustained efforts by Government to enforce new standards that would result in the reduced availability of imported sub-standard and less costly LEDs in Viet

⁸ Ibid 2

¹³ All outcomes monitored annually in the APR/PIR.

¹⁴ VN Schreder is not included in the targets.

Outcomes	Indicator	Baseline	Targets	Means of Verification	Critical Assumptions
	<ul style="list-style-type: none"> Number of LED lighting products that are standardized by Year 3 and EOP Number of new LED lighting products that are labeled by Year 3 	<ul style="list-style-type: none"> 0 0 	<ul style="list-style-type: none"> 6¹⁵ 4 	<ul style="list-style-type: none"> LED manufacturing technology Official monitoring and evaluation document on new LED manufacturing facilities Data from LED manufacturers on sales of LEDs to retailing outlets. Training assessments and feedback from participants 	
Outcome 2: Increased use and deployment of locally-produced high-quality LED lighting technologies.	<ul style="list-style-type: none"> % rural and urban households and commercial establishments that have purchased locally produced LED lamps by EOP Annual number of sold LED lamps that are locally produced and certified LED lights in Viet Nam by EOP for 	<ul style="list-style-type: none"> <1 	<ul style="list-style-type: none"> 10¹⁷ 	<ul style="list-style-type: none"> Demonstration project reports LED market survey reports 	<ul style="list-style-type: none"> Willingness of existing lighting manufacturers to embrace new LED manufacturing technologies is assured Households and commercial establishments provide information on numbers of LEDs purchased

¹⁵ 4 indoor lamps and 2 outdoor lamps

Outcomes	Indicator	Baseline	Targets	Means of Verification	Critical Assumptions
	the local lighting market • % of market share of locally produced LED lamps in the Vietnamese lighting market by EOP	• 1.3 million ¹⁶ • <1	• 15 million ¹⁸ • 7	• Monitoring reports on energy consumption and energy savings	• Willingness of local LED manufacturers to disclose sales LED sales information

- **Initial 'budget revision for 5 years - Local Development and Promotion of LED Technologies for Advanced General Lighting (LED Lighting Project); Code: UNDP PIMS no.: 5192, GEF PMIS no: 5555, UNDP Project Id.: 00092227**

Account	Operating Unit	Fund Code	Department	ACTIVITY	Implementing Agent	Donor	Budget Item	Year 1	Year 2	Year 3	Year 4	Year 5	Amount Total (USD)	Description
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¹⁶ Estimated based on data from Ralaco in 2013

¹⁶ To be determined through completion of a statistical survey as a part of Output 1.1

¹⁸ This is the annual sales of LED lamps in Year 4. See Annex IV for annual targets for the duration of the Project

71200	VNM	62180	B0438	ACTIVITY1	001461	10003	71200	8,000	176,000	200,000	32,000.		416,000	International Consultants
71300	VNM	62180	B0438	ACTIVITY1	001461	10003	71300		90,200	78,300	52,650		221,150	Local Consultants
71400	VNM	62180	B0438	ACTIVITY1	001461	10003	71400	21,200	63,200	44,200	8,000	9,300	145,900	Contractual Service-Individual
71600	VNM	62180	B0438	ACTIVITY1	001461	10003	71600	3,000	6,000	6,000	4,900	2,000	21,900	Travel
72100	VNM	62180	B0438	ACTIVITY1	001461	10003	72100		1,500	1,500	1,500	400	4,900	Contractual Services
72600	VNM	62180	B0438	ACTIVITY1	001461	10003	72600		90,000				90,000	Grants
75700	VNM	62180	B0438	ACTIVITY1	001461	10003	75700	10,000	43,000	35,000	9,700		97,700	Training, Workshops
	Total of Activity 1:							42,200	469,900	365,000	108,750	11,700	997,550	
71200	VNM	62180	B0438	ACTIVITY2	001461	10003	71200		8,000	16,000	24,000		48,000	International Consultants
71300	VNM	62180	B0438	ACTIVITY2	001461	10003	71300		15,000	39,200	29,200		83,400	Local Consultants
71400	VNM	62180	B0438	ACTIVITY2	001461	10003	71400			18,500	54,700	53,400	126,600	Contractual Service-Individual
71600	VNM	62180	B0438	ACTIVITY2	001461	10003	71600			4,000	3,000		7,000	Travel
72100	VNM	62180	B0438	ACTIVITY2	001461	10003	72100	5,000	30,000		30,000	15,000	80,000	Contractual Services
72600	VNM	62180	B0438	ACTIVITY2	001461	10003	72600		10,000	30,000			40,000	Grants
75700	VNM	62180	B0438	ACTIVITY2	001461	10003	75700			25,600		26,000	51,600	Training, Workshops
	Total of Activity 2:							5,000	63,000	133,300	140,900	94,400	436,600	
71200	VNM	62180	B0438	ACTIVITY3	001461	10003	71200					16,000	16,000	International Consultants
71300	VNM	62180	B0438	ACTIVITY3	001461	10003	71300			2,500	2,500		5,000	Local Consultants
71400	VNM	62180	B0438	ACTIVITY3	001461	10003	71400	3,300	1,700	1,100	2,700	3,300	12,100	Contractual Service-Individual
72200	VNM	62180	B0438	ACTIVITY3	001461	10003	72200	7,000					7,000	Travel
72400	VNM	62180	B0438	ACTIVITY3	001461	10003	72400	600	600	600	500	450	2,750	Communication
72500	VNM	62180	B0438	ACTIVITY3	001461	10003	72500	600	600	600	500		2,300	Office supplies

74100	VNM	62180	B0438	ACTIVITY3	001461	10003	74100		3,000	3,000	3,000	3,000	12,000	Audit
75700	VNM	62180	B0438	ACTIVITY3	001461	10003	74100	2,000	2,000	2,000	2,000	3,100	11,100	Steering Committee meeting
73500	VNM	62180	B0438	ACTIVITY3	001461	10003	73500	2,000	4,000	3,500	3,500	2,000	15,000	UNDP Cost recovery charges
Total of Activity 3:								15,500	11,900	13,300	14,700	27,850	83,250	
GEF Total:								62,700	544,800	511,600	264,350	133,950	1,517,400	

Source: Sommai Phon-Amnuaisuk. International Consultant for the Project Inception Phase. Inception report, December 2015

- Annex 5.2: Final financial report

Final Financial Report (GEF Budget)

Unit: USD

	Planned	Disbursement						
		2015	2016	2017	2018	2019	Commitment in 2020	Total
Outcome 1	1,019,450	26,381	228,961	389,987	315,113	125,258	37,394	1,123,094
Outcome 2	425,900	4,808	28,131	50,932	100,517	100,974	42,630	327,992
Project Management	72,050	12,392	13,429	8,320	19,449	3,747	7,481	64,818
Other			118	442	783	153		1,496
Total	1,517,400	43,581	270,639	449,681	435,862	230,132	87,505	1,517,400

Final Financial Report (Co-financing)

Unit: USD

Co-financing Agencies	Planned				Implemented
	Outcome 1	Outcome 2	Project Management	Total	
VAST	-	-	150,000	150,000	150,000
MOIT	150,000			150,000	150,000
CHTD	40,000	-		40,000	200,000
QUATEST 1	100,000	-		100,000	384,000
Ct. RALACO	2,200,000	36,300		2,236,300	2,238,000
Ct. DIEN QUANG	3,110,000	287,694		3,397,694	3,476,773
Viet Nam – Schreder	-	455,400		455,400	0
UNDP Viet Nam	-	-	100,000	100,000	100,000
Total	5,600,000	779,394	250,000	6,629,394	6,698,773

- Annex 5.3: Report on the success indicators and outputs

Items	Content	indication	Units	Planned indicators ¹⁾	Implemented indicators	Rate (%)
(1)	(2)	(3)	(4)	(5)	(6)	(7)=(6)/(5)
Overall results of the Project on reducing energy savings and reducing GHG emissions by transforming the lighting market towards greater use of LED lighting products manufactured in Vietnam						
Output 1	Direct and indirect cumulative energy savings at the end of the project (EOP)	Energy saving	MW.Hrs	1.000	1.460	146
Output 2	Direct and indirect cumulative CO ₂ reductions at the end of the Project (EOP)	CO ₂ reduction	Tonne CO ₂	623	1.264	202,9
Output 3	Cumulative energy savings for 10 years after the end of the project (2019 – 2028)	Energy saving	MW.Hrs	3.000	150.534	501,8
Output 4	Cumulative CO ₂ emission reduction for 10 years after the end of the project	CO ₂ reduction	Tonne CO ₂	5.154	130.197	252,6
Component 1: Transfer skills, knowledge and technology to produce LED lights in Vietnam						
Category 1.1	Develop policies and standards to create a legal framework for the development of LED lighting technology in Vietnam					
Output.1.1.1	Developing a roadmap of LED lighting technology development up-to 2025	Roadmap developed	Roadmap	1	1	100
Output 1.1.2	Developing TCVN Standards for LED lights	Issued by the MoST	TCVN Standard	3	4	133.3
Output 1.1.3	Developing LED lighting standards	Accepted and implemented by MoC	Standard	1	2	200
Output 1.1.4	Developing an energy labeling program for LEDs	Issued by the state and implemented by the Ministry of Industry and Trade	Program	1	1	100
Output 1.1.5	Researching and Developing a Financial Investment schemes to implement large-scale LED Lighting projects for public lighting in Vietnam	Approved and used by the project	Scheme	0	2	Additional task

Output 1.1.6	Building a monitoring - Reporting - Verification system (MRV)	Used by the project	1 MRV	1	1	100
Category 1.2	Transfer skills, knowledge and technology to produce LED lights in Vietnam					
Output 1.2.1	Organizing training courses on LED lighting technology and quality control of LED lighting products	Training courses are organized and results are assessed	Course	4	9	225
	Developing an online training program on advanced LED technology and applications and organizing training courses	On-line training program	program	0	1	Additional task
Output 1.2.2	Number of LED factories has produced LEDs that meet Vietnam's new standards for LED at the end of the project (EoP)	LED lamp manufacturers	Manufacturer	2	2	100
Output 1.2.3	Number of retailers selling domestically produced LED lighting products labeled at the end of the project (EoP)	LED lighting products retailer	Retailer	200	15.000	750
Output 1.2.4	Number of LED lighting products that meet Vietnamese standards (TCVN).	LED lights	Type of lamps	6	16	266.7
Output 1.2.5	Number of types of LED lighting products labeled with energy	LED lights	Type of lamps	4	16	400
Component 2: Demonstration of domestically produced, cost-effective commercial LED lights						
Category 2.1	Design and implement demonstration projects of locally-produced, cost-effective commercial LED lights					
Output 2.1.1	LED demonstration projects	demonstration project	Project	8	10	125
Output 2.1.2	Number of LED lamps of all kinds installed, replacing the traditional lamps of the demonstration projects	LED lights	Lamp	4.475	5.567	124.4
Output 2.1.3	Cumulative power savings of demonstration projects at the EOP	Energy saving	MW.Hrs	1.000	1.460	146
Output 2.1.4	Direct and indirect cumulative CO ₂ reductions at the EOP	greenhouse gas emission reduction	Tonne CO ₂	623	1.264	202.9

Category 2.2 Increasing the use and deployment of domestically produced LED lighting products						
Output 2.2.1	% Rural and urban households and businesses bought locally produced LED lights at the end of the project (EOP)	Use home-made LED lights	%	10	37	370
Output 2.2.2	The number of domestically produced LEDs achieved a quality certificate sold on the market every year at the end of the project EOP	Domestic LED lights	Million lights	15	40	266.7
Output 2.2.3	% market share of domestically produced LED lighting in the Vietnamese lighting market at the end of the project (EOP)	Market share of domestically produced LEDs	%	7	37	528.6

¹⁾ The objectives and indicators of the project were reviewed and revised at the Inception phase and. approved by GEF / UNDP

Annex 5.4: List of major technical reports and products that have been handed over to the project beneficiaries:

No	Title of reports/products	Summarized content	Entities that the products/reports are handed over to
(1)	(2)	(3)	(4)
1	Project Inception report	Report on the results of the implementation of the Project Inception phase "Development and promotion of LED technology for general lighting in Vietnam"; Adjust the targets and the implementation schedule of the project.	- UNDP-VN - CHTD-VAST
2	Collection of 07 reports on research and development of a roadmap for LED lighting technology in Vietnam until 2025	Research and review on the LED lighting technology development in the world and Roadmaps of LED lighting technology in foreign countries; Situation of production and application of LED lighting technology in Vietnam; Forecasting production situation and Vietnam market until 2025; Recommendations.	- VLA - UNDP-VN - CHTD-VAST - Reports available @ http://htd.vn/led-lighting-projects.html

3	Collection of 20 reports on research and development of National standards for LED lighting products	<p>Researching the current state of the international and domestic standards system for lighting products; Current situation and demand for standards for LED lights in Vietnam; Draft 4 national standards (TCVN) for LEDs and results support the state agencies to issue the following 4 TCVNs:</p> <p>1) TCV 1182:2017, 2) TCV 1183:2017, 3) TCVN 1184:2017, and 4) TCVN: 2019.</p>	<ul style="list-style-type: none"> - VLA - UNDP-VN - CHTD-VAST - Reports available @ http://htd.vn/led-lighting-projects.html
4	Collection of 04 reports on research and development of design standards of LED lighting for urban transport works	<p>Researching the current state of international lighting technical standards using LED technology in traffic constructions; Current situation and demand for LED lighting standards in Vietnam; Draft 2 standards for lighting streets and tunnels; Transferring and supporting results of Ministry of Construction to promulgate 2 above-mentioned standards</p>	<ul style="list-style-type: none"> - Department of infrastructure - MoC - UNDP-VN - CHTD-VAST - Reports available @ http://htd.vn/led-lighting-projects.html
5	Collection of 14 research reports on capacity building for measuring quality control of LED lighting products	<p>Review on measuring and testing of LED lighting products quality in the world; Assess the current situation of measurement & testing laboratories, check the quality of lighting products in general and LED ones in particular; Evaluate the results of 2 training courses for QUATESST-1,2, 3 and 2 VILAS technical staff; Proposing upgrade investment solutions for QUATEST 1; Results of training and technical guidance for LED technicians in measuring & testing of LED lighting product quality.</p>	<ul style="list-style-type: none"> - QUATEST-1 - UNDP-VN - CHTD-VAST - Reports available @ http://htd.vn/led-lighting-projects.html
6	Collection of 20 research reports on studying and developing an energy labeling program for LED lighting products	<p>Study and review the energy labeling programs in foreign countries; Survey, evaluate the situation of production and consumption market of LED lighting products in Vietnam; Survey, evaluate the capacity of the measurement room to check the quality of LED lighting products; Proposing the roadmap for energy labeling (voluntary and compulsory; Dissemination and guidance</p>	<ul style="list-style-type: none"> - Department of Energy saving and sustainable development- MoIT - UNDP-VN - CHTD-VAST - Reports available @ http://htd.vn/led-lighting-projects.html

		for implementation of energy labeling programs in general and pilot labeling projects in general.	
7	Collection of 06 research reports on financial investment mechanisms for public lighting projects using LED technology	Studying financial investment mechanisms / schemes for public lighting constructions using LED technology in the world; Current situation of LED lighting in public lighting works in Vietnam; Financial solutions and problems for public lighting constructions using LED technology; Proposing 2 feasible financial investment schemes for public lighting in cities of categories I and II; Proposals and recommendations (<ul style="list-style-type: none"> - UNDP-VN - CHTD-VAST - Reports available @ http://htd.vn/led-lighting-projects.html
8	Collection of 18 research reports on research and development of training programs and organize 9 training courses on LED lighting technology and measurement & testing techniques for LED lighting products	Survey and assess training needs; Develop a program framework, modules and lectures for 9 training courses; Organizing 9 training courses; Evaluate the results of training courses	<ul style="list-style-type: none"> - UNDP-VN - CHTD-VAST - Reports available @ http://htd.vn/led-lighting-projects.html
9	Online training program on LED technology and 06 research reports on research and development of online training program (on-line) on advanced LED lighting Technology	On-line training needs survey & assessment; Develop a program framework, modules and lectures; Organize on-line training courses; Evaluate the results of the first training course on advanced LED lighting Technology	<ul style="list-style-type: none"> - University of Technology in Ho Chi Minh city - UNDP-VN - CHTD-VAST - Information available @ https://e-learning.hcmut.edu.vn/
10	ANSYS Icepak Software and Collection of 04 research reports on results of procurement and transfer of heat	Introduce features and application of thermal management software "ANSYS Icepak"; Lectures, instructions for using thermal management software "ANSYS Icepak"; User manual of ANSYS Icepak thermal management software to design heat sinks for LEDs.	<ul style="list-style-type: none"> - Rang Dong Thermos Bulb Joint Stock Company - UNDP-VN - CHTD-VAST

	management software "ANSYS Icepak"		
11	Software for design of LED light driver and Collection of 06 research reports on resulting in the design of software for LED lights driver	Research and develop software to design drivers for LED lights; Training results, software manuals; Application of software to design and manufacture radiators for LED lamps.	<ul style="list-style-type: none"> - Dien Quang Lamp Joint Stock Company - UNDP-VN - CHTD-VAST
12	Collection of 29 research reports on Result of technical assistance to improve the production lines and quality of LED lighting products for Rang Dong Thermos Bulb Joint Stock Company and Dien Quang Lamp Joint Stock Company	Providing engineering design, manufacturing LED bulb, LED tube, LED down-light, LED street and alley lights; Tutorial; Solutions to upgrade production lines; Solutions to improve LED quality; The results of training and guiding the technical staff of the two factories to develop product standards for the export of LED lights to European and American countries	<ul style="list-style-type: none"> - UNDP-VN - CHTD-VAST - Rang Dong Light source and Vacuum Flask Joint Stock Company - Dien Quang Lamp Joint Stock Company
13	Collection of 32 research reports on 10 demo-projects using LED lights	The contents of the reports include: Design, feasibility assessment, implementation organization, quality assessment and energy audit of LED lighting systems of 10 demonstration projects	<ul style="list-style-type: none"> - UNDP-VN - CHTD-VAST - Reports available @ http://htd.vn/led-lighting-projects.html
14	Collection of 09 reports on the survey and evaluating the status of LED lighting products production and consumption markets in Vietnam	Results of the survey and evaluation of the situation of LED lamp production in Vietnam; Situation and market segmentation of LED lighting products in residential and commercial areas in urban and rural areas.	<ul style="list-style-type: none"> - UNDP-VN - CHTD-VAST - Reports available @ http://htd.vn/led-lighting-projects.html
15	Collection of 08 reports on building a monitoring reporting and verification	The contents of the newspapers include: Developing MRV software; Using MRV software and survey results of LED lighting products production and consumption	<ul style="list-style-type: none"> - UNDP-VN - CHTD-VAST

	(MRV) system for LED lighting systems	markets of 2016, 2017, 2018 and 2019 in Vietnam to calculate and evaluate the achieved targets. of the LED lighting project and its impacts on the VN lighting industry	
16	Collection of 24 articles, news are regularly updated on the website and "Light & Life" magazine	All articles, news about activities and some results of the Project implementation	<ul style="list-style-type: none"> - UNDP-VN - CHTD-VAST - Vietnam Lighting Association members - Articles available @ https://anhsangvacuocsong.vn/
17	A book "LED lighting technology and applications" Youth Publishing House, December 2018	This book presents basic and advanced knowledge on the theory and technology of LED lighting products production as well as regional and international best experience in LED lighting.	<ul style="list-style-type: none"> - UNDP-VN - CHTD-VAST - Vietnam Lighting Association - Universities in Ha Noi and Ho Chi Minh City - Domestic lighting manufacturers - Vietnam Standards Institute – STAMEQ-MoST

Annex 5.5: Other main annexes as appropriate to the individual programme/project

5.5.1. The main documents related to the Project:

- *Public lighting (PL) policy development*
 - Development of a regulatory framework for public lighting, including the a) Vietnam National Strategy of Urban Lighting Development up to 2025, b) Decree on Urban Lighting Management (2009), c) Circular guiding the implementation of the Decree (August 2010) on integration of EEPL in city planning, d) Circular on the technical requirements for EE luminaires;
 - Energy performance standards for a number of lighting products (compact fluorescent lamps, ballasts for fluorescent lamps, tubular fluorescent lamps, high-pressure sodium lamps);
 - Formulation of local policies and plans regarding installation of EE equipment for public lighting as well as integration of EE public plans in the local urban planning
 - Design of standards lighting for schools and other public buildings;
 - Handbook on EEPL systems.
- *PL technical support program*
 - Technical support provided to various lighting product manufacturers to improve their products (CFLs, T8, ballasts for high-pressure sodium lamps, T8, ADSL control systems),
 - Improvement of lighting test capacity at testing centers; Testing of selected CFL models at the testing centers;
 - Design software tools of lighting and lighting products transferred; Handbook with guideline on use of design software distributed;
 - Proposal on the establishment of National Lighting Testing and Certification Lab has been completed
- *PL financing program*
 - A number of studies have been done on appropriate financing schemes and accompanied mechanisms for public lighting improvement projects. National workshops and forums on EEPL mechanisms and appropriate schemes for the financial sector and lighting industry have been held.
- *PL demonstration program*
 - Large cities such as Hanoi, Ho Chi Minh, Hai Phong, Da Nang, Quy Nhon, have successfully implemented several pilot lighting control measures such as lighting control boxes using power transmission line, lighting control, two-power ballasts, etc.
 - In 2009, the pilot implementation of Central PL System Control (CPLSC) for streets was successfully completed in Ho Chi Minh City with significant lighting quality improvements and energy savings;
 - Replication of pilot projects to other cities (street lighting) and schools;
 - Development of analytical tool to estimate the collective annual and cumulative energy savings and CO₂ reductions resulting from operation of demo projects as well as indirect impacts due to replication.
- *PL info dissemination*
 - Project's website: <http://htd.vn/du-an-chieu-sang.html>; <http://htd.vn/led-lighting-projects.html>

- Project page on the UNDP website:
- http://www.vn.undp.org/content/vietnam/en/home/operations/projects/environment_climatechange/led-technologies-for-advanced-general-lighting.html
- Photos stories (e.g. Exposure):
- <https://www.facebook.com/duan.led.5/posts/195707558015800>
- <https://www.facebook.com/duan.led.5/posts/327846804801874>
- <https://www.facebook.com/duan.led.5/posts/307117636874791>
- <https://www.facebook.com/duan.led.5/posts/191839998402556>
- <https://www.facebook.com/duan.led.5/posts/190625355190687>
- <https://www.facebook.com/duan.led.5/posts/167114214208468>
- Facebook: <https://www.facebook.com/duan.led.5>
- YouTube: <https://www.youtube.com/channel/UCc6baYkjm894umagKRSZjcQ>
- Some hyperlinks to media coverage of the project (for example, stories written by an outside source):
- <http://htd.vn/project-activities/consultation-workshop-on-national-led-lighting-industry-development-roadmap-up-to-2025-1098.html>
- <http://htd.vn/project-activities/consultation-workshop-vietnam-national-standards-labeling-and-certification-program-for-led-lighting-products-1100.html>
- <http://www.vn.undp.org/content/vietnam/en/home/presscenter/pressreleases/2018/energy-labelling-for-led-lighting-products-contributing-to-energy.html>
- <http://www.vast.ac.vn/en/news/activities/1871-workshop-on-energy-labeling-and-certification-for-led-lighting-products>
- Book (in Vietnamese): LED Lighting Technologies and Applications (ISBN: 978-604-973-705-3), Thanh Niên Publishing House, Quarter 4/2018, Ha Noi
- Proceedings in the National Symposium on Lighting Science and Technology 2017 on “Smart Urban Lighting in response to the Fourth Industrial Revolution (I 4.0)” and National Symposium on Lighting Science and Technology 2019 on “Vietnam Lighting in the Digital Era - Opportunities and Challenges” (co-organized with Viet Nam Lighting Association)
- Distribution of promotional materials, printed articles, etc.

Source: (i) *Final Evaluation, Vietnam Energy Efficiency Public Lighting (VEEPL)*, by Jan Van den Akker and Ngo To Nhon (2011), available at <http://erc.undp.org>. (ii) *Terminal Evaluation, Local Development and Promotion of LED Technologies for Advanced General Lighting in Viet Nam*, by Jan Van den Akker and Dang Ngoc Dung (December 2010), available at <http://erc.undp.org>

5.5.2. Documents related to the Project audit

The reports on the results of three audits (2017, 2018 and 2019) conducted by international audit firm Nexia STT is given in a separate book (Appendix 5.5.2).

5.5.3. Document of the transfer of project ownership to the Government of the Socialist Republic of Vietnam (High Technology Development Center, Vietnam Academy of Science and Technology)



**PROJECT "LOCAL DEVELOPMENT AND PROMOTION OF LED
TECHNOLOGIES FOR ADVANCED GENERAL LIGHTING"**

**Address: 3rd Floor, - Building 2C, No. 18 Hoang Quoc Viet Street,
Cau Giay District, Ha Noi, Viet Nam
Tel: 024 37917814 * Fax: 024 37916283**



Empowered lives.
Resilient nations.

Letter for Transfer of Ownership of Project Assets

TRANSFER OF OWNERSHIP OF PROJECT ASSETS

**FROM THE PROJECT No. 00092227 - "LOCAL DEVELOPMENT AND PROMOTION
OF LED TECHNOLOGIES FOR ADVANCED GENERAL LIGHTING IN VIET NAM"**

TO THE GOVERNMENT OF THE SOCIALIST REPUBLIC OF VIET NAM

The UNDP hereby transfers and the Government of the Socialist Republic of Viet Nam hereby accepts the full title and ownership of the assets specified in the attached Inventory List, with the total value at purchase is 152,117,700 VND, after four years of use, the total remaining value is 43,221,380 VND.

The assets represent assistance of the UNDP to the Government of the Socialist Republic of Viet Nam in connection with the Project No. 00092227-"Local Development and Promotion of LED Technologies for Advanced General Lighting in Viet Nam", transfer of such assets being in accordance with the provisions of the Project Document signed by the Government of the Socialist Republic of Viet Nam and UNDP on 11 June 2015.

The transfer of title and ownership is made on the understanding that the assets will be used by the Government of the Socialist Republic of Viet Nam, through the National Implementing Partner, solely for the purposes, in the manner and in the place set out in the Project Document and subject to any limitations contained therein.

On behalf of the National Implementing Partner On behalf of UNDP Agency

By: Nguyen Van Thao

General Director of the Center for High
Technology Development - Viet Nam
Academy of Science and Technology

Date:.....

By: Dao Xuan Lai

Assistant Resident Representative of UNDP
Viet Nam / Head of Climate Change and
Environment Unit

Date: