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Global Environment Facility (GEF)

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Viet Nam Academy of Science and Technology (VAST)

Terminal Evaluation

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

UNDP PIMS no.: 5192 GEF PMIS no.: 5555

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VIETNAM

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

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Disclaimer

Please note that the analysis and recommendations of this evaluation report do not necessarily reflect the views of the United Nations Development Programme, its Executive Board or the United Nations Member States. This publication reflects the views of its authors.

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ABBREVIATIONS AND ACRONYMS

ADB	Asian Development Bank
AWP	Annual Work Plan
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	Gigawatt-hour (= 1 billion Watt-hour)
HCMC	Ho Chi Minh City
HID	High-intensity discharge
IA	GEF Implementing Agency
JSC	Joint Stock Company
ktCO ₂	Kilotons of CO ₂
kW	Kilowatt
LED	Light-emitting diode
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
MW	Megawatt (= 1 million Watt)
NPD	National Project Director
PIF	Project Identification Form
PIR	Project Implementation Review
PM	Project Manager
PMU	Project Management Unit
Ralaco	Rang Dong Light Source and Vacuum Flask JSC
RE	Renewable energy
RTA	Regional Technical Advisor
SDG	Sustainable Development Goal
SME	Small and medium-sized enterprise
STAMEQ	Directorate for Standards, Metrology, and Quality (of MoST)
TCVN	Tiêu chuẩn Việt Nam (Viet Nam Standard)
TE	Terminal Evaluation
ToR	Terms of Reference
tCO ₂	Ton of carbon dioxide
UNDP	United Nations Development Programme
USD	United States dollar
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

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EXECUTIVE SUMMARY

Project Title:	Local Development and Promotion of LED Technologies for Advanced General Lighting in Viet Nam			
GEF Project ID:	5555		<i>at endorsement (USD)</i>	<i>at completion (USD)</i>
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 involved:	Ministries of Construction (MoC), Science and Technology (MoST), Natural Resources and Environment (MoNRE), Industry and Trade (MoIT), Planning and Investment (MPI), Local manufacturer (Ralaco, Dien Quang)	ProDoc Signature (date project began):		11 June 2015
		Operational closing date	Proposed: 30 June 2019	Actual: 30 Dec 2019

*) As of 07 Nov 2019; it is expected that the balance of USD 151,445 will be used for Terminal Evaluation payment, Completion Workshop, and other pending last payments for project activities

Description of the Project

LED lamps have a lifespan and electrical efficiency which are several times greater than incandescent lamps, and are significantly more efficient than most fluorescent lamps, resulting in lower lifetime energy consumptions (see Box 3). Recent developments have produced LEDs and new control systems that are suitable for all applications, in buildings, traffic lights and outdoor lighting LEDs can be used nowadays in a variety of lighting products, such as bulbs, tube lights (TL), panel lights, streetlights, floodlights, and others. Although the purchase price of the LED may be higher than the conventional alternative, the combination of longer lifespan price plus lower electricity bills cost results in lower overall costs of LED lighting. The global LED market has been growing steadily up from a value of USD 3.1 billion in 2009 to about 40-60 billion in 2018 and may reach about USD 132 billion in 2024¹.

Similarly, the market for LED lighting in Vietnam is witnessing robust growth from USD 95 million in 2016 to about USD 249 million in 2018¹. One issue is how local manufacturing of LED lighting products can profit from these trends. Apart from large Vietnamese lighting manufacturers, such as Ralaco and Dien Quang, there are a lot of smaller LED lighting manufacturers. International technology development is fast and competition fierce. Even the big Vietnamese companies find it difficult to innovate using the latest production technology and by offering newer, smarter, lighting solutions. The price of (imported) LED lamps is still relatively high in comparison with conventional products. Unfortunately, low-price but poor-quality LED also enter the market in large volume (some of which are improperly labelled to mislead consumers into believing they meet international standards) but are lamps that have a short service life, and give the product a 'bad reputation'.

While over the past decade Vietnam has introduced mandatory energy labelling and minimum energy performance standards (MEPS) for a range of appliances, including lamps, these have not been formulated for LED lighting products. Other barriers include lack of proper arrangements for standard testing of LED lamps, private and public sector R&D for

¹ See www.imarcgroup.com/vietnam-led-lighting-market and www.expertmarketresearch.com/reports/vietnam-led-market

the advancement of LED lighting products, and lack of consumer confidence in locally produced LED lamps in terms of light quality and service life. The introduction of mandatory LED standards and labelling regime would guide local LED lamp manufacturers, importers, and retailers on the quality of LED lighting products to be supplied for the market.

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 referred to as the “LED Vietnam” project or as the “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) is the GEF Implementing Agency and Viet Nam Academy of Science and Technology (VAST) is the national GEF Executing Partner, implemented by VAST’s Center for High Technology Development (CHTD).

The **objective** of this proposed Project is *to mitigate GHG emissions through the transformation of the lighting market towards greater usage of locally produced LED lighting products in Viet Nam*. To achieve this objective, the Project is comprised of two components:

Component 1 (Transfer of skills, knowledge, and technology in support of local LED lamp manufacturing) 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 (Demonstration of cost-effective local commercial production of LED lighting devices) addresses barriers related to low public awareness about LED lighting product benefits. This was 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.

The project started in June 2015 with the signature of the Project Document and ended operationally in time by December 2019.

Achievements – summary

Outcome indicators and outputs	Achievement
Outcome 1	
Development of a local LED industry that provides locally produced quality LED lamps that are increasingly in demand by local consumers	
Indicators and end-of-project (EoP) target:	
a) By EoP, 2-3 ² LED lamp manufacturing plants have advanced manufacturing to produce LED lamps that meet new VN standards for LED lamps	There are at two larger local companies, the project partners Ralaco and Dien Quang, that have advanced manufacturing of LED lighting products. In addition, there are about plus 200, mostly smaller companies that assemble/manufacture LED lighting products
b) By EoP, 200 retailers sell locally labelled LED lighting products	Ralaco and Dien Quang reportedly sell their LED products through about 15,000 retailers. The high number of retailers is mainly due to the fast development of the LED market with many sales outlets and increased supply of locally manufactured LEDs
c) By EoP, six LED lighting products are standardised	16 LED light types are standardised including nine indoor and seven outdoor types, covering 210 LED light models. Again, this number is much higher than targeted, due to the rapid development of the local LED market
d) By EoP, four new LED lighting products are labelled	The labelling programme for LED was adopted in 2017 with voluntary labeling period from Jan 2018 to Dec 2019. Reportedly 72 different models of the before-mentioned

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

Outcome indicators and outputs	Achievement
	16 LED lamp types have been labelled with approval by the Ministry of Industry and Trade (MoIT)
Outputs of Outcome 1:	
1.1 Completed biennial reviews of national roadmap for LED lighting development	The Project has supported the formulation the National Roadmap for LED Lighting Development up to 2025, which was submitted to the Ministry of Industry and Trade (MoIT)
1.2 Improved LED lighting standards that meet international norms 1.5 Updated building codes that include the use of LED lighting products	Related to the work on EE building codes under VEEPL, the Project has supported MoST-STAMEQ (Directorate for Standards, Metrology and Quality with the elaboration of the national standards TCVN 11843:2017 - Test method for LED lamps, LED luminaires and LED modules, and TCVN 11844:2017 - LED lamps - Energy Efficiency. Another UNDP-supported project has focussed on energy-efficiency building codes. Consequently, the Project has shifted attention to providing technical assistance to MoC's Technical Infrastructure Agency on the development of Viet Nam Standards on Lighting using LED Technologies for Transport Constructions (in streets and tunnels):: 1) LED-TCVN Standard on National Standard Energy Performance for LED Street Light, and 2) draft Vietnamese lighting technical standards using LED technology in traffic works (streets, urban tunnels). These drafts have been submitted to the Ministries of Science and Technology (MoST) and Construction (MoC) respectively for review and approval.
1.3 Training workshops to strengthen LED lamp testing and enforcement regime 1.6 Completed capacity building program to strengthen LED R&D facilities	The Project completed a proposal on strengthening Quatest-1's LED lighting products testing capacity was completed with recommendations to the Directorate for Standards, Metrology, and Quality (STAMEQ), including infrastructure, new testing equipment, facility, testing staff, etc.). Regarding capacity building the following activities were carried out: <ul style="list-style-type: none"> • Training needs assessment study; • Training workshops were organised in Hanoi, Danang, and Ho Chi Minh City on: a) basic and advanced technologies for LED lighting products manufacturing, b) LED lighting roadmap, c) standards and labelling and certification of LED lighting, d) standards for and application of LED lighting in transport constructions, e) Design, installation, operation and maintenance of lighting systems, f) LED lighting testing methods, g) smart lighting and financial investments; • About 335 people participated in these training events, of which 18% women³; • An e-learning package on LED technology and applications has been set up in cooperation with the Vietnam LED projects at HCM University of Technology.
1.4 Labelled and certified LED lighting products	The Project helped to draft documents for the LED labelling and certification (Decision 04/2017/QĐ-TT, Provisions on List of means, equipment must be marked on energy labels, application of minimum energy performance levels and roadmap, issued by Prime Minister (dated 9th March 2017) which came effective on 25 April 2017. As a result, 16 types of LED lamps (covering 72 LED lighting models) were registered for labelling and more than 210 LED light models meet the national standards. The voluntary regime will move in January 2020 to mandatory LED regime with minimum energy performance standards (MEPS) and energy labelling.
1.7 Engineering and construction designs for improved LED lighting production in Viet Nam	Technical assistance was provided by LED experts contracted by the Project to Ralaco and Dien Quang to improve the design and production of various LED products. In the case of Ralaco, the Project procured the 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 with guidelines for its use. Dien Quang was supported with the further development and deployment of the software for the design of LED Drivers, improvement of production management, testing capacity and quality control.
Outcome 2	
Increased use and deployment of locally-produced high-quality LED lighting technologies	
Indicators and end-of-project (EoP) target:	

³ Some people participated in several training event, so number of participants reportedly were 971

Outcome indicators and outputs	Achievement
e) By EoP, 10% share of rural and urban households and commercial establishments that have purchased locally produced LED lamps	Based on a small survey carried out by the Project (of 100 urban households, 20 rural households, and 20 commercial establishments) and combining the results with national statistics on the number of users (urban and rural households; commercial establishments) and the average market share of locally manufactured products in the Vietnamese LED market (which is 49%), the Project estimates that the share is 37%
f) By EoP, 15 million LED lamps sold that are locally produced and certified LED lights in Viet Nam by EoP for the local lighting market (up from a baseline of 1.3 million; 2014)	The project directly contributed to sales of 40 million LED lamps out of 119 million LED lamps in the market (based on sales data provided by two companies (Ralaco and Dien Quang) on the sales of LED lamps. The design and quality improvement of these lamps were technically supported by the project
g) By EoP, 7% market share of locally produced LED lamps in the Vietnamese lighting market	The share reportedly amounts to 49%.
Outputs:	
2.1 Completed feasibility studies of indoor and outdoor LED lighting demonstrations	List of completed demonstration projects: 1. Indoor project: 967 LEDs; Technology Incubation Building, VAST, Cau Giay, Hanoi 2. Indoor project: 251 LEDs; Carton packaging and printing, Tran Thanh Co., Hanoi 3. Indoor project: 595 LEDs; Le Ngoc Han Primary School, District 1, HCMC 4. Indoor project: 132 LEDs; Replacement with LED tubes for 8 classrooms in 4 secondary schools in Hanoi 5. Indoor project: 1,222 LEDs; Sai Gon Tobacco Fiber Factory, Binh Chanh District, HCMC 6. Outdoor project: 1,276 LEDs; Highway lighting, Highway 22A, from HCMC to Moc Bai in Tay Ninh Prov. 7. Outdoor project: 60 LEDs; Trinh Ba street lighting over 1.5 km, Cam Gia Ward, Thai Nguyen 8. Outdoor project: 40 LEDs; 2.8 km of alley lane lighting, Group 22 and 29, Thai Nguyen city 9. Outdoor project: 335 LEDs; Industrial zone lighting in Street in Eco Park in Hung Yen Province 10. Outdoor project: 50 LEDs; Central Campus of HCMC University of Technology in District 10 and Viet Nam National University in HCMC, Thu Duc District, HCMC (smart outdoor lighting system) The Project has developed an Excel-based monitoring tool
2.2 Completed LED lighting application demos	
2.3 Approved system for monitoring and evaluation of LED lighting systems	
2.4 Completed LED lighting product applications awareness raising program	A webpage has been set up as part of the website of the Center for High Technology Development, VAST. With information on the LED Vietnam project can be found at http://htd.vn/led-lighting-projects.html . The Project has been involved in the preparation of updated public awareness messages including websites, TV and radio spots and newspapers to promote and replicate LED lamp uptake.
2.5 Completed workshops for disseminating lessons learned from LED lighting product application demos	

Conclusions

In terms of local production and sales of LED lighting products, the project exceeded its targets, which is commendable. However, in this respect, the project has benefitted from the overall global and local market development of LED lighting products which has shown to have quickly matured over the past few years and has become an affordable technology. Thus, while overall circumstances for promotion of LED lighting were very favourable, the Terminal Evaluation Team has the opinion that the project had a trigger effect that helped the project to serve as a catalyst in realizing substantial changes in the lighting market in Vietnam over a relatively short time frame, in particular with respect to the production (and sales) of quality LED lighting products that comply with the mandatory national (and international) standards.

Being medium-sized (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 greenhouse gas (GHG) emission reduction. The Evaluation Team notes, however, that one 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”, which is currently being carried out.

The Project Management Unit (PMU) has implemented mechanisms to ensure ongoing stakeholder participation and effectiveness. This was helped by conducting regular stakeholder meetings, 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.

Summary of ratings

1. Monitoring and Evaluation	rating	2. IA& EA Execution	rating
M&E design at entry	S	Quality of UNDP Implementation	S
M&E Plan Implementation	S	Quality of Execution - Executing Agency	S
<i>Overall quality of M&E</i>	<i>S</i>	<i>Overall quality of Implementation / Execution:</i>	<i>S</i>
3. Assessment of Outcomes	rating	4. Sustainability	rating
Relevance	R	Financial resources:	ML
Effectiveness	S	Socio-economic & stakeholder capacity	L
Efficiency	HS	Institutional framework and governance:	L
<i>Overall Project Outcome Rating</i>	<i>S</i>	Environmental:	L
		<i>Overall likelihood of sustainability:</i>	<i>ML</i>

Ratings for Outcomes, Effectiveness, Efficiency, M&E, IA&EA Execution

- 6: Highly Satisfactory (HS): no shortcomings
- 5: Satisfactory (S): minor shortcomings
- 4: Moderately Satisfactory (MS)
- 3. Moderately Unsatisfactory (MU): significant shortcomings
- 2. Unsatisfactory (U): major problems
- 1. Highly Unsatisfactory (HU): severe problems

Additional ratings where relevant:

- Not Applicable (N/A)
- Unable to Assess (U/A)

Sustainability ratings:

- 4. Likely (L): negligible risks to sustainability
- 3. Moderately Likely (ML): moderate risks
- 2. Moderately Unlikely (MU): significant risks
- 1. Unlikely (U): severe risks

Relevance ratings

- 2. Relevant (R)
- 1. Not Relevant (NR)

Recommendations

Government/stakeholders

LED production and SMEs

There are about 200 companies involved in LED products manufacturing in Vietnam. Apart from a few big local and international players, many of these are small and medium-sized companies (SMEs). In general, SMEs encounter difficulties in accessing credit and financing, in dealing with market downturns, in recruiting skilled workers, in competition with larger and foreign firms, finding business partners and in meeting regulatory changes. In order to remain competitive on the local market, or even when considering entering the export market, these companies will need to expand and modernize their production line and upgrade their range of products from lamps and fixtures to more integrated and smart lighting solutions. For that, they will need access to credit. Banks providing commercial loans, however, prefer to allocate their resources to larger firms rather than to SMEs. The SME Law makes resources available

for SMEs in terms of incentives and credit access. It may be useful for the Vietnam Lighting Associations (VLA) and MoIT to analyse how smaller LED companies can take advantage of the incentives offered under the SME Law, whether these are enough and if additional incentives are needed for small LED companies upgrade their production line and with high-quality and intelligent lighting systems.

Public sector and finance

Regarding the public sector, 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. In fact, one recommendation the preceding VEEPL project evaluation was “that further capacity building would be needed for public sector decision-makers and for financial institutions and banks on options and issues in EE project financing, leveraging commercial finance, and on options in performance contracting and ESCO business models in public sector energy efficiency”. Sustainable energy financing in the public sector meets barriers and issues that should be addressed in a context wider of more market-based financing that goes beyond the topic of efficient lighting only. VAST’s core competence is as a science and technology institution Hence, in future ‘efficient lighting’ programmes, it may be useful to address the issue of ‘more widespread LED dissemination’ not only from a technology angle (which has been VAST’s expertise) but also the financial angle (e.g. by teaming up with a local financial institutions).

Vietnam Lighting Association

The market of LED lighting has developed rapidly over the past decade in terms of market volume, production methods and LED technology applications. The Evaluation Team suggest that VLA seeks cooperation with national and regional lighting associations in the Asian region, in Europe and North America to stay abreast of the latest technology, manufacturing and product application developments.

Demand stimulation in the public sector and residential sectors

The public sector procurement system works against energy-efficient (EE) investments. There exists a disconnect between investment decisions and savings. Given limitations in public budgets, procurement criteria often favour purchasing goods that have the lowest capital cost over goods that have more (energy-)efficient but have a higher initial investment (even when lifecycle costs are lower). This poses a challenge to the implementation of LED lighting in street lighting and in public buildings. 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.

The LED Vietnam project has done a small survey on the LED lighting market. While giving valuable information on the LED lighting market, due to budget constraints the survey has been limited in scope. The Evaluation Team suggests that a government entity commissions a more comprehensive lighting demand and supply survey (focussing on more cities and regions and with a statistically relevant minimum number of users interviewed). Accurate market information will help to redefine the standards and labelling according to products available on the market and appropriate strategies that promote the replacement of less energy-efficient lighting technologies by LED lighting.

Project

The Evaluation Team suggests that the results and materials of the Project are disseminated widely, by means of making summary technical reports available on the VAST-CHTD ‘lighting’ webpage, mailing lists and making available materials at the Completion Workshop. It should also be investigated how this webpage can be maintained in the post-project future, e.g. in cooperation with the Vietnam Lighting Association.

Lessons learnt

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

- 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 listed in the results framework and their progress is reported in the annual Project Implementation Reviews (PIRs) against baseline values. In development projects, 'results' are the describable or measurable development that include project outputs, short- to medium-term outcomes, and global environmental and development impacts. One such development impact is market transformation. Having evaluated many UNDP/GEF project, the international evaluators observe that sometimes there is a tendency for indicators to measure the higher-level outcomes or impacts only. While project outputs are under the direct influence of the project, outcomes are influenced more by external factors and impacts even less so. In the case of the LED Vietnam Project, the indicators chosen are at a higher level and rather indicate mainly LED market development in general (only indirectly influenced by the Project) than the project's direct results. The Evaluation team suggests that in UNDP/GEF project, in general, the formulation of progress indicators in the project results framework (logframe) should contain a manageable number of outcome indicators with associated output-level indications to be able to measure both direct as higher-level project results.

1. INTRODUCTION

1.1 Purpose of the Terminal Evaluation and objectives

1.1.1 Background

With the rapid development globally of light-emitting diode (LED) technology and sharp decline in the cost of LED lighting over the past decades, the next logical step is the widespread adoption of LED lighting technologies that will bring even more reductions in energy consumption and associated greenhouse gas emissions (GHG) reductions from the current lighting loads from CFLs, tubular lamps (T8 and T12) and High-Intensity Discharge (HID) lamps. The advantage of LED bulbs over these conventional lamps lies in their lower energy consumption and longer lifetime, resulting in lower lifetime energy consumptions. Although the purchase price of the LED may be higher than the conventional alternative, the combination of the longer lifetime plus lower electricity bills cost results in a lower overall cost of LED lighting.

At the time of formulating the project, LED lighting devices still have not significantly penetrated the Viet Nam lighting market. The LED lighting devices used were largely sold for use in buildings owned by large (foreign) investors (such as higher-class luxury apartments and office buildings) who paid higher electricity rates and thus had more incentive to use costlier LED lamps. The project “Local Development and Promotion of LED Technologies for Advanced General Lighting in Viet Nam”, in this report referred to shortly as “LED Vietnam Project”, was formulated to promote a more widespread diffusion of locally produced LED lamps in Viet Nam.

1.1.2 Purpose of the Terminal Evaluation (TE)

With the LED Vietnam project ending, a Terminal Evaluation (TE) needs to be undertaken in accordance with the UNDP and GEF Monitoring and Evaluation (M&E) policies and procedures. The TE must be carried out by independent consultants, i.e. not previously involved in project design or implementation. In a competitive process, two experts were chosen to undertake the Terminal Evaluation, Mr. Johannes (Jan) van den Akker (Netherlands) and Ms. Dang Ngoc Dung hereafter referred to as the “TE Team” or as the “Evaluators”.

The evaluation has assessed the performance of the LED Vietnam project, based on expectations set out in the Project Logical Framework/Results Framework, which provides performance and impact indicators for project implementation along with their corresponding means of verification. The evaluation has covered the criteria of relevance, effectiveness, efficiency, sustainability, and impact. The TE then assessed the key financial aspects of the project, including the extent of co-financing planned and realized. It assessed the extent to which the project was successfully mainstreamed with other UNDP priorities, including improved governance, and gender. The Evaluators also looked at the extent to which the project is achieving impacts or progressing towards the achievement of (intended or unintended) impacts.

1.2 Scope and methodology

Evaluation criteria

The terminal evaluation is based on the OECD-DAC⁴ criteria of *relevance, effectiveness, efficiency, sustainability, and impact*. The rating has taken place according to the evaluation criteria using the rating scales recommended in the

⁴ Organisation for Economic Cooperation and Development (OECD) – Development Assistance Committee (DAC)

Box 1 Rating and rating scales for evaluation criteria in UNDP/GEF projects

1. Monitoring and Evaluation	rating	2. IA& EA Execution	rating
M&E design at entry		Quality of UNDP Implementation	
M&E Plan Implementation		Quality of Execution - Executing Agency	
<i>Overall quality of M&E</i>		<i>Overall quality of Implementation / Execution:</i>	
3. Assessment of Outcomes	rating	4. Sustainability	rating
Relevance		Financial resources:	
Effectiveness		Socio-political:	
Efficiency		Institutional framework and governance:	
<i>Overall Project Outcome Rating</i>		Environmental:	
		<i>Overall likelihood of sustainability:</i>	

Ratings for Outcomes, Effectiveness, Efficiency, M&E, IA&EA Execution

- 6: Highly Satisfactory (HS): no shortcomings
- 5: Satisfactory (S): minor shortcomings
- 4: Moderately Satisfactory (MS)
- 3. Moderately Unsatisfactory (MU): significant shortcomings
- 2. Unsatisfactory (U): major problems
- 1. Highly Unsatisfactory (HU): severe problems

Additional ratings where relevant:

- Not Applicable (N/A)
- Unable to Assess (U/A)

Sustainability ratings:

- 4. Likely (L): negligible risks to sustainability
- 3. Moderately Likely (ML): moderate risks
- 2. Moderately Unlikely (MU): significant risks
- 1. Unlikely (U): severe risks

Relevance ratings

- 2. Relevant (R)
- 1. Not Relevant (NR)

Impact Ratings:

- 3. Significant (S)
- 2. Minimal (M)
- 1. Negligible (N)

UNDP *Guidance for Conducting Terminal Evaluation of UNDP-supported, GEF-financed Projects* (2012)⁵ and given in Box 1. Evaluation conclusions related to the project's achievements and shortfalls (comprehensive and balanced statements which highlight the strengths, weaknesses, and results of the project, based on the OECD-DAC criteria of relevance, effectiveness, efficiency, sustainability, and impact:

- Relevance: How does the project relate to the main objectives of the GEF focal area, and to the environment and development priorities at the local, regional and national levels?
- Effectiveness: To what extent have the expected outcomes and objectives of the project been achieved?
- Efficiency: Was the project implemented efficiently and cost-effectively, in line with international and national norms and standards?
- Sustainability: To what extent are there financial, institutional, social-economic, and/or environmental risks to sustaining long-term project results?
- Impacts: Are there indications that the project has contributed to, or enabled progress toward, reduced environmental or other impacts?

The ratings in this report have been determined based on the project progress reporting and the analysis the Evaluators carried out of the available information and comparing these with observations from the mission (interviews with stakeholders and site visits) and checking with the information presented in project technical reports and policy and background documents. To gather empirical data and information relevant to the project, the evaluators carefully designed several instruments. They included a checklist and evaluative questions for use in collecting primary information. All tools were designed to address the key questions (grouped according to the before-mentioned OECD-DAC criteria) that were part of the Inception Report of the evaluation assignment. Annex D contains the matrix of evaluative questions.

⁵ Other guidelines consulted are those presented in the UNDP *Handbook on Planning, Monitoring and Evaluating for Development Results, Updated Guidance on Evaluation* (2012), the UNDP Discussion Paper: *Innovations in Monitoring & Evaluating Results* (2013) and the GEF *Review of Outcomes to Impacts (ROTI) Handbook* (2009). Regarding gender aspects, the evaluation refers to the *Guide to Gender Mainstreaming in UNDP Supported GEF Financed Projects* (2016).

Approach

The TE has been based on the following *sources of information*:

- Desk review of progress reports and project documents (listed in Annex C),
 - CEO Endorsement Request (CEO ER) and annexes; annual progress reports (PIRs, project implementation reviews); other progress reporting and PowerPoints;
 - Overview of budget expenditures and realized co-financing; annual work plans
 - Project technical reports and description of outputs;
 - Project or counterparts' websites; PowerPoints
 - National policy documents on (renewable and rural energy) as well as other relevant reports, PowerPoint presentations, and documents from counterpart organizations.
- An evaluation mission of 5 working days (from 25 to 29 November 2019) to meet UNDP, VAST, and the Project Team and to hold interviews with project partners and stakeholders in Hanoi and Ho Chi Minh City (see the mission itinerary in Annex B). The meetings and interviews helped the reviewers to obtain in-depth information on impressions and experiences and to explore opinions about the Project and their understanding and identify

Box 2 Evaluation method and approach



opportunities

- A presentation of the initial findings was made at the end of the evaluation mission (on 29/11/2019).

Regarding *data analysis and methods for analysis*, many relevant reports and documents were collected (where possible before the mission). The review of project and background documents (listed in Annex C) provided the basic facts and information for developing the terminal evaluation report, giving a basic insight into progress (target vs. progress) and reasons for under and over achievements were explored.

The evaluation mission served to verify these basic facts, get missing data and to learn the opinions of stakeholders. The mission basically consisted of conducting key informant interviews (in Hanoi and Ho Chi Minh City, HCMC) were made with the representatives of different sector, such as (i) government ministries: Ministry of Trade and Industry, Ministry of Construction; (iii) public entities: such as Sapulico (HCMC lighting company), Quatest-1 (test laboratory), academia (HCMC University of Technology); (iv) NGOs and companies: Ralaco JSC, Dien Quang JSC and Trang Anh JSC, Vietnam Lighting Association,).

Thus, information has been collected mainly by key informant interviews, observation, and visiting the facilities of selected LED companies and LED lighting demonstration sites. In addition, the Evaluators interacted closely with the UNDP Country Office and Project Management Unit staff in Hanoi to validate the information collected from the different sources.

Triangulation (interviews, and document analysis) have allowed validation of information through cross verification from two or more sources. In appraising the result-wise effectiveness of the program's major interventions, evaluators thoroughly assessed targets against progress. To supplement this information, the evaluators used information provided by the Project Team⁶ and later cross-checked with the documents and interview statements. These processes and methods helped evaluators to gather plenty of evidence about the outcomes of the project. Along with collecting information, evaluators reviewed data from the Project Implementation Reviews (PIRs) and other project-related

⁶ PowerPoints, PIR, quarterly progress reports, minutes of meeting.

documents. A draft report was shared with the VAST-based Project Management Unit and UNDP in the agreed format and the report was finalized after incorporating feedback and suggestions.

1.3 Structure of the TE report

This report consists of the report body, executive summary, and annexes. The body of this report is structured around the following chapters: it starts with an introduction to the objectives, scope, and methodology of the terminal evaluation (Chapter One), description of the project context and a summary of project facts (such as start date, duration, the context in which the project started), its objectives and stakeholders (Chapter Two).

The assessment and formulation of the “findings” have been guided by the questions of the “evaluative matrix”, of which a final draft was formulated at the inception stage of the assignment (see Annex D)⁷. The report follows the outline for terminal evaluations of UNDP/GEF projects⁸ but has split the suggested chapter on “Findings” in three parts for practical reasons due to the chapter size and to permit a more reader-friendly presentation of the information. Findings on relevance, design, and formulation are in Chapter Three. Findings on project implementation and monitoring are presented in Chapter Four. An overview of progress regarding the achievement of outcomes and outputs is given in Chapter Five, which ends with a presentation of findings regarding replication effects and sustainability. Chapter Six presents the conclusions, recommendations, and lessons learned from the project. These include actions that might be taken (by the Government) to help ensure the sustainability and continuity of project achievements, as well as steps that can be taken by UNDP (and GEF) to help improve the design and implementation of future projects.

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 longer-term impacts, (including global environmental and development benefits).

The achievement of the results and the longer-term sustainability thereof is influenced by the:

- way project was formulated and designed (discussed in Chapter 3);
- way the project was implemented by the various project partners (discussed in Chapter 4);
- occurrence and impact of internal and external risks (discussed in Chapter 5).

Annexes at the end of the report include the Terms of Reference (Annex A), field visit details and list of organisations and people interviewed (Annex B), documents collected and bibliography (Annex C), evaluative questions and methodology (Annex D).

⁷ See the *Inception Report* of the Terminal Evaluation (June 2019)

⁸ See Annex F, ‘Evaluation Report Outline’ in the UNDP *Guidance for Conducting Terminal Evaluations* (2012)

2. PROJECT DESCRIPTION AND BACKGROUND

2.1 Context and problems that the project sought to address

With rising electricity prices and mounting concerns over climate change and energy security, the Government of Vietnam (GoV) is promoting widespread adoption of energy-efficient (EE) measures for lighting. This commenced in the early 2000s with the migration away from incandescent lighting to compact fluorescent lamps (CFLs) and complete the replacement of high-pressure sodium- vapor street lights and all indoor T8 and T5 light tubes with energy-saving lights. Compact fluorescent lamps were developed in the 1970s as a replacement for the less efficient incandescent lamps and could fit in the same volume and the same fitting. These initiatives were supported by the UNEP/GEF project *Phasing out Incandescent Lamps through Lighting Market Transformation in Vietnam* and the UNDP/GEF *Vietnam Efficient Public Lighting Project (VEEPL)*.

LED is the acronym for “light-emitting diode” where a semiconductor is used to produce light through the process of electroluminescence (see Box 16). LED lamps have a lifespan and electrical efficiency which are several times greater than incandescent lamps, and are significantly more efficient than most fluorescent lamps, resulting in lower lifetime energy consumptions (see Box 3). Recent developments have produced LEDs and new control systems that are suitable for all applications in buildings, traffic lights, and outdoor lighting LEDs can be used nowadays in a variety of lighting products, such as bulbs, tube lights (TL), panel lights, streetlights, floodlights, and others. Although the purchase price of the LED may be higher than the conventional alternative, the combination of the purchase price plus lower electricity bills results in a lower overall cost of LED lighting.

The global LED market has been growing steadily and reached a value of nearly USD 45-60 billion in 2018, up from USD 3.1 billion in 2009, and USD 26 million (31% market share) in 2018. The global LED lighting industry may grow at a robust compound annual growth rate (CAGR) of 11-14% in the forecast period of 2019-2024, attaining a value of USD 132 billion in 2024⁹. LED is set to become the dominant lighting technology worldwide soon producing a range of lighting products such as indoor and outdoor lamps, automotive lights, backlights (like in TVs and smartphones and drivers (the units that regulate the electric current in the lighting equipment) and luminaires. While before, lamps and luminaires were different products, increasingly luminaires and LEDs are one integrated product (facilitated by the high lifespan of LEDs in comparison with traditional lightbulbs). With the rapid development globally of LED technology globally and sharp decline in the cost of LED lighting over the past decades, the next logical step is the widespread adoption of LED lighting technologies that will bring even more reductions in energy consumption and associated greenhouse gas emissions (GHG) reductions by replacing CFLs (compact fluorescent lamps), tube fluorescent lamps (T8 and T12) and high-intensity discharge (HID) lamps.

At the time of formulating the project, LED lighting devices still have not significantly penetrated the Vietnam lighting market (see Box 4 for more details o the Vietnamese LED market demand and supply). The Project Document mentions that the more widespread market penetration of the current LED market is limited by the following:

- LED lamps from well-known manufacturers such as Philips, Osram, etc., meet international standards, but the higher cost of these imported LED lamps (in comparison with cheaper imported or locally produced) lamps discourage their general use;
- Difficulties faced by locally-based lighting manufacturers such as Ralaco and Dien Quang to produce quality LED lighting products at competitive market prices. This is primarily due to:
 - The lack of a developed regulatory regime for LED lamp production and sales in Vietnam that can guide local LED lamp manufacturers on quality of LED lighting products to produce for the market;
 - Insufficient knowledge and capacity of local manufacturers and suppliers on best practices for LED lamp manufacturing and best strategies on improving their production lines to successfully supply LED lamps to the Viet Nam lighting market

⁹ *Vietnam LED Market: Industry Trends, Share, Size, Growth, Opportunity and Forecast 2019-2024* (IMARC, 2019) (www.imarcgroup.com/vietnam-led-lighting-market). See also: www.expertmarketresearch.com/reports/vietnam-led-market

- Related to this, lack of consumer confidence in locally produced LED lamps due to their poor quality in terms of service life, and some of which are improperly labelled to mislead consumers into believing the LED lamps meet international standards, thus giving LED lighting products a ‘bad reputation’;
- An absence of an LED regulatory framework over the quality of LED lamps produced in Viet Nam together with weak institutional arrangements for standard testing of LED lamps, R&D for the advancement of LED lighting products, and for the promotion, appraisal and standards enforcement of LED lighting products.

Box 3 Characteristics of lighting technologies

	Incandescent-type		Fluorescent lighting		Light-emitting diode (LED)	High-intensity discharge lamps (HID)		
	Incandescent	Halogen	CFL	Fluorescent – tube (TL)		Mercury vapour	High-pressure sodium (HPS)	Metal halide
Luminous efficiency (lm/W)	8-17	11-25	60-130	80-110	60-130	45-55	105-125	80-100
Lifetime (hrs)	1000-1500	2000-3000	6000-15000	15000-30000	20000-60000	20000	15000-24000	10000-20000
CRI & colour temperature	100 (CRI) 2600-2800 K	100 (CRI) 2800-3200	70-95 2700-6500 K	60-95 (CRI) 2700-6500 K	70-95 (CRI) 2700-6500 K	15-50 (CRI) 3900-5700 K	25 (CRI) 2000-2100	65-85 (CRI) 2500-6500
Dimmable	Y	Y	if driver dimmable	if ballast dimmable	if driver dimmable	if ballast dimmable	if ballast dimmable	if ballast dimmable
	Produce light by passing electrical current through tungsten metal wire suspended in an inert atmosphere inside a glass bulb.	Halogen lamps are an improvement over incandescent. Contain a small quantity of halogen that increases lamp life.	The lamps incorporate an electronic ballast and phosphor-lined glass tube. An electrical arc is struck at the tube's electrodes, causing the mercury atoms to emit ultraviolet (UV) light, exciting the phosphor coating and emitting visible light. Tubular fluorescent lamps are typically classified by their diameter (most common are: T12 = 38mm, T8 = 25mm, T5 = 16mm). CFLs were developed as retrofits for incandescent, and are essentially a miniaturised version of a linear fluorescent lamp (TL). All fluorescent lamps contain mercury.		A LED is a semiconductor light source, whose p-n junction diode that emits light when activated –(electroluminescence). Many LED products are available that can replace the previous lamp including bulbs and tubular lamps. There are also LED for street lights and outdoor applications.	High intensity discharge (HID) lighting produces light from an electrical arc contained within a capsule of gas (metal vapour) which is sealed inside a bulb. HID lights require a ballast to start and operate, which regulates the voltage. HID lighting is commonly found in outdoor lighting applications such as street lighting, area flood lighting and sports stadium lighting. HID lighting is also found in-door in places such as large retail outlets, warehouses and buildings of manufacturing facilities. A ballast is a piece of equipment designed to start and properly control the flow of power to discharge light sources such as fluorescent and high intensity discharge (HID) lamps		
Incandescent comparison	- 40 W 60 W 100 W	~25% 28-29 W 41-43 W 70-72 W	~ 75% 9-11 W 13-16 W 23-27 W	40 W incandescent compares to 40 (T12)-32 (T8)	80% 5-8 W 10-13 W 20-26 W	Street lighting comparison: MV 240 W HPS 160 W MH 180 W LED 80 W		

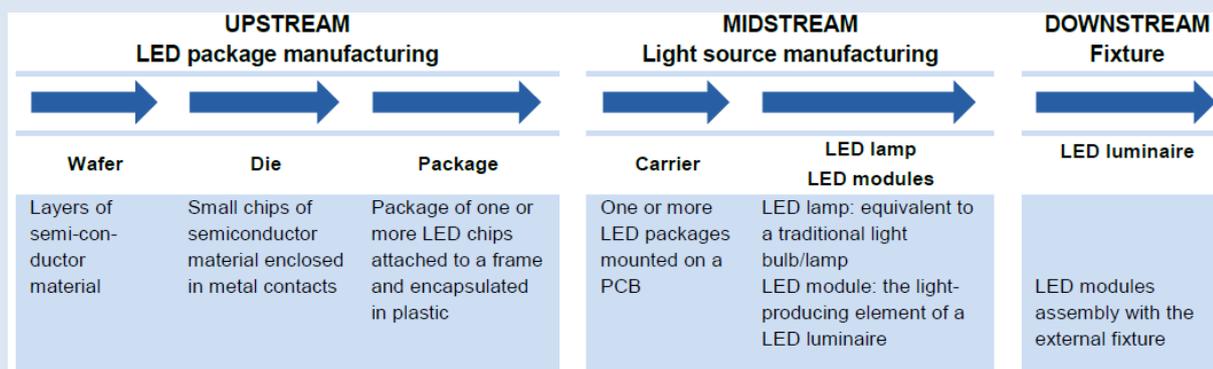
Electricity for lighting accounts for approximately 15% of global power consumption and 5% of worldwide greenhouse gas (GHG) emissions. A switch to efficient on-grid and off-grid lighting globally would save more than USD 140 billion and reduce CO₂ emissions by 580 million tonnes every year. Worldwide, electricity accounts for about 15% of power consumption (and 5% of global greenhouse gas emissions). A transition to more efficient lighting would reduce global power demand for lighting by 30-40%. If countries would follow the integrated efficiency policy approach, the energy savings could reach 640,000 GWh in 2030. This is the equivalent of USD 360 billion in avoided investments in 290 large coal-fired plants, or, the savings would be enough to provide 300 million non-connected households with electric energy (assuming a consumption of 2000 kWh per household per year).

Source: *Accelerating the global adoption of energy-efficient lighting*, UN Environment-GEF ‘United for Energy Efficiency (2016) ; *BC Hydro* (www.bchydro.com); *Lighting the way: Perspectives on the global market*, McKinsey (2011). CRI: colour rendering index

Box 4 Overview of Vietnam LED lighting market

LED lighting technology is replacing conventional bulbs for street lighting applications at a rapid rate. Initially, LED technology in Vietnam was restricted in its utilization, finding uses in traffic lights and the advertisement industry. It has fast expanded to find applications in various sectors like street lighting and in the commercial sector, in restaurants and hotels as interior and exterior decorations. Driven by its numerous advantages over conventional lighting technologies (explained in the main text), the market for LED lighting in Vietnam is witnessing robust growth and is expected to dominate the country's lighting industry in the coming years. 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 (representing a CAGR of 21%).

LED lighting will witness a higher penetration in the Vietnamese market due to the growing urbanization in the country (about 27-45% by 2020). The rising per capita income in Vietnam is expected to lead to an increasing demand for LED in the country, and due to the growing infrastructure sector in the country will provide a further push for the Vietnam LED market (USD 150-160 billion is expected to be invested in new infrastructure by 2020, according to the Ministry of Planning and Investment of Vietnam). The thriving growth of commercial offices and a strong foreign investment in Vietnam is further expected to aid the LED lighting market. As planned by the Ministry of Industry and Trade, Vietnam will accommodate 1,200 to 1,300 supermarkets, 180 commercial centres and 157 shopping malls by 2020. The occupancy rate in Ho Chi Minh City exceeded 95%. It's projected that the city will complete construction of up to 500,000 m² of office building within five years, providing and extra 160% office space. Meanwhile, lots of commercial and industrial districts are under construction in Ho Chi Minh City and its vicinity areas. Vietnam will surely need more luxury hotels to accommodate the increasing number of tourists from around the world. According to Vietnam's tourism department, HCMC will need more than 13,000 three to five stars hotel rooms to accommodate tourists, while Ho Chi Minh city requires approximately 7,000 rooms^{**)}.



LED chips manufacturing (the upstream market) is dominated by Chinese manufacturers, accounting for roughly half of the world's semi-conductive wafer installation capacity. The global supply of LED chips has exceeded demand in recent years due to excessive capacity expansion from various Chinese manufacturers and combined with increased economies of scale, has led to price reduction. The upstream segment does not exist in Vietnam and the lighting industry focusses on the mid-stream and downstream segment. Currently, about 200 companies have registered their LED products in Vietnam and have been divided into three broad groups. The first group, which contains 3% of the companies holding about 20% market share in the Vietnamese LED light industry. Rang Dong Light Source and Vacuum Flask JSC (Ralaco), based in Hanoi, and Dien Quang Light Source Company (DQC), based in HCMC, are the two long-standing leaders of Vietnam's lighting sector and have modern production lines, standard testing facilities, and R&D centres, possessing extensive distribution networks (Ralaco with about 7,000 points of sale, and QDC about 15,000) and sell popular brands^{***)}. The second group comprises of foreign-invested enterprises whose selling prices are generally higher than the average prices by two to three times. These include global players such as Signify (Phillips Lighting) and Osram, that operate in a higher-end segment, focusing on large-scale and premium lighting projects in office buildings, street lighting or even smart lighting. About 13% of the 200 companies are included in this second group, with their products holding a 15-20% market share. The third group dominates the market with 60-70% market share and comprises 84% of the companies. These are often newcomers with family-level scale capital but who lack technological expertise and/or facilities for quality control. Thus, they assemble LED products using cheap input products (mainly from China. An LED lamp is made up of a variety of small components and a single faulty one among them can dramatically shorten the lamp's lifespan as well as accelerate its brightness decay. After several years, consumers will realize and turn away from these low-quality products, helped by government-initiated mandatory labelling and energy performance standards. In the case of CFLs, the market was also abundant with low-quality products in the beginning, but later the CFL market consolidated, in which Ralaco and QSC held a combined market share of 80%^{*)} ^{***)}.

Source:

*) <https://www.imarcgroup.com/vietnam-led-lighting-market> Vietnam LED Market: Industry Trends, Share, Size, Growth, Opportunity and Forecast 2019-2024

***) <https://www.ledinside.com/node/23797> Vietnam's LED Lighting Market Potential and Government Policies

****) Info from Viet Capital Securities, Dien Quang Lighting Report (2018)

2.2 Project description and strategy

2.2.1 Objective, outcomes, and indicators

The LED Vietnam Project was formulated to help the lowering or removal of the above-mentioned barriers to more widespread adoption of LED lamps in Viet Nam. Main source of financing is the Global Environmental Facility (GEF) with a USD 1,517,400 contribution, which is supplemented with co-financing by the United Nations Development Programme (UNDP) with USD 100,000, national government entities (USD 400,000) and leveraged co-financing from private sector companies (Ralaco, Dien Quang, Schredér Vietnam) of USD 6,089,394. UNDP is the GEF Implementing Agency and Viet Nam Academy of Science and Technology (VAST) is the national GEF Executing Partner, implemented by VAST's Center for High Technology Development (CHTD).

The **objective** of this proposed Project is to *mitigate GHG emissions through the transformation of the lighting market towards greater usage of locally produced LED lighting products in Viet Nam*. To achieve this objective, the Project is comprised of two components:

Component 1 (Transfer of skills, knowledge, and technology in support of local LED lamp manufacturing) 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 (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.

The project started in 2015 (ProDoc signature: June 2015; Inception workshop: November 2015) and has been implemented over four years (operationally ending December 2019). A summary of the project framework with **objective, outcomes, outputs, and indicators** is provided in the Box below.

Box 5 Summary of the project objective, outcomes, and outputs

Project objective: Mitigation of GHG emissions through the transformation of the lighting market towards greater usage of locally-produced LED lighting products in Viet Nam	<ol style="list-style-type: none"> 1) Cumulative direct (at end-of-project, EoP) and indirect CO₂ emission reductions <i>Target:</i> 623 tonnes of CO₂ (from direct investment and generate during project period), and 69,382 tonnes of CO₂ (post-project direct, cumulative 10 years after EoP + lamps installed after EoP (see Section 5.3)) 2) Cumulative direct and indirect energy saving (MWh) by EoP <i>Target:</i> 1,000 MW direct savings (of which 705 MWh from indoor and 293 MW from outdoor savings and indirect savings of 3,000 MWh (assuming a replication factor of 3)) 3) Share of% urban households and commercial establishments with reduced electricity bills from the use of LED lamps by EoP <i>Target:</i> 5%
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Outcomes and indicators	Output and activities
Outcome 1: Development of a local LED industry that provides locally produced quality LED lamps that are increasingly in demand by	Output 1.1: Completed biennial reviews of a national roadmap for LED lighting development <i>Activities</i> <ol style="list-style-type: none"> 1. Review of the results of the LED market surveys (from Output 2.3) to compare the implementation of the roadmap of the previous year, and revise the roadmap for LED

Outcomes and indicators	Output and activities
<p>local consumers</p> <p><i>Indicators:</i></p> <p>4) Number of LED lamp manufacturing plants that have advanced manufacturing to produce LED lamps that meet new VN standards for LED lamps <i>Target: 2-3¹⁰</i></p> <p>5) Number of retailers that sell locally labelled LED lighting products <i>Target: 200</i></p> <p>6) Number of LED lighting products that are standardized <i>Target: 6</i></p> <p>7) Number of new LED lighting products that are labelled <i>Target: 4</i></p>	<p>market transformation;</p> <p>2. Setting targets for LED market penetration based on information in the national roadmap for LEDs.</p>
	<p>Output 1.2: Improved LED lighting standards that meet international norms.</p> <p><i>Activities</i></p> <p>1. Develop two national standards (TCVN) on (i) Approved method for electrical & photometric measurements of solid-state lighting products, and (ii) Approved method for measuring lumen maintenance of LED light sources that refer to IES LM-79-0834 and IES LM-80-0835;</p> <p>2. Conduct workshops to discuss the contents of the new TCVN standards and plans for promulgation and enforcement of the new standards.</p>
	<p>Output 1.3: Training workshops to strengthen LED lamp testing and enforcement regime</p> <p><i>Activities</i></p> <p>1. Identification of new Quatest equipment required to meet new testing protocols for LEDs (from Output 1.2);</p> <p>2. Conduct of training on new testing protocols for LEDs involving 15 officers from Quatest and various other testing centres that are public and private sector in Viet Nam;</p> <p>3. Capacity building for an enforcement regime with MoIT that requires LED suppliers to meet minimum testing requirements for LED lighting products (including standards LM79-08 and LM 80-08). The new enforcement regime under MoIT oversight will provide testing certification for declared lifetimes of LED products to be sold on the Vietnamese market</p>
	<p>Output 1.4: Labelled and certified LED lighting products</p> <p><i>Activities</i></p> <p>1. Preparation of plans to implement the certification and labeling of LED lamps that as a minimum provides minimum energy performance standards for each LED product;</p> <p>2. Preparation of updated circulars on the latest LED lighting products to fall under certification and labeling regime;</p> <p>3. Training of Market Management Department field officers for spot market inspections of LED lamp suppliers for labelled products for compliance to new standards.</p>
	<p>Output 1.5: Updated building codes that include the use of LED lighting products</p> <p><i>Activities</i></p> <p>1. Specification of the use of LED lamps to comply with new LED lamp standards developed in Output 1.2, to comply with MoC's Construction Standard on Energy Efficiency Building Code (EEBC)</p>
	<p>Output 1.6: Completed capacity building program to strengthen LED R&D facilities</p> <p><i>Activities</i></p> <p>1. Enabling lighting technology professionals (from Ralaco, DQ and other participating LED manufacturing companies) to design LED-based lighting products for general use within the regulatory framework designed by the Project in Outputs 1.1 and 1.4;</p> <p>2. Facilitating dialogue between these professionals and national R&D centres of LED lighting products</p>
	<p>Output 1.7: Engineering and construction designs for improved LED lighting production in Viet Nam</p> <p><i>Activities</i></p>

¹⁰ At Project Inception, this indicator was changed from the original "3" to "2"

Outcomes and indicators	Output and activities
	<p>1. Delivery of knowledge on a) LED lamp product design, b) Driver design for high powered outdoor LED lighting products in tropical areas; c) LED package manufacturing (for LED replacement lamps from processed wafers); d) Review of raw material standards and testing methods; e) Identification of required equipment for improved LED lamp manufacturing process; and f) International standards and certification for LED lighting products</p>
<p>Outcome 2: Increased use and deployment of locally-produced high- quality LED lighting technologies</p> <p><i>Indicators:</i></p> <p>8) Share of rural and urban households and commercial establishments that have purchased locally produced LED lamps <i>Target: 10% by EoP</i></p> <p>9) Annual number of sold LED lamps that are locally produced and certified LED lights in Viet Nam by EOP for the local lighting market <i>Target: 15 million by EoP (up from a baseline of 1.3 million; 2014)</i></p> <p>10) Market share of locally produced LED lamps in the Vietnamese lighting market <i>Target: 7% by EoP</i></p>	<p>Output 2.1: Completed feasibility studies of indoor and outdoor LED lighting demonstrations</p> <p><i>Activity:</i></p> <p>1. Preparation and completion of feasibility studies for (i) a demonstration for over 4,000 locally produced LED lamps for indoor lighting at 3 locations (i.e. residential, commercial and industrial); (ii) a demonstration for over 400 locally produced LED lamps for outdoor and indoor lighting at 3 locations (i.e. street and alley lighting); and (iii) assistance to other property owners who want to convert their lighting systems, indoor or outdoor, to LED lamps</p> <hr/> <p>Output 2.2: Completed LED lighting application demonstrations.</p> <p><i>Activity:</i></p> <p>1. Implement the above-mentioned demonstrations; (j) about 4,000 lamps from Dien Quang (in VAST complex and in Nha Be garment factory), (ii) demo of 400 lamps (high-bay lamps at Nha Angh garment factory; streetlights at selected alleys from Ralaco</p> <hr/> <p>Output 2.3: Approved system for monitoring and evaluation of LED lighting systems</p> <p><i>Activity:</i></p> <p>1. Based on the MRV system elaborated under VEEPL, assess energy savings and CO₂ emission reduction and formulate GHG emission reduction reports within the framework of the EE&C Law;</p> <p>2. Conduct assessment of LED lamp sales, consumer attitudes towards LED lamps, assessment of the LED lighting products manufacturer capacity, market development, and energy savings and GHG reductions</p> <hr/> <p>Output 2.4: Completed LED lighting product applications awareness raising program</p> <p><i>Activities:</i></p> <p>1. Discussions on the effective dissemination of consumer information on LED lamp benefits that may include roles for ESCOs and service providers who are involved with LED lighting system installations;</p> <p>2. Design of consumer messaging on LED lamp benefits that will include user benefits (i.e. reduced electricity bills, improved lighting quality, reduced power outages), national benefits (reduced dependence on imported fossil fuels) and global benefits (reduced GHG emissions and reduced risk of severe climate change);</p> <p>3. Preparation of updated public awareness messages including websites, TV and radio spots and newspapers to promote and replicate LED lamp uptake.</p> <hr/> <p>Output 2.5: Completed workshops for disseminating lessons learned from LED lighting product application demonstrations</p> <p><i>Activities:</i></p> <p>1. Propose further actions to change policies, standards, and regulations as well as target dates for the national LED roadmap;</p> <p>2. Identify where capacity efforts should be made to increase LED lamp market penetration;</p> <p>3. Propose new LED lighting product lines that will boost LED sales and provide further national energy savings</p>

2.3 Project partners and stakeholders

2.3.1 Main project partners and project implementation arrangement

The LED Vietnam project

has been implemented by the Vietnam Academy for Science and Technology (VAST), UNDP's Implementing Partner, and the Centre for High Technology Development (CHTD) under VAST, which will assume the overall responsibility for the achievement of project results as the Project's Implementing Entity. The Director-General of CHTD acts as the National Project Director¹¹

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, and the Project Steering Committee.

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

The Project Management Unit, physically based at VAST, is headed by a Project Manager (PM)¹² who reports to NPD. He is aided by the expert technical guidance services of the National Senior Technical Advisor (NSTA)¹³ and a (part-time) International Technical Advisor that are supported by a Project Accountant¹⁴. The Project Management Unit has ensured that the project outcomes have been met.

Box 6 Project management structure



UNDP also has a role of project assurance. This role has been exercised by the UNDP Programme Officer responsible for the project, based in the UNDP Country Office (CO) and the Regional Technical Advisor (RTA) based in the UNDP Bangkok Regional Hub¹⁵.

2.3.2 Stakeholders

The Box below gives a description of the main stakeholders involved and the nature of their involvement in the LED Vietnam project.

¹¹ Mr. Nguyen Van Thao

¹² Mr. Nguyen Kien Cuong

¹³ Mr. Phan Hong Khoi

¹⁴ Ms. Thanh Thuy

¹⁵ Currently, Ms. Vu Thi Thu Hang and Ms. Milou Beerepoot, respectively

Box 7 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)	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)
Ministry of Science and Technology	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. 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. 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. The project also supported Quatest 1 to improved their testing capacity through training and hand-on training and technical advice by the international expert engaged by the project
Ministry of Industry and Trade (MoIT)	MoIT's Energy Efficiency and Sustainable Development Department implements the National Program on Energy Efficiency (VNEEP). MoIT involvement in the LED Viet Nam project is 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 and Dien Quang) that are producing LED products for indoor and outdoor general lighting and are partners with the 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 Lo 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.
Universities	The Ho Chi Minh University of Technology has been involved in research and development (R&D) on LED and smart lighting technology. The Vietnam National University in HCMC has been involved in the LED demonstration on its campus.

3. FINDINGS: PROJECT DESIGN AND STRATEGY

Next in this report follows an overview of the evaluation findings. Due to the size of the main text it has been divided over three chapters that cover a) project design & formulation, b) project implementation, and c) project results and sustainability. The findings are based on several evaluative criteria and questions (originally formulated in the Inception report and slightly re-formulated). Here, the reader can make a link between what was asked and what was found. The questions in the orange-coloured boxes in this and in other Chapters are taken from the Evaluative matrix (Annex D) as these correspond to the appropriate Section in this report.

Chapter 3 looks first at the project relevance and country drivenness (at project design), and links with national goals and development. Second, it looks at the design logic (in the framework of outcomes and objectives to reach the objective) and how the design framework was formulated, including the definition of indicators and target values for outcomes and outputs.

3.1 Relevance and design

Country priorities and relevance

- Have project outcomes been contributing to national development priorities and plans and take into account national realities?
- Consistency with the GEF focal areas in Climate Change/operational program strategies of the GEF CC and with the UN and UNDP country programming in Viet Nam
- Is the Project addressing the needs of the target beneficiaries? Relevance of the project's objectives, outcomes and outputs to the different target groups of the interventions.

Relevance

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 importance¹⁶:

- *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 consumption and promote 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 the business-as-usual baseline;
- *Intended Nationally Determined Contributions* (INDCs): submitted to the Secretariat of the United Nations Framework Convention on Climate Change (UNFCCC) and the Action Plan for Implementation of Paris Agreement;
- *Renewable Energy Development Strategy* (REDS; Decision No. 2068/2015/QD-TTg: setting RE targets in energy and power sectors; supporting schemes for RE development (Feed-in Tariff, F iT); Renewable Portfolio Standard (RPS), net-metering etc.).

¹⁶ Vietnam Energy Outlook Report 2019, Electricity and Renewable Energy Authority (EREA); MoIT

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 Fund¹⁷.

Box 8 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 (ERA; MoIT)

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, as Evaluators we can confirm that the project addresses several SDGs both directly as well as indirectly, as indicated Box 9.

Box 9 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	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
7.3 Double the global rate of improvement in energy efficiency	
<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 appropriate 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
13. Take urgent action to combat climate change and its impacts	The carbon-intensive energy sector (based on fossil fuels) is a key driver of climate change.

Compiled from *Transforming our World: the 2030 Agenda for Sustainable Development* (UN, 2015), *Indicators and a Monitoring Framework for the Sustainable Development Goals*, Sustainable Development Solutions Network (SDSN)

¹⁷ Vietnam Energy Outlook Report 2019, Electricity and Renewable Energy Authority (ERA); MoIT

GEF and UNDP programming

The LED Vietnam project results framework in the ProDoc refers to the following Outcome (# 1.3) 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-sectoral 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 CO₂-eq avoided”.

Gender

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.

3.2 Conceptualization and results framework

- Were lessons from other relevant projects (e.g. VEEPL) properly incorporated in the project design? Were the partnership arrangements properly identified and the roles and responsibilities negotiated prior to project approval?
- Has the project’s design (logframe) been adequate to address the problems at hand? Was the project internally coherent in its design (logical linkages between expected results and design (components, choice of partners; scope, use of resources)? Were any (major) amendments to the assumptions or targets been made or planned during the Project’s implementation?

Previous efficient lighting activities

VAST implemented the UNDP/GEF *Vietnam Energy Efficiency Public Lighting (VEEPL)* from 2005 to 2011. The project focused on shifting the market towards more efficient lamp technologies. At that time, this implied substitution by CFLs for incandescents, T8 tube fluorescent for less-efficient TL types, and shifting away from mercury vapour lamps in public lighting. The main achievements are summarized in [Box 10](#). The setup of the UNDP/GEF LED Vietnam does look quite similar to the VEEPL programme, maybe not surprisingly with VAST as leading agency in both, with policy development (roadmap, LED standards and labelling), technical support (to selected manufacturers) and training; as well as demonstration (public lighting, educational facilities) and info dissemination, of course, now focusing on LED lighting production and market penetration.

One main difference is the absence of a financial component in the LED Vietnam project. One reason may be the size of the LED Vietnam project with a USD 1.5 million GEF budget, i.e. half of the VEEPL budget. The larger size of VEEPL (with GEF USD 3 million budget) allowed the inclusion of more Components with other topics (such as financing). Another reason, according to the Evaluation Team, was that the Terminal Evaluation of VEEPL observed that the ‘financial mechanism’ component in VEEPL did not meet expectations. This may reflect VAST’s core competence as a science and technology institution but is also indicative that sustainable energy financing in the public sector meets barriers and issues that should be addressed in a context wider of more market-based financing that goes beyond the topic of efficient lighting. This is further discussed in Section 5.4 on ‘financial sustainability’.

Box 10 Summary of the UNDP/GEF VEEPL project implemented by VAST

The project's main achievements have been:

1) *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 lighting standards for schools and other public buildings;
- Handbook on EEPL systems.

2) *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.

3) *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.

4) *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.

5) *PL info dissemination*

- Maintenance of VEEPL website;
- Distribution of promotional materials, printed articles, etc.

The final evaluation report of VEEPL concludes most progress towards results had been obtained in the more technological Components 2 (standards and support to industry), rated as highly satisfactory and in Component 4 (demonstration schemes), rated as satisfactory. The project has raised awareness among certain beneficiary groups (street lighting in selected cities; schools), but less so in another intended target groups, i.e., hospitals. The component 4 (financing) did some analysis on financial issues, but this analysis did not result in a clear indication on how the success of the demo activities in the large cities, such as HCMC or Hanoi, could be translated to the poorer cities and regions of Viet Nam by means of sustainable technology delivery and financing models for public sector entities that have the support of national and local governments. It was recommended that further capacity building would be needed for public sector decision-makers and for financial institutions and banks on options and issues in EE project financing, leveraging commercial finance, and on options in performance contracting and ESCO business models in public sector energy efficiency.

Source: *Final Evaluation, Vietnam Energy Efficiency Public Lighting (VEEPL)*, by Jan Van den Akker and Ngo To Nhien (2011), available at <http://erc.undp.org>

The Project design might have included more specific support to smaller companies rather than the two largest ones. One reason has been the limitation in size of this medium-sized project (leaving little budget space to address smaller companies' technology and financial needs) and a decision to focus on improving domestic technology for which the largest companies would have the investment needed. In the recommendation section, the issue of supporting smaller companies is re-addressed.

Analysis of the project results framework (logical framework or logframe)

The results framework is well-designed and mirrors in many ways the VEEPL setup, as does the choice of project partners. The outputs and outcomes are well-designed to address the barriers summarised in section 2.1. Chapter 5 of this TE report explains how the project results have helped to lower these barriers.

The Evaluators noticed one curious aspect regarding the 'List of indicators', in terms of the difference between the VEEPL indicators of its results framework and those of the LED Vietnam project. In the VEEPL Final Evaluation report (see Box 10) it was noted that indicators tended to be mostly 'output-level' (e.g. number of studies developed, number of workshops organised) with only a few outcome indicators. In the Vietnam LED project results framework, in contrast, has only outcome/objective indicators. In fact, the Evaluation Team finds that the indicators (e.g. number of LED lamps sold) are more indicative of the overall LED market development in general rather than measuring project results as such. One would expect indicators for, for example, number of policies or regulations formulated, number of demonstrations implemented; number of people trained. Applying a mix of outcome and output-level indicators would have given a better insight into the project's results. For this reason, the Evaluation Team bases its rating for success in Chapter 5 on the (qualitative) description of realised outcome and outputs rather than on the qualitative indicators mentioned in the Project Implementation Reviews (PIRs).

3.3 Ratings for project design

The UNDP/GEF rating requirements and criteria for TEs do not include a 'rating on project design and formulation', except for the item "M&E at design". This is surprising because we think that the 'design' is one of the main factors, alongside 'implementation' and 'external factors' that determine the achievement of 'results'. We believe that the good results of LED Vietnam (as described in Section 5) are partly based on the logic in the project design.

In the rating for 'design' of the Vietnam LED project using a six-point rating scheme:

- Highly satisfactory (HS), no shortcomings
- Satisfactory (S), minor shortcomings
- Moderately satisfactory (MS), moderate shortcomings
- Moderately unsatisfactory (MU), significant shortcomings
- Unsatisfactory (U), major shortcomings
- Highly unsatisfactory (HU), severe shortcomings
- U/A = unable to assess.

Box 11 Evaluation ratings of project design and relevance

Evaluation item	Corresponding section	Rating
Design logic and approach; assumptions and risks	Section 3.2	S
Formulation of the log-frame (outcomes/outputs; choice and values of indicators)	Section 3.2	MS
Relevance	Section 3.1	R
M&E at design and entry	Section 4.1	S

Regarding 'relevance', rating is on a two-point scale with "R" meaning 'Relevant' and "NR" meaning 'not relevant'. Rating the project design strictly speaking is not part of the TE's Terms of Reference, but our rating is between 'S' for the design logic of outcomes and outputs (in terms of addressing barriers) and 'MS' as progress indicators do not measure well the (direct) project results but are more indicative for the LED market development as a whole.

4. FINDINGS: PROJECT IMPLEMENTATION

This part of the Evaluation Report describes the assessment and rating of the quality of the execution by the GEF Implementing Agency (IA), UNDP, and the Executing Partner VAST. An assessment is made of the partnerships established and stakeholder interaction during implementation and the important role of adaptive management. The Evaluation Report presents an assessment and rating of the project monitoring and evaluation (M&E) at implementation. A special section is dedicated to the budget, expenditures, and co-financing of the LED Vietnam project.

4.1 Implementation and management

4.1.1 *Management arrangements and adaptive management*

- Was the project implemented (by IA) and executed (by EA) in an efficient way?
- What have been management responses to issues and recommendations indicated in progress reports and Mid-Term review?
- Did UNDP and Project staff identify problems in a timely fashion and submit advice to the project team? If so, has the project practicing adaptive management e.g., (approve modifications in time)? If so, how effective were the adaptive management approaches practiced during 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) is the GEF Implementing Partner. For more details on the management arrangements, the reader is referred to Section 2.3.1.

The Center for High Technology Development (CHTD) under VAST has the overall responsibility for the achievement of project results. CHTD has set up the Project Management Unit (PMU) and designated a senior official as the National Project Director (NPD) for the project. The Vietnam LED project is headed by a Project Manager (PM), supported by the expert technical guidance services of the National Senior Technical Advisor (NSTA) and a (part-time) International Technical Advisor that are supported by a Project Accountant. VAST assigned a deputy NPD, an accountant for counterpart fund and an office assistant to assist PMU in project implementation and management.

Adaptive 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 a 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 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 (with the argument that carrying the study out in 2016, when the LED market was just

establishing itself, would have been too early)¹⁸. These are examples of adaptive management exercised by both PMU and UNDP in this project.

4.1.2 Monitoring and evaluation

- Was the information provided by the M&E system (annual work plans, PIRs, other) used to improve performance and to adapt to changing needs; Are there any annual work plans?
- What have been management responses to issues and recommendations indicated in progress reports and the Mid-Term review? How have the project management systems, including progress reporting, administrative and financial systems and monitoring and evaluation system been operating as effective management tools to aid in effective implementation and provide a sufficient basis for evaluating performance and decision making?

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's objectives. 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
- Project Steering Committee (PSC) meetings
- Mid-Term Review and 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 Reports 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's 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), with the minutes of meeting including discussion points and agreements that have been made available. At the meetings, usually, five to seven PSC members have been present¹⁹.

The Mid-Term Review was not conducted, because (i) the LED project is medium-sized, and therefore it was not mandatory to undertake the review; (ii) the project implementation results achieved over the years were deemed satisfactory enough to eliminate the need for a MTR (thus also saving on the project budget). PMU staff and UNDP officials did not make separate field visits to monitor progress on a periodic basis (to save cost monitoring activities were combined with or accompanying the project activities). The performance of the Project was monitored and assessed according to the goals defined and agreed upon in the AWP, with outcomes and outcome indicators (which

¹⁸ The argument can be disputed as good information on demand and supply is essential. In fact, a limited market survey was in fact carried out during the project (see Box 21), while the Evaluation Team suggests in the 'recommendations' section that a more comprehensive demand and supply survey is carried by a relevant Vietnamese authority (see Box 25)

¹⁹ 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 staff from PMU, CHTD, VAST, Universities, as well as consultants and experts have participated.

are based on the logframe of the Project Document) and reported on in the before-mentioned annual progress reports or PIRs.

The Project used two reporting systems, one for UNDP and another one for the Government. With UNDP reporting requirements, the Project produces quarterly and annual reports²⁰. The reporting requirements for the Government of Vietnam entailed 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.

4.2 Stakeholder involvement and relations

- How efficient are partnership arrangements for the project? Did stakeholders participated in the project management and decision-making have ownership over project outcomes and their further replication and scaling-up? Did the project efficiently utilize local capacity in its implementation?

Stakeholder involvement

The project has 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, and 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

Box 12 Knowledge activities and products

- 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-energ.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)

project activities in the reporting period. The Project has worked with LED lights producers by 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.

External communication

The Project has used different communication channels through webpages (part of HTDC and UNDP's website), Light and Life Magazine, Newspaper, Facebook, Instagram, Zalo, training, workshops, etc. The PMU decided not to develop a specific project website due to budget limitations and considering too that when the Project would finish nobody would continue maintaining it. Instead, project information has been posted on CHTD's website and CHTD will continue operating this website after LED project termination. Staff of CHTD is in charge of communication of both CHTD and the LED project. The external communication started in 2018 and posted 3-5 articles each quarter on the website. Films were developed and broadcasted on the VTV2 scientific channel and were also shown at project events, seminars, and workshops. The films are intended to be broadcasted on VTC channel (2019). For an overview of the project's information and knowledge products, the reader is referred to [Box 12](#).

4.3 Project finance and co-financing

- How efficient was the financial management of the project, including specific reference to cost-effectiveness of its interventions? If there was a difference in the level of expected co-financing and the co-financing actually realized, what were the reasons for the variance?

The GEF budget planned for disbursement USD 1,517,400 for the whole 4-year project life during which most of the budget was allocated for Outcome 1 (67% of GEF budget), 5% of the budget for project management, and the remainder for Outcome 2. As of 07/11/2019, the project disbursed USD 1,365,954, i.e. a disbursement rate achieved of 90% of the total budget (see [Box 13](#)) with about 10% left for planned commitments at project closing (such as the December Completion Workshop, Terminal Evaluation, and audit/spot check).

Box 13 UNDP/GEF budget and actual expenditures and co-financing data

GEF Budget (USD)	Planned	Disbursement					Total
		2015	2016	2017	2018	as of 7/11/2019*	
Outcome 1	1,019,450		228,961	389,987	315,133		934,081
Outcome 2	425,900		28,131	50,932	100,517		179,580
Project mng't	72,050		13,429	8,320	19,449		41,198
Other			118	442	762		1,322
Total	1,517,400	43,581	270,639	449,681	435,861	166,192	1,365,954

Co-financing (USD)	Planned		Total	Realised Total
	Outcome 1	Outcome 2		
VAST			150,000	150,000
MolT	150,000		150,000	150,000
Quatest	100,000		100,000	384,000
CHTD		40,000	40,000	200,000
Ralaco	2,200,000	36,300	2,236,300	2,238,000
Dien Quang	3,110,000	287,694	3,397,694	3,476,773
Schreder	290,400	165,000	455,400	0
UNDP			100,000	100,000
Total	5,850,400	528,994	6,629,394	6,698,773

Note: The data are compiled from the *UNDP ProDoc* and data provided by the PMU/UNDP. Co-financing consists of grants (government), loans (from the banking sector) and equity investment.

Co-financing planned 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 Schreder was not realized as they closed their representative office in Vietnam (Schreder does maintain a regional office in China), but other co-financiers, such as Quatest, CHTD and Dien Quang, actually contributed more than planned. The level of co-financing met the target, achieving about 101%.

4.4 Ratings of project M&E and project implementation/execution

In assessing ‘implementation and adaptive management’ of the LED Vietnam Project, a six-point rating scheme is used:

- Highly satisfactory (HS), Implementation of all components, 1) management arrangements, work planning, reporting, project-level monitoring and evaluation, 2) stakeholder engagement and communications, 3) finance and co-finance, is leading to efficient and effective project implementation and adaptive management. The project can be presented as demonstrating “good practice”.
- Satisfactory (S), implementation of most of the components has led to efficient and effective project implementation and adaptive management except for only a few components that are subject to remedial action
- Moderately satisfactory (MS), implementation of some of the components has led to efficient and effective project implementation and adaptive management, with some components requiring remedial action.
- Moderately unsatisfactory (MU), implementation is not leading to efficient and effective project implementation and adaptive management, with most components requiring remedial action.
- Unsatisfactory (U), implementation of most of the components is not leading to efficient and effective project implementation and adaptive management.
- Highly unsatisfactory (HU), implementation of none of the components is leading to efficient and effective project implementation and adaptive management.
- U/A = unable to assess.

Box 14 Evaluation ratings of project implementation and execution

Evaluation item	Corresponding report section	Rating
Quality of UNDP implementation (adaptive management; finance)	4.1, 4.3	S
Quality of execution (AEPC), coordination; adaptive management; stakeholder involvement	4.1, 4.2, 4.3	S
Overall UNDP implementation and implementing partner execution; Efficiency in achieving results		S
M&E plan implementation	4.1	S

5. FINDINGS: PROGRESS TOWARDS OUTCOMES AND OBJECTIVE

5.1 Introduction

- To what extent have the expected outcomes and objectives of the project been achieved?
- What outputs and outcomes has the project achieved (both qualitative and quantitative results, comparing the expected and realized end-project value of progress indicators of each outcome/output with the baseline value)?
- Were objectives, outcomes and outputs achieved on time? How did the project contribute to GHG emissions reduction within the project implementation cycle and beyond?
- Were there any unplanned effects? Which external factors have contributed or hinder the achievement of the expected results?
- Impact: has the project had any impact on gender equality and economic empowerment for women and other marginalized groups? Was it intended to?

Chapter 5 presents progress towards results. For each of the five project components, as mentioned in paragraph 1.2, this section assesses the progress in the implementation of the project's outcomes and outputs, following the 'project results framework' format and as reported by the Project Team in the annual UNDP/GEF Project Implementation Reports (PIRs) as well as information and documents by the Project Team to the Evaluators and interviews with stakeholders. Section 5.2 describes the progress achieved in outputs and activities for each Component/Outcome, following the outline of outcomes and outputs of Box 4. Section 5.2 tries to provide a quantitative and descriptive overview of the achievements of outputs and outcomes. Section 5.3 provides an assessment of results in terms of attainment of the outcomes and outcome indicators. The baseline and target values of the indicators are taken from the project's logical framework (as reported in the Inception Report and PIRs), while the achievements (i.e. indicator value at project's end, is compiled from PowerPoint presentations made by the project team for the TE mission), supplemented by additional info obtained during the mission (provided by the Project Team) and analysis of the outputs and reports produced during 2015-2019. The greenhouse gas emissions reported have also been reviewed; these are discussed in Section 5.3.3. Section 5.3 ends with a summary of the Evaluators' ratings towards results. Section 5.4 discusses sustainability and replicability.

5.2 Progress in achieving outputs and outcomes

5.2.1 Outcome 1 *Development of a local LED industry that provides locally produced quality LED lamps that are increasingly in demand by local consumers*

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: 2-3.</i>	The two largest local LED lighting companies with advanced manufacturing facilities include the project partners Ralaco and Dien Quang. Also, there are mid-range companies and several smaller companies. The Project Document target of "3" was reset at project Inception to "2" after Vietnam Schreder was not included anymore
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 of retailers and stores selling LED lights
Number of LED lighting products that are standardized <i>Target 6</i>	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.
Number of new LED lighting products that are labelled <i>Target: 4</i>	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

Baseline

The absence of a regulatory framework (for LED lighting) indicating LED lamp minimum requirements has led to the flooding of sub-standard LED lamps that are locally produced or imported into the Vietnamese lighting market. Unlike other lamp technologies, there were no mandatory standards and labelling for LED lamp production at the time of project conceptualisation. There is a need for:

- Minimum energy performance standards (MEPS) for LED lighting products;
- Formalized testing method standards for LED lamps and their components;
- Monitoring, verification and enforcement (MVE) regulations for LED lighting product MEPS and energy labelling.

The Quatest Laboratories (under STAMEQ) are the largest accredited product testing laboratories in Viet Nam. Under a mandatory standards and labelling (S&L) regime, prior to any product being sold on the market, the seller, distributor or producer of the product is obligated to obtain certification of compliance from Quatest. Quatest and other national laboratories (private and public) developed test method standards for lamps and fixtures including CFLs, fluorescent ballasts and lamps. As mentioned in [Box 16](#), testing of LED lighting products differs from conventional lighting. At the time of project formulation, Quatest did have the capacity to test some LED specifications, but not to do the full testing for electrical compliance, energy performance, and photometry (could only test LED bulbs and LED tubes not all LED lighting products) and, consequently, the QUATEST testing centers had not yet obtained accreditation as a LED lighting product testing laboratory. Therefore, MoIT was planning to upgrade the capacity of the Quatest laboratories for testing all locally manufactured LED lighting products, in line with international standards²¹.

One barrier mentioned in the ProDoc is that local LED lamp manufacturers have insufficient knowledge and capacity on the latest practices for LED lamp manufacturing and best strategies on improving their production lines to successfully supply LED lamps to the Viet Nam lighting market. This has resulted in a low level of investment into LED lamp production lines, also because previously the focus was on CFLs and other lighting products. Given the rapid growth of the LED market (see Section 2.1), Ralaco and Dien Quang, the two major LED lighting product companies in Viet Nam, stated their intentions of increasing their sales of LED lamps to the Vietnamese lighting market through committing investment plans for LED manufacturing infrastructure and technology transfer in the order of USD 4 million each during the 2013-2017 period²². Strengthening private and public R&D centres and improved local manufacturing is needed to have high-quality LED lighting products that meet new and adopted Vietnamese LED lamp standards and regulations and are more responsive to consumer demand trends for smart LED lighting solutions.

At the institutional level, there was a lack of focus on LED technology at the time of LED Vietnam project conceptualisation. The Ministry of Science and Technology (MoST) and Ministry of Industry and Trade (MoIT) needed support for the formulation of LED lighting product standards and to encourage LED lighting technology development and application. The same applied to the Ministry of Construction (MoC) concerning the installation of LED lighting systems in buildings and transportation infrastructure was limited²³.

Achievements

Output 1.1. Completed biennial reviews of national roadmap for LED lighting development

MoIT has formulated roadmaps for various components of the Vietnam National Energy Efficiency Programme (VNEEP) that articulates how to achieve the sector-based EE goals and contribute to national socio-economic goals. LED project

²¹ IES LM-79-2008, *Approved Method for the Electrical and Photometric Testing of Solid State Lighting Devices*, that provides a foundation for accurate comparisons of luminaire performance for solid state lighting (SSL) and all other sources; and IES LM-80-2008, *Approved Method for Measuring Lumen Depreciation of LED Light Sources* that defines a method of testing lamp depreciation. LED packages have a long lifetime in comparison with other lighting devices and may become unusable long before they fail; hence, this mode of failure can be accounted for in this standard

²² As mentioned in the Project Document, page 23

²³ The standard for the use of energy efficient lighting in buildings falls under the Construction Standard on Energy Efficiency Building Code (EEBC) numbered QCXDVN 09:2013 issued under decision number QCVN 09:2013/BXD by MoC. The standard applies to new buildings or buildings greater than 2500m². The building code sets design requirements for outside layers, ventilation, lighting, energy consumption, water heating, and outlines how to calculate energy efficiency for the entire building. The code, however, does not include the use of LEDs

provided support for the development of the *Roadmap of Vietnam's LED Lighting up to 2025*²⁴. This included an assessment of similar roadmaps in other countries and LED lighting industry promotion in other countries, as well as an analysis of the international and national status of the LED lighting market. The proposed has been submitted to MoIT (and distributed to three other government entities, including VAST, MoST and MoC). The main elements of the Roadmap are summarised in Box 15.

Box 15 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	- Need for to hi-tech requirement to develop - Should import LED - Considering to invest special LED packages in agriculture, aquaculture, UV LED		
	- LED lamp production	- Researching and fabricating parts: optical part, heat sink, driver and lamp body (increasing localization rate to 60%-70%) - 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).		Vietnam has over 200 companies at present
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		
4	LED lighting standards	- Issuing energy efficiency standards and adding standards conformed with IEC, CIE, IES for LED lamps - Developing infrastructure and technical competence for QUATEST - 1 (EMC lab, Goniophotometer, etc.)	- Completing standards related to LED lamps for rationale of Vietnam explicit market management - Developing competence labs who can issue international certificates for exporting	Vietnam has 12 LED lamp standards at present
5	Marking	Mandatory label of energy saving for LED product from 1 January 2020		Decision No. 04/2017/QĐ-TTg
6	Market management	Issuing sanctions of strict resolution of announcement on labels, LED products quality circulated in market		

Output 1.2. Improved LED lighting standards that meet international norms

The project has assisted STAMEQ – MOST in development of TCVN standards for LED lamps and their components. The support included an assessment of existing LED lighting standards and of the capacity of selected testing laboratories in comparison with international standards and practices and recommendations for the development of three TCVN's, and proposals for monitoring of compliance by manufacturers with norms and standards. This has resulted in the following TCVN's issued by the Ministry of Science and Technology in December 2017:

- TCVN 11842:2017 (IES TM-21-11) - Projecting Long Term Lumen Maintenance of LED Packages;
- TCVN 11843:2017 (CIE S 025:2015) - Test Method for LED Lamps, LED Luminaires and LED Module

²⁴ Before, the predecessor VEEPL Project provided support for the formulation of a Road Map (Strategic Direction) on Viet Nam Urban Lighting Development up to 2025

- TCVN 11844:2017 - LED lamps - Energy Efficiency;

During 2018-2019, three additional national standards were drafted with technical support by the project: 1) LED-TCVN Standard on National Standard Energy Performance for LED Street Light, and 2) draft Vietnamese Lighting Technical Standards using LED technology in traffic works (streets, urban tunnels). These drafts have been submitted to MoST and MoC respectively for review and approval.

Output 1.3 Training workshops to strengthen LED lamp testing and enforcement regime

By bringing in international expertise and experience, the project has supported the assessment of training needs of laboratory personnel the local lighting testing laboratories Quatest, Ralaco, Dieng Quang (in terms of human resources, facility, testing equipment, testing methods, procedures/protocols, as well as quality assurance) and guidelines for improving the testing procedures to meet the requirement of the new National Standards (TCVNs; see Output 2.1).

A detailed proposal on strengthening Quatest-1’s LED lighting products testing capacity was completed and recommended to the Quality Assurance and Testing Center 1 (QUATEST1) and the Directorate for Standards, Metrology, and Quality (STAMEQ). As a result, the LED lighting products testing capacity of QUATEST -1 including infrastructure, new testing equipment, facility, testing staff, etc.) and protocols for LED lighting products for measuring of key parameters have been considerably improved.

Technical assistance to Ralaco and Dien Quang (to improve the design and production of various LED products and to reduce cost) was completed in 2018. In addition, the LED Vietnam project technical support to other companies such as Duhal, Dai Quang Phat, Trang An V.E.M, GEN, Vi-Light, Hung Phu Hai, University of Technology in Ho Chi Minh city and some others with technical training and related training materials, information and technical guidelines on applicable national and international standards of LED lamps, testing and certification & labeling program for their preparation for LED light products to be standardized and labelled.

Output 1.4 Labelled and certified LED lighting products

Another task has been the provision of technical assistance to the Ministry of Industry and Trade to develop and manage the labeling and certification program for LED lighting products available on the market. This included a review of national and international labeling and certification programs for performance lighting products; evaluation of the impact of such programs on LED lighting products in the countries in question; with recommendations for the labeling and certification program for LED lighting products in Vietnam with proposals for a) energy performance standards for LEDs for lighting in buildings, b) labels with specifications, and c) recommendations for the inspection, monitoring, and evaluation of the labelling programme. A roadmap for labelling of LEDs, including a communication and awareness plan for LED products was drafted with Project support, as well as two legal-type of documents, namely a) Decision on Promulgation of the Regulation on technical requirements for energy-saving LED lamp; and b) Regulation on “Technical requirements for LED lights for voluntary labeling”.

The EE Labeling & Certification roadmap (Decision 04/2017/QĐ-TTg on March 09, 2017) came effective in January 2018, as an initial voluntary phase (2018-2020). As a result, 16 types of LED lamps that consist of 72 LED light models were registered for labeling and more than 210 LED light models met the national standards. From January 2020 onwards, the MEPS and energy labelling will be mandatory, starting with self-ballasted LED bulbs and double-head LED tubes to be followed by other LED lighting products in the foreseeable future.



Box 16 Basics of LED lighting

In electronics, a diode is a component that restricts the direction of movement of charge carriers. Essentially, it allows an electric current to flow in one direction. A “light-emitting diode” is a semiconductor device that emits visible light of a certain color. Like a normal diode, the LED consists of a chip of semiconducting material impregnated or doped with impurities to create a p-n, (positive-negative) junction. Atoms in the n-type material have extra electrons, atoms in the p-type material have electron holes. Applying current, pushes the atoms toward the junction. When they get close, the n-type atoms ‘donate’ their extra electrons to the p-type atoms which ‘accept’ them. A negative charge to the n-side allows current to flow from the (-) charged area to the (+) charged area. When extra electrons in the n-type material fall into the holes in the p-type material, they release energy in the form of photons (light). The material in an LED is selected so that the wavelength of the photons falls within the visible portion of the spectrum. Different materials produce photons at different wavelengths (i.e. colour). LEDs can combine red, green and blue in a single device and create millions of colors by controlling the relative intensity of each color (additive’ RGB color mixing).

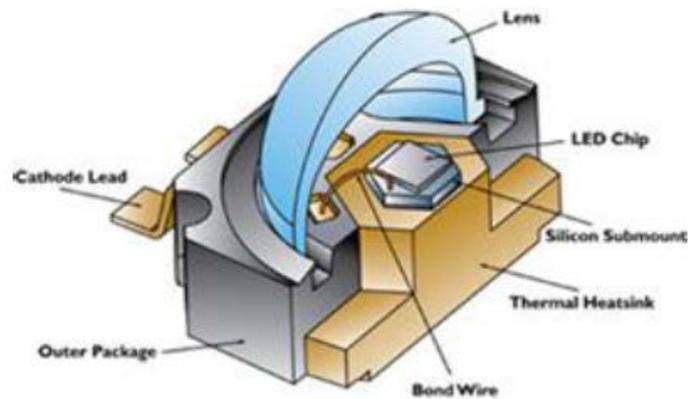
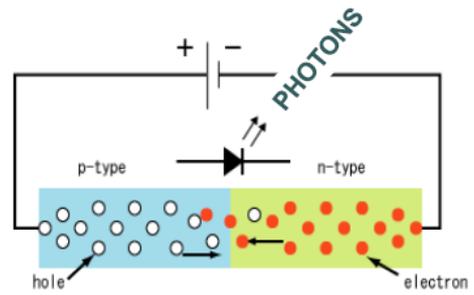
To be used for illumination, LEDs must be integrated into systems that incorporate optics (lens, reflector cups), contacts to apply power, drivers (i.e. microprocessor-based power management) and thermal management (consisting of a heat sink and vents). The light beam from an LED is cool, but because they are not perfectly efficient, a great deal of heat can be generated at the p-n junction. A well-designed heat sink and other thermal management features are critical. As the temperature increases, output and ‘lifetime’ of the LED decrease



Increasingly, well-designed luminaires integrate all these features into the fixture itself, erasing the distinction between lamp & luminaire. This has also consequences for testing. The specification most commonly used for evaluating and comparing the performance of ‘conventional’ lighting fixtures is lumen output. Luminaires and their lamps are tested separately. Lumens and chromaticity of lamps measured with an integrating sphere. Distribution and efficiency measured with a goniophotometer. The lamp lumen output serves as a reference and the lumen output of the fixture is measured relative to it.

LED fixtures and conventional fixtures are tested differently, hence some photometric data can be difficult to compare. Because LEDs are often inseparable from their fixtures, only fixture lumens measured, not lamp lumens. For a valid comparison, the measured lamp lumens of a conventional fixture must be reduced by its efficiency. Also, it should be noted that a fixture’s total lumen output does not account for wasted light. LED fixtures typically waste less light than conventional fixtures. Instead of lumen output, ‘useful light’ is the portion of a fixture’s output that is effectively delivered to the task area

Source: *Basics of LEDs*, J. Robbins et.al. (2012), Lighting Design Lab



Output 1.5 Updated building codes that includes the use of LED lighting products

Another UNDP-supported project has focussed on energy-efficiency building codes²⁵. Consequently, the Project has shifted attention to providing technical assistance to MoC's Technical Infrastructure Agency on the development of Viet Nam Standards on Lighting using LED Technologies for Transport Constructions (in streets and tunnels). The draft TVCN for road lighting and tunnel lighting with LED technology were submitted to MoC in 2018.

Output 1.6 Completed capacity building program to strengthen LED R&D facilities

The Project has carried out a training needs assessment and, based thereon, developed a training module that consisted of four modules: 1) Basics of LEDs, 2) Advanced core technologies for LED lighting products manufacturing, 3) Quality assurance of LED lighting products manufacturing, and 4) 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 people²⁶ 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

Box 17 Training and workshops organized and participation

No.	Name of training, workshop, event	Number of participants	Number of males	Number of females	% male	% female
1	Inception WS on 18/11/2015	61	36	25	59%	41%
2	Training Course on Basic and Advance LED Technologies for General Lighting, Hanoi from 28-30/3/2017	86	72	14	84%	16%
3	Training Course on Basic and Advance LED Technologies for General Lighting in HCM City from 23-25/5/2017	70	65	5	93%	7%
4	Workshop (WS) on LED Lighting Roadmap in Ba Vi on 14/6/2017	42	33	9	79%	21%
5	WS on National Standards and Labeling and Certification Program for LED Lighting in Hanoi on 24/8/2017	58	44	14	76%	24%
6	WS on Technical supports from Project UNDP/GEF to local LED Lighting industry in HCM City on 16/11/2017	51	47	7	92%	14%
7	WS on Technical supports from Project UNDP/GEF to local LED Lighting industry in Hanoi on 25/11/2017	54	40	14	74%	26%
8	WS on VN Standards on Lighting using LED Technologies for Transport Constructions in Hanoi on 16/3/2018	26	19	7	73%	27%
9	WS on LED Lighting Application in Urban Transport Construction in Hanoi on 28/8/2018	59	48	11	81%	19%
10	Training Course on Design, Installation, Operation, Maintenance and Management of LED Lighting Systems in Hanoi from 24-26/9/2018	69	58	11	84%	16%
11	WS on EE Labeling and Certification Pilot Scheme for LED Lighting Products in Hanoi on 27/9/2018	69	54	15	78%	22%
12	WS on EE Labeling and Certification Pilot Scheme for LED Lighting Products in Da Nang on 01/10/2018	57	51	6	89%	11%
13	WS on EE Labeling and Certification Pilot Scheme for LED Lighting Products in HCM city on 06/11/2018	73	63	10	86%	14%
14	Training Course on Design, Installation, Operation, Maintenance and Management of LED Lighting Systems in HCM City from 7-9/11/2018	91	83	8	91%	9%
15	Training Course on Solutions for Smart Lighting and Financial Investments for Viet Nam Urban Lighting in HCM City from 19-20/6/2019	105	91	14	87%	13%
	Total	971	804	170	83%	18%

Source: Based on data provided by the Project Management Unit

²⁵ Energy Efficiency Improvement in Commercial and High-Rise Residential Buildings in Viet Nam (implemented during 2016-2019)

²⁶ A survey was carried out with 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 (Consultant: Tran My Hanh)

lighting technology), to the impact of LED Lighting on energy saving, as well as on developing LED lighting technologies for export to markets in 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. An overview of training courses and workshops organised by the LED Vietnam Project is given in Box 19. In total, 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.

An online training (e-learning) facility on advanced LED technologies and applications in lighting (co-founded with HCMC University of Technology) is being developed and is about to be completed. 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.

Output 1.7 Engineering and construction designs for improved LED lighting production in Viet Nam

Technical assistance was provided through the 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 products.

Box 18 Examples of LED lighting products

Sample of Dien Quang LED products:



60W Equivalent Soft White A19 LED Light Bulb



LED Mica Lamp Set



DoubleWing Lamp Set



LED Desk Lamp

Sample of Ralaco LED products:



LED TR80N1
- 20 W, VND 146,000
- 30 W, VND 217,000
- 40 W, VND 267,000



LED A601N
- 7 W, VND 76,000
- 9 W, VND 81,000



BD LTO3 02
- 4 W, VND 106,000
- 8 W, VND 114,000
- 16 W, VND 159,000



BD T8L N02
- M11, 18 W, VND 188,000
- M21, 18 W, VND 168,000
- M11, 10 W, VND 143,000



LED panel DP06
- 40 W, VND 957,000



LED smart TR70
- 25 W, VND 214,000

Sources:

Rang Dong *Bang Gia* (2019). Prices are indicative only.
Viet Capital Securities, *Dien Quang Lighting Report* (2018)

For Ralaco, the project supported²⁷ 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. For Dien Quang, the project supported the further development and deployment of the software being developed for the design of LED Drivers²⁸, 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 a reduction in the use of packaging materials.

5.2.2 Outcome 2 *Increased use and deployment of locally-produced high quality LED lighting technologies*

Indicator with end-of-project target	Actual value or status of the indicator
Share of rural and urban households and commercial establishments that have purchased locally produced LED lamps <i>Target: 10% by end-of-project (EoP)</i>	Based on a survey carried out (of 100 urban households, 20 rural households, and 20 commercial establishments) combined with national statistics on the number of users (urban and rural households; commercial establishments) and the average market share of locally manufactured products in the Vietnamese LED market (which is 49%), the Project derived that the share is 37%
Annual number of sold LED lamps that are locally produced and certified LED lights in Viet Nam by EOP for the local lighting market <i>Target: 15 million by EoP (up from the baseline value of 1.3 million)</i>	The project directly contributed to sales of 40 million LED lamps out of 119 million LED lamps in the market (based on data provided by two companies (Ralaco and Dien Quang) whose sales have to better design and quality improvements that were realised with Project support
Market share of locally produced LED lamps in the Vietnamese lighting market. <i>Target: 7% by EoP</i>	Reportedly, the share of local products has increased to 49%.

Baseline

At the time of project conceptualisation, most LEDs in Viet Nam were sold to foreign companies based in Vietnam (e.g. hotels) and there was little awareness of the benefits of LED lamps amongst many Vietnamese-based businesses and consumers. Moreover, there was a perception that quality LED lamps were only imported (and costly), while locally produced LED lamps were of poor quality, resulting in a general lack of consumer confidence in LED lamps. Indeed, up to now there have been many LED lamp producers that sell their products on the Vietnamese market compromising on quality to compete with importers or local larger companies that manufacturing LEDs at better economies of scale. The impact of these compromises is the assembly of LED lamp components from different sources that are not properly engineered and fail to provide an improved service life over other traditional lighting devices. The lack of standards (MEPS) and labelling for energy consumption and service life has reduced consumer confidence in local LED lamp technology. The disparity of price between conventional lighting technologies and imported high quality LED lighting products, as well as relatively low energy prices, discourage the more widespread adoption for local use.

Achievements, demonstration projects

Output 2.1 Completed feasibility studies of indoor and outdoor LED lighting demonstrations

Output 2.2 Completed LED lighting application demonstrations

Output 2.3 Approved system for monitoring and evaluation of LED lighting systems

Component 2 has addressed barriers related to low public awareness about LED lighting product benefits, by means of 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.

²⁷ The total cost of a commercial licence for the ANSYS ICEPAK software is US\$85,000,

²⁸ To develop LED driver design simulation software which will automatically generate bill of materials (BOM) for prototype development and testing, instead of purchasing heat transfer analysis software.

This started with an assessment of the feasibility of several LED lighting demonstration projects. Thereafter, LED lamps were installed by two local companies (Ralaco and Dien Quang) and by Schredér Vietnam in 10 demonstration projects. A summary of demonstration projects is provided in [Box 19](#).

It should be noted that these have received co-financing from the above-mentioned LED manufacturers rather than the (public sector) building or street infrastructure building owners. This does raise questions on the financial sustainability of such projects in the public sector and how financial mechanisms could be in support of replication. The issue is discussed further in section 5.4 on 'sustainability'.

Achievements, awareness and dissemination

Output 2.4 Completed LED lighting product applications awareness raising program

Output 2.5 Completed workshops for disseminating lessons learned from LED lighting product application demonstrations

The Project has supported setting up a website at the Center for High Technology Development, VAST, with information on the LED Vietnam project (see <http://htd.vn/led-lighting-projects.html>). Furthermore, the Project was involved in a)

Box 19 Support provided to demonstration projects and role of consultants

Demonstration Project(s)	Output 2.1		Output 2.2 Implementation of the demonstration projects	Output 2.3 Evaluation and audit of LED Lighting demonstration
	Stage 1: Feasibility study and design	Stage 2: Assessment of the feasibility		
1. Indoor project (I-1): 967 LEDs Technology Incubation Building, VAST, . Cau Gia, Hanoi	Dien Quang (Co-financing Budget)	NAF consultant (Project Budget)	Dien Quang (Co-financing Budget)	NAD-I consultant Le Minh Phuong (Project Budget)
2. Indoor project (I-2): 251 LEDs Carton packaging and printing, Tran Thanh Co., Hanoi	Dien Quang (Co-financing Budget)			
3. Indoor project (I-3): 595 LEDs Le Ngoc Han Primary School, District 1, HCMC	NCSL consultant (Project Budget)			
4. Indoor project (I-5): 132 LEDs Replacement with LED tubes for 8 classrooms in 4 secondary schools in Hanoi	Ralaco (Project Budget)	Ralaco (Project Budget)	Ralaco (Co-financing Budget)	Ralaco (Project Budget)
5. Indoor project (I-4): 1,222 LEDs Sai Gon Tobacco Fiber Factory, Binh Chanh District, HCMC	Ralaco (Co-financing Budget)	NAF consultant (Project Budget)		Vietnam Schreder (Co-financing Budget)
6. Outdoor project (O-1): 1,276 LEDs Street lighting, Highway 22A, from HCMC to Moc Bai in Tay Ninh Prov.	NCDP consultant (Project Budget)			
7. Outdoor project (O-2): 60 LEDs Trinh Ba street lighting over 1.5 km, Can Gia Ward, Thai Nguyen	Vietnam Schreder (Co-financing Budget)			
8. Outdoor project (O-3): 40 LEDs 2.8 km of alley lane lighting, Group 22 and 29, Thai Nguyen city	Vietnam Schreder (Co-financing Budget)	Dien Quang (Project Budget)	Dien Quang (Co-financing Budget)	NAD-III consultant Nguyen Khanh Binh (Project Budget)
9. Outdoor project (O-4): 335 LEDs Industrial zone lighting, in LEDs Street in Eco Park in Hung Yen Prov	Vietnam Schreder (Co-financing Budget)			
10. Outdoor project (O-5): 50 LEDs Central Campus of HCMC University of Technology (smart outdoor lighting system)	Dien Quang (Project Budget)	Dien Quang (Project Budget)	Dien Quang (Co-financing Budget)	Dien Quang (Project Budget)

Source: Based on data provided by the Project Team; PIR 2019

Box 20 Visiting some demonstration projects



Le Ngoc Han primary school – Ho Chi Minh City



Quatest - Hanoi

discussions on the effective dissemination of consumer information on LED lamp benefits that may include roles for ESCOs and service providers who are involved with LED lighting system installations; b) design of consumer messaging on LED lamp benefits that will include user benefits (i.e. reduced electricity bills, improved lighting quality, reduced power outages), national benefits (reduced dependence on imported fossil fuels) and global benefits (reduced GHG emissions and reduced risk of severe climate change); and c) preparation of updated public awareness messages including websites, TV and radio spots and newspapers to promote and replicate LED lamp uptake.

5.3 Progress towards the objective

5.3.1 Gender and capacity building

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. From Box 17 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.

5.3.2 Objective and GHG emission reduction

- Impact: how did the project contribute to GHG emissions reduction within the project implementation cycle and beyond?

The table in Box 20 provides an overview of progress against the indicators reported in the project's results framework and a subsequent PIRs.

For Component 2, the 10 demonstration projects saw the installation of 4,830 indoor and outdoor LED lamps (roughly 400 units higher than the target) and with the total wattage of the LED lights also higher than the target. The direct emission reduction is estimated (over a 10-year cumulative period) as 6,426 tons of CO₂ due to the energy savings

(cumulative) of 7,430 MWh, as explained in more detail in Box 22). The pilot deployment of LED lamps in those demonstration has proven the merit of quality of certified and standardized LED lamp produced by local companies.

Box 21 Development progress (objective and indicators)

<p>Project objective: Mitigation of GHG emissions through the transformation of the lighting market towards greater usage of locally-produced LED lighting products in Viet Nam</p>	<p>Indicators:</p> <ol style="list-style-type: none"> 1) Cumulative direct (at end-of-project, EoP) and indirect CO2 emission reductions <i>Target:</i> 623 tonnes of CO₂ (from direct investment and generate during project period), and 69,382 tonnes of CO₂ (post-project direct, cumulative 10 yrs after EoP + lamps installed after EoP) 2) Cumulative direct and indirect energy saving (MWh) by EoP <i>Target:</i> 1,000 MW direct savings (of which 705 MWh from indoor and 293 MW from outdoor savings and indirect savings of 3,000 MWh (assuming a replication factor of 3) 3) Share of% urban households and commercial establishments with reduced electricity bills from the use of LED lamps by EoP <i>Target:</i> 5% 	<p>Realisation (by mid-2019), as reported in PIR</p> <ol style="list-style-type: none"> 1) Direct: 6,426 tCO₂ (assuming 10 yr lifetime), Indirect: 130,197 MWh (indirect, top-down) 2) Direct: 7,430 MWh; indirect: 150,534 MWh (top-down) <p>[Note on the indirect impact: The LED market size grew very fast, much faster than predicted (up to 50% from 2017 to 2019), it is assumed that the LED project has a 40% causality factor for indirect impact of the project].</p>
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For the purpose of estimating greenhouse gas emission reduction, a study was carried out on the LED lighting market, based on a) Survey data on production and supply of LED lamps to domestic market from local enterprises; b) Survey data on 100 households in urban and suburban areas, 20 households in rural areas and 10 office centres and public buildings, industrial factories and public lighting companies; c) seven industrial factories, d) five public lighting companies, as well as e) 50 lighting products shops. The data obtained were combined with the results of the demonstration projects (Component 2). A summary of recent sales data is given in Box 21.

Based on market projection of 262 million LEDs sold by 2028 (as estimated by the consultant Le Nho Hoan, the indirect GHG emission reduction can be estimated. In reality, only part of the indirect impact should be attributed to the LED Vietnam project (resulting from the post-project influence of its capacity building and awareness creation). Applying a ‘coincidence factor’ of 40%, gives an amount of 105 million LEDs in 2028 with cumulative GHG emission reduction of 130,197 kiloton of CO₂ (and energy savings of 150,534 GWh). The indirect on energy saving and emission reduction of the lighting sector of the Project are visualised in Box 22.

Box 22 Energy savings and CO₂ emission reduction estimates

The direct greenhouse gas (GHG) emission reduction calculation is based on the 11 demonstration projects (see Box 18):

No	Demo Project	Replaced Quantity	Replaced Capacity (W)	Replacing Quantity (LED)	Replacing Capacity (W)	Saved Energy per Year
1	Sai Gon Tabaco Company (1,222 36W LED replace 1,188 40W TL)	1,188	47,520	1,122	40,392	21,384
2	Tran Thanh Company (in Ha Noi) (43 120W LED replace 120 80W CFL)	129	10,320	43	5,160	24,768
3	Tran Thanh Company (in Bac Ninh) (208 120W LED replace 624 80 W CFL)	624	49,920	208	24,960	119,808
4	Ecopark residential area (335 21-96W LED replace 335 58-192W HID)	335	28,189	335	15,862	53,253
5	Trinh Ba Street - Thai Nguyen City (42 120W LED replace 54 175W HPS)	54	9,450	42	5,040	17,464
6	National Road 22 (1,276 120-193W LED replace 1,276 200-325W HID)	1,276	295,075	1,276	207,131	379,918
7	Unit 22 & 28, Cam Gia Ward, Thai Nguyen City (60 30W LED replace 100 40W CFL)	100	4,000	60	1,800	8,712
8	Technology Incubation Building of VAST (967 9-18W LED replace 1,038 20-40W CFL)	1,038	29,095	967	12,000	53,335
9	Le Ngoc Han Primary School (595 9-18W LED replace 654 20-40W CFL)	654	18,332	595	7,652	39,986
10	Secondary schools in Tay Ho and Thanh Oai District , Hanoi (132 20W LED replace 119 33W TL)	119	33	132	20	4,979
11	HCMC University of Tech., Viet Nam Nat'l University HCMC (50 60W LED replace 50 250 W HPV)	50	250	50	160	19,440
Total		5,567	492,184	4,830	320,177	743,046
Total saved energy in 10 years (kWh):						7,430,462
Total reduced CO₂ in 10 year (ton CO₂):						6,426.61

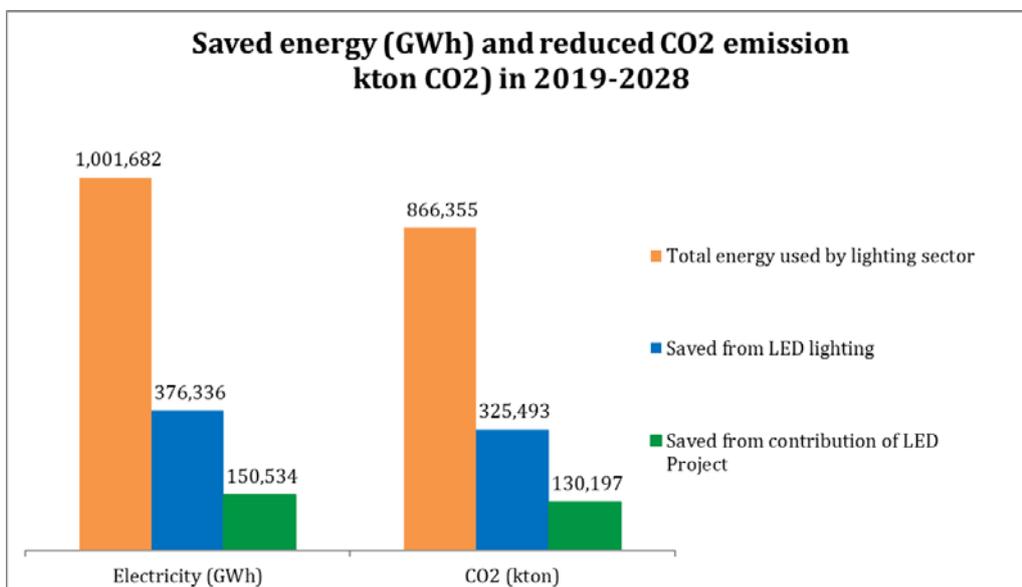
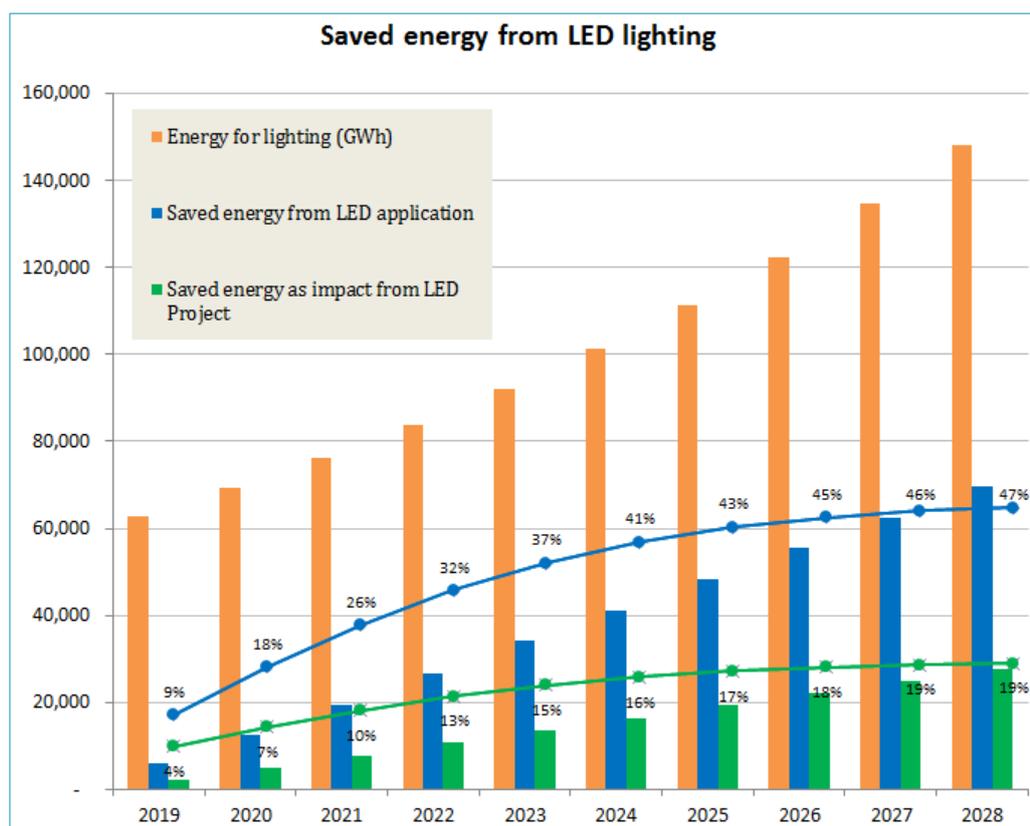
Indirect impacts (also termed 'consequential GHG emission reduction') reflect the overall impact of the Project on the whole lighting sector. They are measured under a range in which the lower end is calculated following the bottom-up method and the upper end is calculated following the top-down method. In the top-down method the market development

Year	Quantity of LED lamps sold to local market	Annual saved energy (GWh)	Cumulative saved energy (GWh)	Annual reduced emission (kton CO ₂)	Cumulative reduced emission (kton CO ₂)
2019	119,302,055	2,370.16	2,370.16	2,049.95	2,049.95
2020	141,200,193	5,011.84	7,382.00	4,334.74	6,384.69
2021	163,101,494	7,835.86	15,217.86	6,777.23	13,161.92
2022	180,571,144	10,733.63	25,951.49	9,283.52	22,445.44
2023	195,096,812	13,637.77	39,589.25	11,795.30	34,240.75
2024	208,016,311	16,514.88	56,104.14	14,283.72	48,524.47
2025	220,774,402	19,364.39	75,468.53	16,748.26	65,272.73
2026	233,824,373	22,195.00	97,663.53	19,196.46	84,469.19
2027	247,399,960	25,019.32	122,682.85	21,639.21	106,108.40
2028	261,638,379	27,851.49	150,534.35	24,088.76	130,197.16
Total		150,534.35		130,197.16	

Source:

Completion Report of the Assignment on Data Processing & Analysis and MRV Tool Update (2019), by Le Nho Hoan

Box 23 Indirect impacts of the Project: saved energy and avoided GHG emission



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.

Source: Completion Report of the Assignment on Data Processing & Analysis and MRV Tool Update (2019), by Le Nho Hoan

5.4 Sustainability and replication

- To what extent are there financial, institutional, social-economic, and/or environmental risks to sustaining long-term project results? How sustainable (or likely to be sustainable) are the outputs and outcomes? Is there an exit strategy that is well planned? What could be done to strengthen exit strategies and ensure sustainability of interventions?
- To what extent will the stakeholders sustain the project?
- What impact has the project had on policy, legal and institutional frameworks ?

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 (discussed in detail in Section 4.1.1). 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 (mentioned in Section 6.1) is determined by the mitigation response of Project management to these external and internal risk factors as these manifest themselves more intensely and/or more frequently than expected.

In assessing the ‘sustainability’ of the Project, a simple rating scheme is used:

- 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.

Four main areas are considered in this section and then rated as to the likelihood and extent that risks will impede sustainability.

Socio-economic sustainability (likely)

As explained in Chapter 2, 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 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. Lower-income households may not benefit at first from LED lighting in comparison with higher-income sectors²⁹. However, the continuing trend of price drops will continue, so over time LEDs will be cheaper than CFLs (compact fluorescent lamps) and then also be preferred by lower-income households as well as public sector entities. Hence, the Evaluation gives a ‘likely’ rating.

Governance and institutional sustainability (likely)

Under the VNEEP umbrella, the Government has shown a 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

²⁹ Some countries (or regions) have used subsidy or rebate programmes in the past to incentivize the use of efficient lighting, such as CFL rebate programmes in the past.

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 manufacturers³⁰. 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 (moderately 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](#)) and have the financial muscle to investment, hence from this point of view financial sustainability is 'likely'. Most of these smaller enterprises assemble LED products with imported components, mainly using imported LED product assembly and packaging equipment, that is low in price but does not always deliver good quality LEDs. 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. the government's SME support scheme) will help innovative smaller LED companies improve their production lines and quality management system while shifting the range of products from LED equipment to offering model lighting solutions³¹.

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). However, as prices of LEDs continue to drop (both in relative and absolute terms), the market share of LEDs is likely to rise.

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 organized and operated more according to market-based mechanisms (see [Box 24](#)). The before-mentioned cities, Hanoi, HCMC and Halong city will 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. In this respect, financial sustainability is 'moderately unlikely'

The overall conclusion is that financial sustainability is 'moderately likely'.

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.

³⁰ There might be a small risk that the LED market grows so rapidly that the testing and investigating agencies will be overburdened, and as a result be temporarily unable to enforce the standards. However, this is difficult to predict at this stage and dependent (apart from market volume) on how many companies and products will be on the market.

³¹ The issue can arise that most (if not all) of smaller companies will not be able to compete will this result in an oligopoly of two or three local producers? The Team observes that in this case the local companies would still face stiff competition from foreign producers (e.g. China) so these oligopolists would still need to adjust prices in accordance with international prices

Box 24 Public sector financing and the role of ESCOs

Public lighting is currently in the hands of state-owned enterprises, public entities or municipalities. Their investment basically comes from Government budget. These institutions are allocated by the responsible decision-making body (e.g. People's Committee). Procedures for getting government budget can be complicated and time-consuming, but the money is ensured and creates no risks for the public entity. This system works against energy-efficient (EE) investments, because of the disconnect between the investment decision and savings. Public procurement systems traditionally resist purchasing goods with a higher capital cost even if these, being more energy-efficient have lower life-cycle costs. Within the public institution, different departments are responsible for the capital budgets and operating budgets that are thus treated separately. Saving in operating costs through efficiency interventions does not automatically link with increased capital budget.

Hanoi, HCMC, Ha Long People's Committee and few other local governments have approved the policy for implementation of energy savings during 2016-2020, and have investment programmes to renovate, replace the existing public lighting systems (HPS, MH) by LED lamps during this period. However, these are among the wealthiest of the Vietnamese cities and are not exemplary for most of the Vietnamese municipalities in the smaller or rural municipalities. There, the lighting companies may not be able to raise enough funds from the state or other budget sources or there may not be a separate public lighting company (with public lighting part of the national public utility).

Linkages between the commercial financing institutions and public lighting agencies are lacking. The latter prefer government budget, not commercial loans and credits. On the other side, banks and credit institutions prefer to give loans to "really-doing-business companies" and do not consider lighting companies as commercial companies. Another element is the level of investment; most public lighting projects are small in scale and are considered 'light-weight' by the big national banks. 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. This is a special service provider that combines the procurement of goods, project installation capability and post-installation service. ESCOs work on 'energy performance contracting (EPC)' basis, which provides energy savings measured in comparison with a previous energy cost baseline and in which the ESCO's remuneration depends on the respective outputs of the services provided. In principle, customers can have off-balance financing that will pay for the project through energy savings. A major advantage is that customers can fund the project over time and can do so with very little or no discretionary budgets and at relatively low risk:

- In the guaranteed savings (or performance guarantee) modality, the client makes the investment (from his own funds or the banks, or leasing) but the ESCO provides a guarantee for the energy savings realised. Based on end-user or third-party financing, this model has the advantage that interest rates are usually much lower and therefore more energy efficiency investment is possible. At the same time, the risk for the end-client is reduced by transferring to the ESCO the responsibility that the project will perform correctly;
- In the shared savings modality, the ESCO guarantees the performance of the installation and invests or provides financing, and recoups this through the contracting fee, i.e. the cost savings (due to reduced energy consumption and maintenance) are shared by the ESCO and the client at a pre-determined percentage for a fixed number of years. Thus, the ESCO guarantees a certain level of cost savings to the customer, assuming both the performance and the credit risk. Maintenance of the facilities is also typically included in the scope of the ESCO.

There are about 50 ESCO players in Viet Nam that mainly have performed EPC contracts in industry (e.g. milk, paper, food, textile) and hotels. However, most ESCOs are small, operate in a nascent market (with relatively low trading volumes) and lack suitable financial products (due to lack of attention by financial institutions that consider the ESCO business as too risky).

Source: Terms of Reference, *Study and Development of Financial Investment Schemes for wide-scale implementation of LED Projects* (2019), LED Vietnam Project; *Final Evaluation, Vietnam Energy Efficiency Public Lighting (VEEPL)*, 2019; *Vietnam ESCO Market, Opportunities and Challenges*, PowerPoint, by Duong Trung Kien (2019)

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. LEDs can also benefit from the same

lamp recycling programmes (and of other electronic products) that have been established for CFL recycling in the past. Packaging needs are the same as that of other products.

Replication and scaling up

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 2024³². 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. It should be noted that the two players, Rang Dong and Ralaco, (can) produce for export markets (and can adjust according to standards applicable in these markets). Their technology is pretty much advanced and experience shows these can be acquired by larger companies (with the Project helped them to put on track).

5.5 Ratings of progress towards results and sustainability

Box 25 Evaluation ratings of progress towards results and sustainability

Evaluation item	Rating	Comment / correspondence with sections in the report
Relevance	R	See rating in Section 3.1
Efficiency	S	See rating in Section 4.4
Effectiveness:	S	Chapter 5 (progress towards results)
• Outcome 1	S	Section 5.2.1. The project has supported successfully government entities with setting up a (mandatory) standards and labelling system for LED products, including test lab capacity enhancement. Private sector (LED manufacturers) and other stakeholder have been provided with technical assistance to improve LED production and application.
• Outcome 2	S	Section 5.2.2 The project has successfully supported demonstration of lighting applications in larger cities, although it remains unclear if public sector in smaller/rural cities with less budget can replicate in the same way.
• Attainment of the objective	S	Section 5.3. Given the fast LED lighting market development, the objective (number of LEDs sold and the associated energy savings and GHG emission reduction) is met almost by default.
Overall project outcome	HS	Overall project outcome rating,
Financial	ML	LED lighting will witness a higher penetration in the Vietnamese market, which is line with the global trend towards higher-quality, more diverse, and lower-priced products. The TE team believes that this transition is likely to happen first in commercial and higher-income urban household sector with low-income and rural municipalities lagging.
Socio-economic	L	
Institutional	L	
Environmental	L	
Likelihood of sustainability	ML	

- (HS) Highly Satisfactory: Project is on track to exceed its end-of-project targets, and is likely to achieve transformational change by project closure. The project can be presented as 'outstanding practice'; (S) Satisfactory: Project is on track to fully achieve its end-of-project targets by project closure. The project can be presented as 'good practice'; (MS) Moderately Satisfactory: Project is on track to achieve its end-of-project targets by project closure with minor shortcomings only; (MU) Moderately Unsatisfactory: Project is off track and is expected to partially achieve its end-of-project targets by project closure with significant shortcomings. Project results might be fully achieved by project closure if adaptive management is undertaken immediately; (U) Unsatisfactory: Project is off track and is not expected to achieve its end-of-project targets by project closure. Project results might be partially achieved by project closure if major adaptive management is undertaken immediately.

³² Vietnam LED Market: Industry Trends, Share, Size, Growth, Opportunity and Forecast 2019-2024 (IMARC, 2019)

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 General conclusions

The UNDP/GEF Project “Local Development and Promotion of LED Technologies for Advanced General Lighting in Viet Nam”, referred to in this report as “LED Vietnam” project consists of two Components:

- Transfer of skills, knowledge, and technology in support of local LED lamp manufacturing;
- Demonstration of cost-effective local commercial production of LED lighting devices.

The first component has concentrated on knowledge and technical capacity building among lighting manufacturers. While the project has been working intensively with two producers throughout the project implementation (Ralaco and Dien Quang), over the past year training and workshops focused on other companies such as Duhal, Dai Quang Phat, Trang An V.E.M, GEN, Vi-Light, Hung Phu Hai and the University of Technology in Ho Chi Minh city.

It should also be mentioned that the Project supported the HCMC University of Technology with the development of an online training (e-learning) facility on advanced LED technologies and applications in lighting; an activity which was not initially in the project document. This facility will continue after the Project’s end and is deemed highly relevant in terms of project sustainability (continuing capacity development).

Other activities of Component 1 have focused on developing supportive policy and regulatory measures to improve the quality and to promote the utilisation of LED lamp technologies; standardization and labeling of LED lighting products now covers 16 LED light types (including 9 for indoor and 7 for outdoor) covering about 210 LED light models. After an initial voluntary phase (2018-2019), the LED standards and labelling will move to a mandatory regime starting in January 2020. This will give an important signal for local LED manufacturers and suppliers on the quality and energy performance of LED lighting products for the Vietnamese market. Also, the Project supported the development standards for LED technology in transportation infrastructure (streets, urban tunnels).

The second component has focused on the demonstration of cost-effective local production of LED lighting devices. The project realized 10 demonstration projects, 5 for indoor lighting and 5 for outdoor lighting, thereby further contributing to direct energy savings and emission reductions.

In terms of local production and sales of LED lighting products, the project exceeded its targets, which is commendable. However, in this respect, the project has benefitted from the overall global and local market development of LED lighting products which has shown to have quickly matured over the past few years and has become an affordable technology. Thus, while overall circumstances for promotion of LED lighting were very favourable for the Project’s results, the Terminal Evaluation Team has the opinion that the project indeed had a trigger effect that helped the project to serve as a catalyst in realizing substantial changes in the lighting market in Vietnam over a relatively short time frame, in particular with respect to the quality improvements in the production (and sales) of LED lighting products that comply with (mandatory) national (and international) standards.

Being a medium-sized (MSP), the LED Vietnam Project consists of only two 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. The Evaluation Team notes, however, that one 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. Being an MSP and with a limited budget size, the MSP did not include a specific component for financial issues. It should be noted, however, that the Project has commissioned a study on “financial investment schemes for the wide-scale implementation of LED projects for public lighting”, which is currently being carried out.

The project's activities are being finalised and about 90% of the GEF budget has been utilised (see [Box 13](#)). The remaining of the budget used in Q4-2019 and Q1 2020 to cover the costs of remaining activities (such as the study on financial investment schemes, terminal evaluation, communication). A Completion Workshop will be organised in December 2019.

The rating in the last Project Implementation Review (PIR) 2019, carried out by mid-2019, gives the rating of 'satisfactory' or implementation/execution and development results (project outcomes). Given the findings presented in this Terminal Evaluation Report, the Evaluators concur with this rating and judge the project to be **satisfactorily implemented with satisfactory results**.

6.2 Recommendations

Government/stakeholders

LED production and SMEs

There are about 200 companies involved in LED product manufacturing in Vietnam. Apart from a few big local and international players, many of these are small and medium-sized companies (SMEs). In general, SMEs encounter difficulties in accessing credit and financing, in dealing with market downturns, in recruiting skilled workers, in competition with larger and foreign firms, finding business partners and in meeting regulatory changes. In order to remain competitive on the local market, or even when considering entering the export market, these will need to expand and modernize their production line and upgrade their range of products from lamps and fixtures to more integrated and smart lighting solutions.

For that, they will need access to credit. Banks providing commercial loans prefer to allocate their resources to larger firms rather than SMEs. Higher default risks, lack of financial transparency, and lack of assets for a mortgage are the major factors for not providing loans to SMEs. The government introduced Law 04/2017/QH14 - Support for Small- and Medium-sized Enterprises (SME Law) in 2018, establishing support measures for SMEs with incentives and credit access³³. It may be useful for the Vietnam Lighting Associations (VLA) and MoIT to analyse how smaller LED companies can take advantage of the incentives offered under the SME Law, whether these are enough and if additional incentives are needed for small LED companies upgrade their production line and with high-quality and intelligent lighting systems.

Regarding the public sector, 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. One recommendation the preceding VEEPL project evaluation was "that further capacity building would be needed for public sector decision-makers and for financial institutions and banks on options and issues in EE project financing, leveraging commercial finance, and on options in performance contracting and ESCO business models in public sector energy efficiency". Hence, in future 'efficient lighting' issue, it may be useful to address the issue of 'more widespread LED dissemination' not only from a technology angle (which has been VAST's expertise) but also the financial angle (e.g. by teaming up with a local financial consultant).

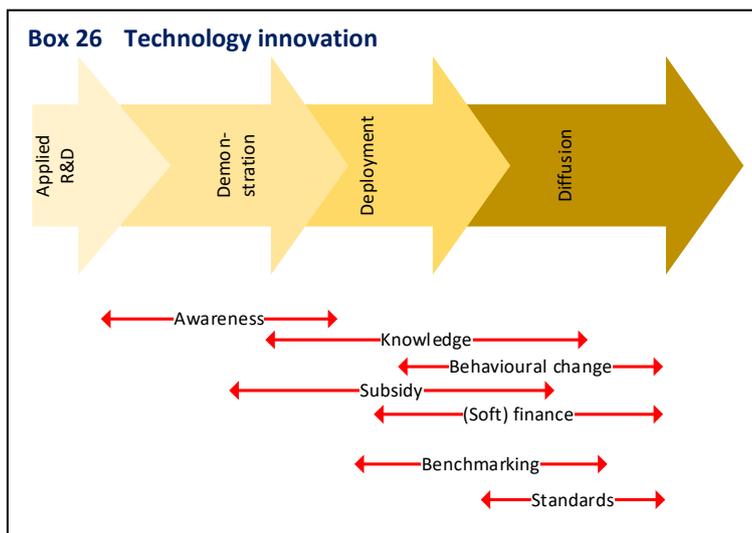
Vietnam Lighting Association

The market of LED lighting has developed rapidly over the past decade in terms of market volume, production methods and LED technology applications. The Evaluation Team suggest that VLA is supported in strengthening contacts and cooperation with national and regional lighting associations in the Asian region, in Europe and North America to stay abreast of the latest technology, manufacturing and product application developments.

Demand stimulation in public sector and residential sector

The public sector procurement system works against energy-efficient (EE) investments. There exists a disconnect between investment decisions and savings. Given limitations in public budgets, procurement criteria often favours

³³ Key incentives include tax support (SMEs will be entitled to a lower tax rate than the standard rate for a finite period), accounting procedures (SMEs can opt for a simpler accounting system as per accounting regulations), and access to credit (SMEs can get access to credit guarantees through the SME Development Fund and SME Credit Guarantee Funds);



purchasing goods that have the lowest capital cost over goods that have more (energy-)efficient but have a higher initial investment (even when lifecycle costs are lower). This poses a challenge to the implementation of LED lighting in street lighting and in public buildings. 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. It is recommended to MoIT makes an action plan for the design and implementation of appropriate financing modalities for public lighting. However, local government finances tend to be tightly controlled by the higher (national) level and performance contracting through the ESCO

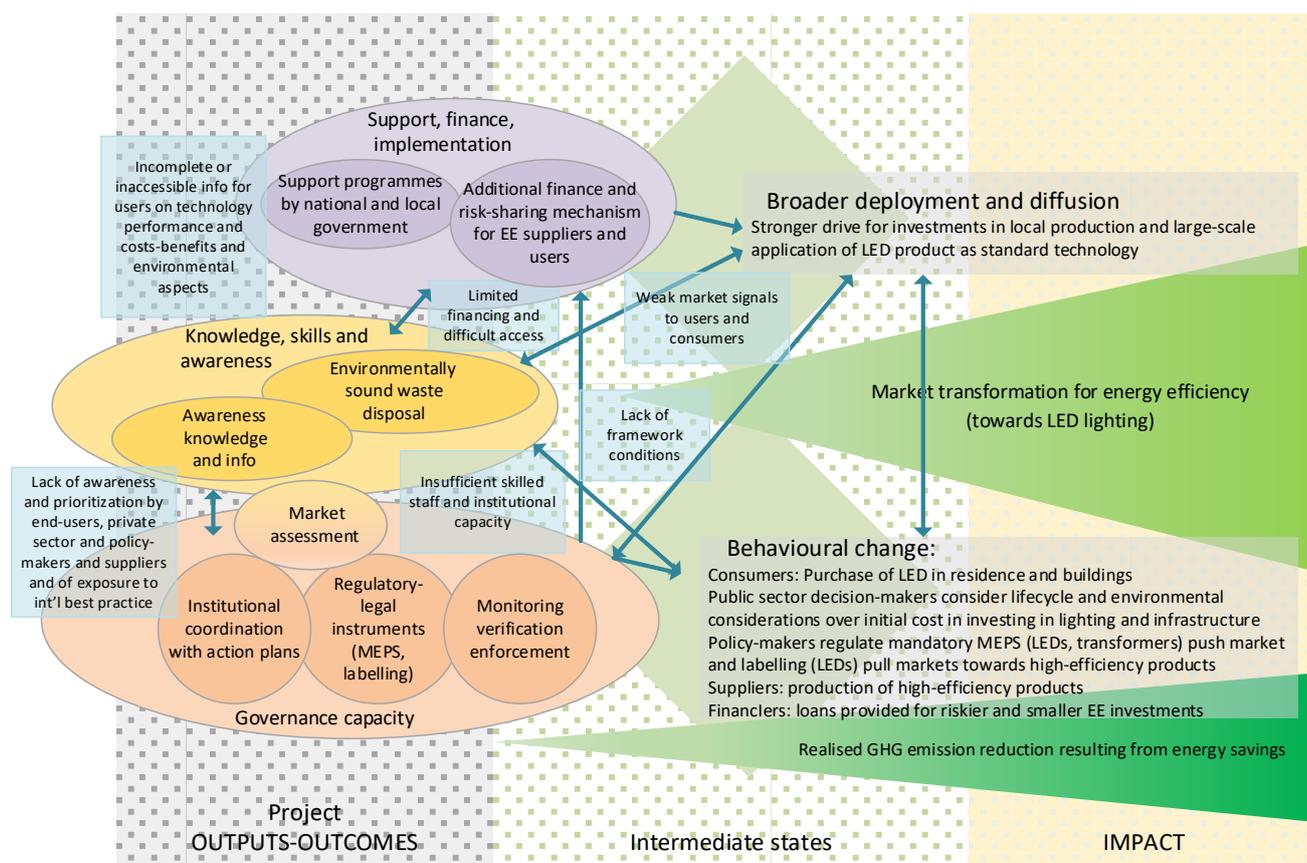
model does not fit easily with standard procurement procedures in Vietnam (e.g., raising issues around asset ownership; separation in responsibilities for investment and operations), increased by relatively long payback periods and lack of established precedent. The issue goes beyond lighting as such but covers the procurement of energy-efficient and environmentally sound products and equipment in general. Currently, both UNDP and ADB have commissioned (in parallel and in cooperation) studies on ESCO and other finance modalities. Sustainable energy financing in the public sector meets barriers and issues that should be addressed in a context wider of more market-based financing that goes beyond the topic of efficient lighting only. VAST's core competence as a science and technology institution Hence, in future 'efficient lighting' issue, it may be useful to address the issue of 'more widespread LED dissemination' not only from a technology angle (which has been VAST's expertise) but also the financial angle (e.g. by teaming up with a local financial institutions).

The LED Vietnam project has done in a small survey on the LED lighting market. While giving valuable information on the LED lighting market, due to budget constraints it has also been limited in scope. The sample has been limited in size and geographically coverage. Also, it does not differentiate between socioeconomic (income) groups. It can be

Box 27 Lighting demand and supply survey topics

- A. Criteria, scope, methodology, sampling
- B. Lighting product demand and energy consumption
 - Consumer profiles (socio-economic and geographical), type
 - Purchase decision-maker (gender-sensitive); attitudes, preferences and frequency in lighting product purchase; knowledge on prices, lifetime and energy consumption; perception of quality of electricity supply and lighting; quality of street lighting; average use per day of lighting
 - Number of lighting points; type, brand and wattage of lamps; sales outlets
 - Aggregate data on stock (installed lamps and lighting points) per type and wattage (bulbs, tubes, street lighting, outdoor lighting, other), annual demand, energy consumption
- B1. Residential sector (low/middle/higher income; urban/suburban/rural)
- B2. Public buildings (offices, schools, hospitals, etc.) and street lighting
- B3. Commercial-industrial buildings
- C. Historical demand LED and other lighting products and forecast
 - Imports and local production; supplier analysis
 - Manufacturing process of LED products in Vietnam
- D. Capacity building and awareness raising needs
- E. Cost analysis, price projections; comparison of LED with conventional lighting technologies
- F. Projections of (LED) lighting products market development;
 - Scenarios and substitution potential
 - Energy savings, GHG emission reduction and peak load demand reduction

Box 28 Dynamic model of barriers, outcomes and impacts in LED lighting market transformation



Source: J.H.A. van den Akker (2018/2019)

suspected that there are large differences in attitude and knowledge on efficient lighting products between the various consumer groups in terms of purchasing power.

The LED lighting market is now at a point somewhere between “deployment” and large-scale “diffusion” (see Box 25). As an information tool to tailor policy instruments (for government entities) and product design (for LED suppliers) in this transition from ‘deployment’ to ‘diffusion’, the TE Team suggest that a government entity commissions a more comprehensive demand and supply survey, covering topics as summarized in Box 27.

Creating a standards and labeling programme (EE S&L) is a dynamic process. Over time the population of appliances will change and the energy consumption levels of the label categorized would have to be re-defined, while the MEPS could be stricter. This requires constant monitoring and evaluation of the standards and labelling system. Having accurate market information will be needed to redefine the standards and labelling categories (in future revisions) according to change range of products available on the market.

Project

The Evaluation Team suggests that the results and materials of the Project are disseminated widely, by means of making summary technical reports available on the VAST-CHTD ‘lighting’ webpage, mailing lists and making available materials at the Completion Workshop. It should also be investigated how this webpage can be maintained in the post-project future, e.g. in cooperation with the Vietnam Lighting Association.

6.3 Lessons learnt

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

- Having an effective policy-regulatory framework is an important condition to achieve a market shift 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 that include project outputs, short- to medium-term outcomes, and global environmental and development impacts. One such development impact is market transformation. Having evaluated many UNDP/GEF project, the international evaluators observe that sometimes there is a tendency to measure the higher-level outcomes or impacts only. While project outputs are under the direct influence of the project, project outcomes are influenced more by external factors. The higher the level of results, the less the influence of project actions. In the case of the LED Vietnam Project, the indicators chosen at quite a 'high' level, indicating LED market development in general (indirectly influenced by the Project) but tell little on the project's direct results. A hierarchy of such indicators (distinguishing between objective, outcome and output level). An example of such a hierarchy for LED/lighting products is given below in Box 29. It should be noted that in a typical project a limited number of these indicators will be used. For later progress reporting most relevant key indicators should be chosen keep the number manageable between 10 or 20, depending on the size and scope of the project.
- The Evaluation team suggests that in UNDP/GEF project formulation progress indicators in the project results framework (logframe) should be a mix of outcome/objective indicators and more output-level indications to be able to measure the (direct and indirect) project results. Since many GEF climate change mitigation projects have similar outcomes and outputs, the Team wonders if UNDP cannot provide some guidelines with some base or model indicators, rather than having to invent the wheel of indicators again, each time a project document is formulated. Of course, the set will differ per country (status), expected outcomes and topics covered, and energy subsector involved (energy efficiency appliances, energy efficiency in industry, on-grid renewable energy, off-grid renewable energy, energy technology innovation), but often projects have a similar cluster of activities (such as policy and regulations; technology and demonstration, financing and incentives, awareness creation).

Box 29 Examples of objective, outcome and output indicators for LED/lighting projects

RESULT	INDICATOR
Objective	Indicator
<ul style="list-style-type: none"> • Direct GHG emission reduction 	<ul style="list-style-type: none"> • Avoided GHG emission reduction (direct – related to demo projects or to increased sales on the market above baseline) • Avoided consequential GHG emission reduction (post-project)
<ul style="list-style-type: none"> • Energy savings 	<ul style="list-style-type: none"> • Energy savings (direct – related to demo projects or to increased sales on the market above baseline)
Goal	
<ul style="list-style-type: none"> • Market development 	<ul style="list-style-type: none"> • Number of (locally) produced LED lamps • Market share of LED lamps in lighting • Share of locally produced lamps • Share of LED lamps in various sectors (household, public, commercial) • Market price and lifecycle cost
Outcomes and outputs	
Outcome:	<ul style="list-style-type: none"> • Status of policy document (strategy, roadmap, action plan)

RESULT	INDICATOR
<i>Policy and regulatory</i>	<ul style="list-style-type: none"> • Status of regulatory system: LED and lighting standards and labelling (products and type; regulations on EE in buildings) • Status of MRV system (verification, certification) • Status of testing labs (number, accreditation status) • Government budget made available to support investment, promotion, R&D, MRV; existence of incentives
<ul style="list-style-type: none"> • Market and info 	<ul style="list-style-type: none"> • Completed market studies • Status of information system with market data, products, etc.
<ul style="list-style-type: none"> • Policy development 	<ul style="list-style-type: none"> • Number of relevant policy and planning documents formulated (policy, strategy, action plan, roadmap,) • Integration in local development plans • Existence of capacity assessment • Number of capacity building events (workshops, seminar6, study tour) with number of participants trained
<ul style="list-style-type: none"> • MEPS and labels; building codes 	<ul style="list-style-type: none"> • Number of norms developed/proposed and number/type of products covered
<ul style="list-style-type: none"> • MRV strengthening 	<ul style="list-style-type: none"> • Existence of capacity assessment • Number of labs supported with technical assistance (TA) • Number of capacity building events and level of participation
<i>Outcome: Technology</i>	<ul style="list-style-type: none"> • Number of manufacturing plants that can produce/assemble/import products (that meet quality standards) • Sales volume of plants
<ul style="list-style-type: none"> • Technology development 	<ul style="list-style-type: none"> • Number of manufacturing plants supported with TA • Number of designs/production lines upgraded • Existence of capacity assessment • Number of capacity building events on application of LEDs and lighting products with # of participants • Number and type of technical materials (guidebooks, manuals, etc.)
<ul style="list-style-type: none"> • Demonstration 	<ul style="list-style-type: none"> • Number of demonstration projects with investment and number/type/size of LED installed • Number of feasibility/design studies carried out
<i>Outcome: Financing mechanisms and availability and business services</i>	<ul style="list-style-type: none"> • Status and type of financing (for end-users; for public sector; for manufacturers) • Amount of funding provided • Existence and operational status of ESCOs
<ul style="list-style-type: none"> • Public sector projects 	<ul style="list-style-type: none"> • Number of proposals developed; feasibility assessments carried out • Number of projects and/or companies supported • Volume of financing and investment • Number of workshops and training events with participation
<ul style="list-style-type: none"> • End-users 	<ul style="list-style-type: none"> • Number and types of schemes aimed at groups of end-users (e.g. rebate, pay-on-power-bill, etc.); volume (numbers, financing)
<i>Outcome - awareness</i>	<ul style="list-style-type: none"> • Level of awareness and knowledge of end-users (households, public sector, commercial, other) • Level of awareness of retailers
<ul style="list-style-type: none"> • Campaigning and marketing 	<ul style="list-style-type: none"> • Number/type of promotional materials elaborated and distributed • Number type of mass media events • Number and type of promotional events (fairs, workshops, roadshows)

ANNEX A. TERMS OF REFERENCE (TOR)

The Project was implemented over a 4-year period and promoted and enabled the widespread utilization of LED lamps in Viet Nam. This has reduced electricity generation from fossil fuel-fired power plants, and the estimated direct GHG emission reduction attributable to the project was approximately 0.623 k tonnes CO2eq by the end of the project. The projected direct post-project GHG emission reductions from LED lamp applications that will be influenced by the project are about 69.38 k tonnes CO2eq. The estimated potential indirect GHG emission reductions are 5.154 k tonnes CO2eq (cumulative for a 10-year period after the end of the Project).

The TE will be conducted according to the guidance, rules and procedures established by UNDP and GEF as reflected in the UNDP Evaluation Guidance for GEF Financed Projects. The objectives of the evaluation are to assess the achievement of project results, and to draw lessons that can both improve the sustainability of benefits from this project, and aid in the overall enhancement of UNDP programming.

EVALUATION APPROACH AND METHOD

An overall approach and method¹ for conducting project terminal evaluations of UNDP-supported GEF financed projects has developed over time. The evaluator is expected to frame the evaluation effort using the criteria of relevance, effectiveness, efficiency, sustainability, and impact, as defined and explained in the UNDP Guidance for Conducting Terminal Evaluations of UNDP-supported, GEF-financed Projects. A set of questions covering each of these criteria have been drafted and are included with this TOR (Annex C). The evaluator is expected to amend, complete and submit this matrix as part of an evaluation inception report, and shall include it as an annex to the final report.

The evaluation must provide evidence-based information that is credible, reliable and useful. Interviews will be held with the following organizations and individuals at a minimum: The TE team is expected to follow a collaborative and participatory approach, ensuring close engagement with the Project Team, government counterparts including Viet Nam Academy of Science and Technology, Ministry of Industry and Trade, Ministry of Construction, the UNDP Country Office(s), UNDP-GEF Regional Technical Advisors, and other key stakeholders including Dien Quang company, Rang Dong Company, and demonstration site owners, etc. The evaluators are expected to conduct a field mission to Viet Nam including the project sites in Hanoi and Ho Chi Minh city.

The evaluator will review all relevant sources of information, such as the project document, project reports – including Annual APP/PIR, project budget revisions, midterm review, progress reports, GEF focal area tracking tools, project files, national strategic and legal documents, and any other materials that the evaluator considers useful for this evidence-based assessment. A list of documents that the project team will provide to the evaluator for review is included in Annex B of this Terms of Reference.

EVALUATION CRITERIA & RATINGS

An assessment of project performance will be carried out, based against expectations set out in the Project Logical Framework/Results Framework (see Annex A), which provides performance and impact indicators for project implementation along with their corresponding means of verification. The evaluation will at a minimum cover the criteria of: relevance, effectiveness, efficiency, sustainability and impact. Ratings must be provided on the following performance criteria. The completed table must be included in the evaluation executive summary. The obligatory rating scales are included in Annex D.

Evaluation Ratings:	
1. Monitoring and Evaluation	rating
M&E design at entry	rating
M&E Plan Implementation	Quality of UNDP Implementation
	Quality of Execution - Executing Agency
	rating

¹ For additional information on methods, see the [Handbook on Planning, Monitoring and Evaluating for Development Results](#), Chapter 7, pg. 163
² For ideas on innovative and participatory Monitoring and Evaluation strategies and techniques, see [UNDP Discussion Paper: Innovations in Monitoring & Evaluation Results](#), 05 Nov 2013.



TERMINAL EVALUATION TERMS OF REFERENCE

INTRODUCTION

In accordance with UNDP and GEF M&E policies and procedures, all full and medium-sized UNDP support GEF financed projects are required to undergo a terminal evaluation upon completion of implementation. These terms of reference (TOR) sets out the expectations for a Terminal Evaluation (TE) of the Local Development and Promotion of LED Technologies for Advanced General Lighting in Viet Nam (PIMS#-5193)

The essentials of the project to be evaluated are as follows:

PROJECT SUMMARY TABLE

Project Title:	Local Development and Promotion of LED Technologies for Advanced General Lighting in Viet Nam		
GEF Project ID:	5555	At Endorsement (Million US\$)	At completion (Million US\$)
UNDP Project ID:	00092227	\$ 1,517,400	To be completed upon the commencement of the TE
Country:	Viet Nam	IA/EA own: \$ 100,000	
Region:	Country wide	Government: \$ 440,000	
Focal Area:	Inclusive, Equitable and Sustainable Growth	Private Sector: \$ 6,089,394	
FA Objectives, (OP/SP):	COM-1: 1.1 Technologies successfully demonstrated, deployed and transferred COM-1: 1.2 Enabling policy and mechanisms created for technology transfer systems	Total co-financing: \$6,629,394	
Executing Agency:	Viet Nam Academy of Science and Technology (VAST)	Total Project Cost:	
Other Partners involved:	Ministries of Construction (MoC), Science and Technology (MOST), Natural Resources and Environment (MNHRE), Ministry of Industry and Trade (MOIT), Planning and Investment (MPI), Local manufacturer (Balaco, Dien Quuong)	ProDoc Signature (date project began):	June 11, 2015
		(Operational) Proposed: June 30, 2019	Actual: 30, December 2019
		Closing Date:	

OBJECTIVE AND SCOPE

The project was designed to mitigate GHG emissions through transformation of the lighting market towards greater usage of locally produced LED lighting products in Viet Nam. This objective was to be achieved by removing barriers to the increased production and utilization of locally produced LED lighting products in Viet Nam through implementation of the following project components.

- Component 1: Transfer of skills, knowledge, and technology in support of local LED lamp manufacturing; and
- Component 2: Demonstration of cost-effective local commercial production of LED lighting devices

Overall quality of M&E	Overall quality of Implementation / Execution	rating	rating
3. Assessment of Outcomes	4. Sustainability		
Relevance	Financial resources:		
Effectiveness	Socio-political:		
Efficiency	Institutional framework and governance:		
Overall Project Outcome Rating	Environmental :		
	Overall likelihood of sustainability:		
Environmental Status Impact Improvement			
Environmental Stress Reduction			
Progress towards stress/status change			
Overall Project Results			

PROJECT FINANCE / COFINANCE

The Evaluation will assess the key financial aspects of the project, including the extent of co-financing planned and realized. Project cost and funding data will be required, including annual expenditures. Variances between planned and actual expenditures will need to be assessed and explained. Results from recent financial audits, as available, should be taken into consideration. The evaluator(s) will receive assistance from the Country Office (CO) and Project Team to obtain financial data in order to complete the co-financing table below, which will be included in the terminal evaluation report.

Co-financing (type/source)	UNDP own financing (mill. US\$)		Government (mill. US\$)		Partner Agency (mill. US\$)		Total (mill. US\$)	
	Planned	Actual	Planned	Actual	Planned	Actual	Actual	Actual
Grants								
Loans/Concessions								
• In-kind support								
• Other								
Totals								

MAINSTREAMING

UNDP supported GEF financed projects are key components in UNDP country programming, as well as regional and global programmes. The evaluation will assess the extent to which the project was successfully mainstreamed with other UNDP priorities, including poverty alleviation, improved governance, the prevention and recovery from natural disasters, and gender.

IMPACT

The evaluators will assess the extent to which the project is achieving impacts or progressing towards the achievement of impacts. Key findings that should be brought out in the evaluations include whether the project has demonstrated: a) verifiable improvements in energy savings; b) verifiable reductions of GHG emission reduction, and/or c) demonstrated progress towards these impact achievements.³

CONCLUSIONS, RECOMMENDATIONS & LESSONS

The evaluation report must include a chapter providing a set of conclusions, recommendations and lessons. Conclusions should build on findings and be based in evidence. Recommendations should be prioritized.

³ A useful tool for gaining progress to impact is the Review of Outcomes to Impacts (ROtI) method developed by the GEF Evaluation Office. [ROtI Handbook 2009](#)

specific, relevant, and targeted, with suggested implementers of the recommendations. Lessons should have wider applicability to other initiatives across the region, the area of intervention, and for the future.

IMPLEMENTATION ARRANGEMENTS

The principal responsibility for managing this evaluation resides with the UNDP CO in Viet Nam. The UNDP CO will contract the evaluators and ensure the timely provision of per diems and travel arrangements within the country for the evaluation team. The Project Team will be responsible for liaising with the Evaluators team to set up stakeholder interviews, arrange field visits, coordinate with the Government etc.

EVALUATION TIMEFRAME, DUTY STATION AND EXPECTED PLACES OF TRAVEL

Duration and Timing: Estimated 20 working days for an international consultant and 15 working days for one national consultation during October – December 2019.

The tentative schedule is according to the following plan:

Activity	Timing (international consultants)	Timing (national consultants)	Completion Date
Reviewing documents and Preparation	5 working days	5 working days	20 October 2019
Evaluation Mission	5 working days (tentatively 4-8 November)	5 working days	8 November 2019
Draft Evaluation Report	7 working days	3 working days	29 November 2019
Final Report	3 working days	2 working days	20 December 2019

Duty station: Home based and Hanoi with in-country travel as required. The international consultant is expected to have 5 working day mission to Hanoi, Viet Nam. In case of in-country travel (if required), local travel cost shall be covered by the project based on UNDP policy or UN-EU cost norm.

EVALUATION DELIVERABLES

The evaluation team is expected to deliver the following:

#	Deliverable	Content	Timing	Responsibilities
1	TR Inception Report	TR team clarifies timing, objectives and methods of Terminal Review	No later than 2 weeks before the TE mission: (20, October 2019)	TE team submits to the UNDP CO and project team
2	Presentation	Initial Findings	End of TE mission: (8, November 2019)	TE Team presents to project team and the UNDP CO
3	Draft Final Report with Notes of all meetings with	Full report (using guidelines on content outlined in Annex B) with annexes	Within 3 weeks of the TE mission: (29 November 2019)	Sent to the UNDP CO, reviewed by CO, project team, RTA, Project Coordinating

stakeholders	Unit, GEF OFFs
4 Final Report*	Revised report with audit trail detailing how all received comments have (and have not) been addressed in the final TE report
	Within 1 week of receiving UNDP comments on draft: (20, December 2019)
	Sent to UNDP CO for uploading to UNDP ERC

*When submitting the final evaluation report, the evaluator is required also to provide an 'audit trail', detailing how all received comments have (and have not) been addressed in the final evaluation report.

TEAM COMPOSITION

The evaluation team will be composed of 1 international team lead and 1 national consultant. The consultants shall have prior experience in evaluating similar projects. Experience with GEF financed projects is an advantage. The team lead will be responsible for finalizing the report. The evaluators selected should not have participated in the project preparation and/or implementation and should not have conflict of interest with project related activities.

The Team members must present the following qualifications:

- For International Consultant (Team Leader)
- Master's degree in project management, energy efficiency, environmental sciences or relevant fields.
 - At least ten (10) years of international experience in the areas of project development, project implementation, and project evaluation for donor-funded development projects in developing countries.
 - Recent experience in leading results-based management evaluation management evaluation for international donor supported projects in climate change mitigation, energy efficiency
 - Y: Experience working with the GEF or GEF-evaluations; Project evaluation/review experiences within United Nations system will be an asset;
 - Work experience in climate change mitigation, energy efficiency projects in developing countries in Asia is an advantage.
 - Good interpersonal and analytical skills and ability to work under diverse/varied cultural environments;
 - Demonstrated command over writing professional reports in English.

Specifically, the international expert (team leader) will perform the following tasks:

- Lead and manage the evaluation mission; Guide the national expert in collecting data and information and preparation of relevant sections in the report
- Design the detailed evaluation scope and methodology (including the methods for data collection and analysis);
- Conduct an analysis of the outcome, outputs and partnership strategy (as per the scope of the evaluation described above);
- Draft related parts of the evaluation report; and
- Finalize the entire evaluation report.

For National Consultant (Team member)

- Graduate degree in degree in project management, energy efficiency, environmental sciences or relevant fields

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- At least five (5) years of experience in the areas of project development, project implementation, and project evaluation for donor-funded development projects in Viet Nam;
- Familiarity and past experience with evaluation of international donor supported projects, especially energy efficiency, climate change mitigation projects;
- Work experience in climate change mitigation for donor-supported projects is an advantage
- Experience with evaluation of GEF supported projects is an asset
- Good interpersonal and analytical skills and ability to work under diverse/varied cultural environments;
- Excellent English skills with evidence through practical experience.

Specifically, the national expert will perform the following tasks:

- Documentation of evaluation and data gathering and consultation meetings;
- Contributing to the development of evaluation plan and methodology;
- Conducting specific elements of the evaluation determined by the International Lead Consultant;
- Contributing to presentation of the evaluation findings and recommendations at the evaluation wrap-up meeting;
- Contributing to the drafting and finalization of the TE reports, notes of the meetings and other related documents prepared by the international consultant
- Performing translation for the international consultants during meetings with various stakeholders and necessary documents discussed during the international consultant's mission.

EVALUATOR ETHICS

Evaluation consultants will be held to the highest ethical standards and are required to sign a Code of Conduct (Annex E) upon acceptance of the assignment. UNDP evaluations are conducted in accordance with the principles outlined in the [LNEG Ethical Guidelines for Evaluations](#).

PAYMENT MODALITIES AND SPECIFICATIONS

%	Milestone
60%	Following submission and approval of the IST draft terminal evaluation report
40%	Following submission and approval (UNDP-CO and UNDP RTA) of the final terminal evaluation report and all products under the contract

APPLICATION PROCESS

UNDP applies a fair and transparent selection process that will take into account the competencies/skills of the applicants as well as their financial proposals. **Qualified women and members of social minorities are encouraged to apply.**

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ANNEX B. ITINERARY OF THE EVALUATION MISSION

No	Time	Organization	Name/Tel.	Position	Meeting contents	Venue and Focal Points
Monday, 25 November 2019						
1.	9:00 - 12:00	PMU VAST Incubator visit Project Terminal evaluation team (PTE) UNDP CO	- Mr. Nguyen Van Thao - Ms. Hoang Thi Thu Linh - Mr. Phan Hong Khoi - Mr. Nguyen Kien Cuong - Ms. Nguyen Thi Thanh Thuy - Mr. Jan van den Akker - Ms. Dang Ngoc Dung - Ms. Vu Thi Thu Hang	- NPD - Deputy NPD - NSTA - Project Manager - Project Accountant - Team leader - Team member - UNDP Programme officer	- Briefing meeting - Sharing additional information - Project Implementation and Adaptive Management - Project internal & external communication means - M&E Tools - Update of mission agenda (if needed)	PMU Office, Meeting room, 3 rd floor, 3C building, 18 Hoang Quoc Viet Street, Cau Giay District, Ha Noi
2.	14:00 – 15:00	Ministry of Industry and Trade PTE PMU	- Mr. Trinh Quoc Vu Tel. 0913534464 - Mr. Dang Hai Dzung Tel. 0903224791 - Mr. Jan van den Akker - Ms. Dang Ngoc Dung - Mr. Phan Hong Khoi - Mr. Nguyen Kien Cuong	- Vice Director - Senior Admin for EE Labeling and Certification for LED products - Team leader - Team member - NSTA - PM	- National Energy Efficiency Programme III and the role of LED lighting - Current and trend of LED lighting technology and market in Viet Nam - Labeling programme for LED Lighting and its implementation.	54 Hai Ba Trung Street, Hoan Kiem District, Ha Noi
3.	15:30 – 16:30	Ministry of Construction (MOC) PTE PMU	- Ms. Mai Thi Lien Huong Tel. 0983325569 - Mr. Do Quoc Khanh Tel. 0913006613 - Mr. Jan van den Akker - Ms. Dang Ngoc Dung - Mr. Phan Hong Khoi - Mr. Nguyen Kien Cuong	- Director, Technical Infrastructure Agency, MOC - Head, Technical Infrastructure Dept. - Team leader - Team member - NSTA - PM	- The cooperation between the LED Project and the Technical Infrastructure Agency, MOC in developing standards for lighting streets and tunnels, 37 Le Dai Hanh, Hai Ba Trung District, Ha Noi	15:30 – 16:30
4.	15.30-16.00	UNDP CO	Mr. Dao Xuan Lai	Head, Climate Change and Environment Unit		304 Kim Ma Street, , Ha Noi
Tuesday, 26 November 2019						
5.	9:00 – 10:00	Rang Dong Light Sources and Vacuum Flasks JSC. (RALACO) PTE	- Mr. Nguyen Doan Thang Tel. 0903412958 - Mr. Tran Trung Tuong Tel. (24) 38584310; 38584576 (24) - Mr. Jan van den Akker - Ms. Dang Ngoc Dung	- Director General - Deputy Director General - Team leader - Team member	- Past, current status, and trend of LED lighting products manufacturing and products quality of RALACO in the period of 2015 – 2019. - Main results of technical supports of the UNDP/GEF LED lighting project to Ralaco (Technology, R&D, Quality improvement, LED Demo-projects, EE labeling, and so on)	87-89, Ha Dinh Street, Thanh Xuan District, Ha Noi

No	Time	Organization	Name/Tel.	Position	Meeting contents	Venue and Focal Points
		PMU	- Mr. Phan Hong Khoi - Mr. Nguyen Kien Cuong	- NSTA - PM		
6.	10:00 – 11:00	Vietnam Lighting Association (VLA) PTE PMU	- Mr. Nguyen Hong Tien Tel. 0913232228 - Mr. Tran Dinh Bac Tel. 0913318907 - Mr. Jan van den Akker - Ms. Dang Ngoc Dung - Mr. Phan Hong Khoi - Mr. Nguyen Kien Cuong	- President - Deputy President - Team leader - Team member - NSTA - PM	- VLA and the activities - Issues related to the Technical support of UNDP/GEF LED Lighting Project to the development of LED Lighting industry in Viet Nam. - Roadmap of LED lighting industry development in Viet Nam - Other Issues related to VLA and UNDP/GEF project activities.	87-89, Ha Dinh Street, Thanh Xuan District, Ha Noi
7.	11:30 – 12:30	Ministry of Construction (MOC) PTE PMU	- Ms. Mai Thi Lien Huong Tel. 0983325569 - Mr. Jan van den Akker - Ms. Dang Ngoc Dung - Mr. Phan Hong Khoi - Mr. Nguyen Kien Cuong	- Director, Technical Infrastructure Agency, MOC - Team leader - Team member - NSTA - PM	- The cooperation between the LED Project and the Technical Infrastructure Agency, MOC in developing standards for lighting streets and tunnels	37 Le Dai Hanh, Hai Ba Trung District, Ha Noi
8.	14:00 – 15:30	Quality Assurance and Testing Center No. 1 (QUATEST-1), MOST PTE PMU	- Mr. Kim Duc Thu Tel. 0972682186 - Mr. Jan van den Akker - Ms. Dang Ngoc Dung - Mr. Phan Hong Khoi - Mr. Nguyen Kien Cuong	- Director - Team leader - Team member - NSTA - PM	- The situation of upgrading and operating the system of lighting quality testing equipment, especially for LED lamps and luminaires - The effective cooperation between LED Project and QUATEST-1 in the chain of Standard - Testing - Labeling of LED lighting products	8 Hoang Quoc Viet Street, Cau Giay District, Ha Noi
	15.30	<i>Flight to HCMC (e.g.,</i>	18.00-20.15 VN 263)			
Wednesday, 27 November 2019						
9.	09:00 – 10:30	Ho Chi Minh city University of Technology PTE PMU	- Mr. Le Minh Phuong Tel. 098857217 - Mr. Phan Quoc Dzung Tel. 0988572177 - Mr. Jan van den Akker - Ms. Dang Ngoc Dung - Mr. Phan Hong Khoi - Mr. Nguyen Kien Cuong	- Vice Rector - Head of Online Training Team - Team leader - Team member - NSTA - Project Manager	- R&D and of LED lighting and Smart lighting in Ho Chi Minh city University of Technology. - Issues related to the technical supports of UNDP/GEF LED Lighting Project to the Education and R&D and of LED lighting and Smart lighting, including E-learning.	268 Ly Thuong Kiet Street, District 10, Ho Chi Minh City

No	Time	Organization	Name/Tel.	Position	Meeting contents	Venue and Focal Points
10.	11:00 – 12:00	Trang An V.E.M JSC. PTE PMU	- Mr. Trinh Duc Chau Tel. 0983221167 - Mr. Nguyen Giang Thanh Tel. 0983012030 - Mr. Jan van den Akker - Ms. Dang Ngoc Dung - Mr. Phan Hong Khoi - Mr. Nguyen Kien Cuong	- Director General - Sales Manager - Team leader - Team member - NSTA - Project Manager	- Role of transfer of skills, knowledge and technology for the local manufacturing of LED lamps in Viet Nam, including training & education activities. - LED lighting manufacturing in Middle and Small enterprises in general and in V.E.M JSC. in particular.	43-45 Dat Thanh Street, 6 Ward, Tan Binh District, Ho Chi Minh City
Wednesday, 27 November 2019						
11.	14:00-15:30	Public Lighting Company in Ho Chi Minh City (SAPULICO) PTE PMU	- Mr. Huynh Tri Dzung Tel. 0963337118 - Mr. Tran Anh Dzung Tel. 0907965569 - Mr. Jan van den Akker - Ms. Dang Ngoc Dung - Mr. Phan Hong Khoi - Mr. Nguyen Kien Cuong	- Director General - Training Unit - Team leader - Team member - NSTA - Project Manager	- Past and current status of LED outdoor lighting applications in Ho Chi Minh City in the period 2015 – 2019. - SAPULICO with the development of LED lighting technology and applications in the period 2015 – 2019.	121 Chau Van Liem Street, 14 Ward, District 5, Ho Chi Minh City
12.	15:30 – 17:00	Project Terminal evaluation team (PTE)	- Mr. Jan van den Akker - Ms. Dang Ngoc Dung	- Team leader - Team member	Reporting	
Thursday, 28 November 2019						
13.	9:00-10:00	Le Ngoc Han Primary School PTE PMU	- Mr. Le Viet Phuong Tel: 083 839 1563 - Mr. Jan van den Akker - Ms. Dang Ngoc Dung - Mr. Phan Hong Khoi - Mr. Nguyen Kien Cuong	- Principal - Team leader - Team member - NSTA - Project Manager	- The effectiveness of indoor LED lighting demonstration project at Le Ngoc Han Primary schools - The impact of efficient LED lighting on education, teachers, parents and pupils	12 Suong Nguyet Anh, Ben Thanh ward, District 1, Ho Chi Minh City
14.	10.30-12.00	Project Terminal evaluation team (PTE)	- Mr. Jan van den Akker - Ms. Dang Ngoc Dung	- Team leader - Team member	Reporting	
Check out hotels (13.00)						

No	Time	Organization	Name/Tel.	Position	Meeting contents	Venue and Focal Points
15.	14:00 – 15.00	Dien Quang Lamps JSC PTE PMU	- Mr. Ho Quynh Hung Tel. 0903656044 - Mr. Tran Quoc Toan Tel. 0909762506 - Mr. Le Xuan Nghiem Tel. 0979882539 - Mr. Jan van den Akker - Ms. Dang Ngoc Dung - Mr. Phan Hong Khoi - Mr. Nguyen Kien Cuong	- Director General - Deputy Director General - Head of Sci-Tech & Project Division - Team leader - Team member - NSTA - Project Manager	- Past, current status, and trend of LED lighting products manufacturing and products quality of DIEN QUANG in the period 2015 – 2019. - Main results of technical supports of the UNDP/GEF LED lighting project to DIEN QUANG (Technology, R&D, Quality improvement, LED Demo-projects, EE labelling, and so on).	Lô HT-2-2, D2 Street, Sai Gon High-Tech Park, Tan Nhon Phu B Ward, 9 District, Ho Chi Minh City
		<i>Flight to Hanoi</i>	18.00-20.10 VN266)			
Friday, 29 November 2019						
16.	9:00 – 10:00	Quality Assurance and Testing Center No. 1 (QUATEST-1), MOST PTE PMU	- Mr. Kim Duc Thu Tel. 0972682186 - Mr. Dang Thanh Tung Tel. 0912349896 - Mr. Bui Anh Tuan Tel. 0984226735 - Mr. Jan van den Akker - Ms. Dang Ngoc Dung - Mr. Phan Hong Khoi - Mr. Nguyen Kien Cuong	- Director - Head of Electronic and Electrical Testing Dept. - Consultant, Electronic and Electrical Testing Dept. - Team leader - Team member - NSTA - PM	- The situation of upgrading and operating the system of lighting quality testing equipment, especially for LED lamps and luminaires - The effective cooperation between LED Project and QUATEST-1 in the chain of Standard - Testing - Labeling of LED lighting products	8 Hoang Quoc Viet Street, Cau Giay District, Ha Noi
17.	10.30-12.00	PTE UNDP CO PMU	- Mr. Jan van den Akker - Ms. Dang Ngoc Dung - Ms. Vu Thi Thu Hang (could not attend due to UNDP CO retreat that day; PowerPoint was shared for comments - PMU staff	- Team leader - Team member - UNDP PO - NSTA - Project Manager - Project Accountant	- De-briefing with PowerPoint - Mission conclusions - Next steps	PMU Office, Meeting room, 3 rd floor, 3C building, 18 Hoang Quoc Viet Street, Cau Giay District, Ha Noi

ANNEX C. LIST OF DOCUMENTS COLLECTED AND REVIEWED

Project design documents and progress reports

- UNDP Project Document and Annexes:
- CEO Endorsement document
- Project Implementation Reviews (2016, 2017, 2018)
- Inception Report (January 2016)
- Excel tables with gender participation data and overview of budget and co-financing
- Quarterly Progress Reports
- Combined Delivery reports
- Project Steering Committee minutes of meeting

Project technical reports

National consultants

- Contract “Building an Itinerary to Develop LED Lighting Sector” (Nguyen Doang Thang)
- Contract “Support LED Lighting Labeling and Certification” (Dang Hai Dung)
- Contract “Building and Implementation of Pilot Project on Efficient Energy Labeling and Certificate for LED Products” (Hoang Minh Lam)
- Contract “National Standards for LED Lamps” (Doan Thi Than Vanh)
- Contract “Development of Vietnam National Energy Performance Standards (TCVN-EP) for LED Street Lighting Luminaires” (Doan Thi Than Vanh)
- Contract “Strengthening of LED Products Testing” (Bui Anh Tuan)
- Contract “Supporting to Development of Viet Nam Standards on lighting using LED Technologies for Transport Constructions (streets, tunnels)” (Tran Nguyen Chinh)
- Contract “Support for the Development and Implementation of R&D Training Program on LED Lighting Technologies” (Le Van Doanh)
- Contract “Technical Assistance for the Production of LED Lighting Products of JSC Dien Quang” (Le Minh Phuong)
- Contract “Developing of Software for Supporting LED Driver Design for Dien Quang Company (Phan Quoc Dung)
- Contract “Technical Support to LED Lighting Products Manufacturing of Rang Dong Company” (Nguyen Viet Hung)
- Contract “Data Collection and Assessment of LED Lighting Industry” (Nguyen Thai Thu Nga)
- Contract “Development of Monitoring, Reporting and Verification (MRV) Systems for LED Lighting” (Le Nho Hoan)
- Contract “Research, design and construction of LED lighting system for schools” (Le Xuan Nghiem, Dien Quang)
- Contract “Evaluation of indoor LED lighting demonstration (NAD I)” (Le Xuan Nghiem, Dien Quang)
- Contract “Feasibility Studies Design and Development of School LED Lighting Demonstration” (Tran Trung Tuong)
- Contract “Assessment of the Feasibility of LED Lighting Demonstration Projects (NAF)” (Nguyen Nguyen Tra)
- Contract “For Assessment of the Feasibility of LED Lighting (Indoor)” (Le Minh Phuong)
- Contract “Study, design and establish LED lighting system for school” (Nguyen Khanh Binh)
- Contract “Developing and implementing an online training course on LED Advanced Technologies and Applications” (Phan Quoc Dung, et.al.)

International consultants

- Contract “Project Inception Phase” (Sommai Phon-Amnuasiuk)
- Contract “LED Lighting Product Standards (ILPS)” (Li Tienan)
- Contract “Support for LED Lighting Product Testing (ILPT)” (Indika Perera)
- Contract “Development and Implementation of R&D Training Program on LED Lighting Technologies” (Sommai Phon-Amnuasiuk)
- Contract “Quality Testing and Assessment of LED Lighting Products (IQTA-Ralaco)” (Gareth Jones)
- Contract “Technology and Production Management of LED Lighting Products (ITPM-Ralaco) (Takeo Tatematsu)
- Contract “Training in the use of ANSYS Icepak software package for LED Lighting Products” (An Young Hoon)
- Contract “Quality Testing and Assessment of LED Lighting Products (ITS-1 Dien Quang)” (Gareth Jones)
- Contract “Improving the Quality of LED Lighting Products manufactured by Dien Quang Lamp Joint-Stock Company (ITS-2 Dien Quang)” (Gareth Jones)
- Contract “Energy Efficient Labeling & Certification Implementation for LED lighting products (ILCP)” (My Ton)

National policy and planning documents; reports, articles

- *Decision on approval of the National Energy Efficiency Programme (VNEEP) for the period of 2019-2030* (280/QD-TTg)
- *Dien Quang Lamp (DQC)*, Viet Capital Securities, 2019
- *Green Growth Action Plan and Outcomes of Energy Efficiency & Conservation Programme* (VNEEP), PowerPoint, MoIT, 2017
- IMARC (2018), <https://www.imarcgroup.com/vietnam-led-lighting-market> Vietnam LED Market: Industry Trends, Share, Size, Growth, Opportunity and Forecast 2019-2024
- *Vietnam Energy Outlook Report 2019*, Electricity and Renewable Energy Authority; MoIT; Danish Energy Agency); 2019
- *Vietnam ESCO Market Development Experience*, PowerPoint, Ecoloner, 2015
- *Vietnam ESCO Market Opportunities and Challenges*, PowerPoint, Duong Trung Kien, 2019
- *Vietnam LED Light Market Report and Forecast 2019-2024*, EMR (2019); Summary

ANNEX D. QUESTIONNAIRE AND EVALUATION MATRIX

Contents	Model evaluation criteria and/or questions	Indicator(s)	Means and sources of information	Sources of verification
<p>1. Findings: Relevance and design</p> <ul style="list-style-type: none"> • Relevance and country drivenness • Stakeholder involvement • Assessment of logframe and M&E design 	<p>Relevance:</p> <ul style="list-style-type: none"> • Have project outcomes been contributing to national development priorities and plans and take into account national realities? • Consistency with the GEF focal areas in Climate Change/operational program strategies of the GEF CC and with the UN and UNDP country programming in Viet Nam • Is the Project addressing the needs of the target beneficiaries? Relevance of the project's objectives, outcomes and outputs to the different target groups of the interventions. <p>Design:</p> <ul style="list-style-type: none"> • Were lessons from other relevant projects (e.g. VEEPL) properly incorporated in the project design? Were the partnership arrangements properly identified and the roles and responsibilities negotiated prior to project approval? • Has the project's design (logframe) been adequate to address the problems at hand? Was the project internally coherent in its design (logical linkages between expected results and design (components, choice of partners; scope, use of resources)? Were any (major) amendments to the assumptions or targets been made or planned during the Project's implementation? 	<p>Relevance:</p> <ul style="list-style-type: none"> • Extent to which Project supports national energy priorities, policies and strategies • Coherency and complementarity with other national and donor programmes • Extent to GEF climate change focal area is incorporated • Degree to which the project supports aspirations and/or expectations of stakeholders <p>Design:</p> <ul style="list-style-type: none"> • Degree of involvement of government partners and other stakeholders in the Project design process • Number and type of performance measurement indicators (SMART indicators) 	<ul style="list-style-type: none"> • Desk review of project design and technical documents; Documents from GEF; national policies and strategies; • Interviews with project staff management, project partners (incl. former staff), stakeholders (local and national government entities, private sector, universities/NGOs) and UNDP staff 	<ul style="list-style-type: none"> • Interviews with project partners and stakeholders and analysis thereof • Document and report analysis (see Annex C)
<p>2. Findings: Results and effectiveness</p> <ul style="list-style-type: none"> • Assessment of outcomes and outputs (cf. with baseline indicators) • Effectiveness • Global environmental and other impacts 	<p>Results and effectiveness</p> <ul style="list-style-type: none"> • To what extent have the expected outcomes and objectives of the project been achieved? • What outputs and outcomes has the project achieved (both qualitative and quantitative results, comparing the expected and realized end-project value of progress indicators of each outcome/output with the baseline value)? • Were objectives, outcomes and outputs achieved on time? How did the project contribute to GHG emissions reduction within the project implementation cycle and beyond? 	<p>Results and effectiveness:</p> <ul style="list-style-type: none"> • Level of achievement (as laid out in the logframe) • Achievement of outputs (qualitative, quantitative) and description of activities • Evidence of adaptive management and/or early application of lessons learned 	<ul style="list-style-type: none"> • Desk review of project design and technical documents other relevant docs • Interviews with project staff management, project partners (incl. former staff), stakeholders (local and national government 	<ul style="list-style-type: none"> • Interviews with project partners and stakeholders and analysis; • Document and report analysis • Check with publicly available

Contents	Model evaluation criteria and/or questions	Indicator(s)	Means and sources of information	Sources of verification
	<ul style="list-style-type: none"> • Were there any unplanned effects? Which external factors have contributed or hinder the achievement of the expected results? • Has the project produced results (outputs and outcomes) within the expected time frame Is the project proactively taking advantage of new opportunities, adapting its theory of change to respond to changes in the development context? Are there any unaddressed barriers remaining? 		<p>entities, private sector, universities/NGOs) and UNDP staff</p> <ul style="list-style-type: none"> • Interviews with project experts (national and international) 	information
<p>3. Findings: implementation, processes and efficiency</p> <ul style="list-style-type: none"> • Management and administration; role of UNIDO • Monitoring and evaluation systems • Stakeholder engagement and communications • Budget, expenditures and co-financing; procurement 	<p>Implementation and management</p> <ul style="list-style-type: none"> • Was the project implemented (by IA) and executed (by EA) in an efficient way? • How efficient was the financial management of the project, including specific reference to cost-effectiveness of its interventions? If there was a difference in the level of expected co-financing and the co-financing actually realized, what were the reasons for the variance? • How efficient are partnership arrangements for the project? Whether or not national stakeholders participated in project management and decision-making have ownership for project outcomes and their further replication and scaling-up? Did the project efficiently utilize local capacity in implementation? • Was the information provided by the M&E system (annual work plans, PIRs, other) was used to improve performance and to adapt to changing needs; Are there any annual work plans? • What have been management responses to issues and recommendations indicated in progress reports and Mid-Term review? How have the project management systems, including progress reporting, administrative and financial systems and monitoring and evaluation system been operating as effective management tools aid in effective implementation and provide sufficient basis for evaluating performance and decision making? • Did UNDP and Project staff identify problems in a timely fashion and advice to the project? If so, has the project practicing adaptive management e.g., (approve modifications in time)? If so, how effective was the adaptive management practiced under the project and lessons learnt? 	<p>Implementation and management</p> <ul style="list-style-type: none"> • Extent to which project partners committed time and resources to the project • Extent of commitment of partners to take over project activities • Evidence of clear roles and responsibilities for operational and management structure <p>M&E</p> <ul style="list-style-type: none"> • Actual use of the M&E system to change or improve decision-making/adaptive management • Share of M&E in the budget • Quality and quantity of progress reports <p>Stakeholders and communications</p> <ul style="list-style-type: none"> • Extent to which project partners committed time and resources to the project • Extent of commitment of partners to take over project activities <p>Financial planning</p> <ul style="list-style-type: none"> • Extent to which inputs have been of suitable quality and available when required to allow the Project to achieve the expected results; 	<ul style="list-style-type: none"> • Desk review of project design and technical documents (incl. PIRs; data on budget; other relevant docs; media coverage, official notices and press releases • Interviews with project staff management, project partners (incl. former staff), stakeholders (local and national government entities, private sector, universities/NGOs) and UNDP staff • Interviews with project experts (national and international) 	<ul style="list-style-type: none"> • Interviews with project partners and stakeholders and analysis thereof • Document and report analysis

Contents	Model evaluation criteria and/or questions	Indicator(s)	Means and sources of information	Sources of verification
<p>4. Findings: sustainability and impact</p> <ul style="list-style-type: none"> Risks and external factors Replication 	<p>Sustainability</p> <ul style="list-style-type: none"> To what extent are there financial, institutional, social-economic, and/or environmental risks to sustaining long-term project results? How sustainable (or likely to be sustainable) are the outputs and outcomes? Is there an exit strategy that is well planned? What could be done to strengthen exit strategies and ensure sustainability of interventions made? To what extent will the stakeholders sustain the project? <p>Impact</p> <ul style="list-style-type: none"> How did the project contribute to GHG emissions reduction within the project implementation cycle and beyond? What impact has the project had on policy, legal and institutional frameworks? Has the project had any impact on gender equality and economic empowerment for women and other marginalized groups? Was it intended to? 	<p>Sustainability</p> <ul style="list-style-type: none"> Extent to which risks and assumptions are adequate and are reflected in the project documentation Extent to which project is likely to be sustainable beyond the project; Extent to which main stakeholders plan to provide sustainability to the project's results in the future, including commitment of financial resources 	<ul style="list-style-type: none"> Desk review of project design and technical documents (incl. PIRs; other relevant docs) Interviews with project staff management, project partners (incl. former staff), stakeholders (local and national government entities, private sector, universities/NGOs) and UNDP staff 	<ul style="list-style-type: none"> Interviews with project partners and stakeholders and analysis thereof Document and report analysis Check with international practices and publicly available information
<p>5. Conclusions and recommendations</p> <ul style="list-style-type: none"> Conclusions on attainment of objectives and results Lessons learned Recommendations 	<ul style="list-style-type: none"> Evaluation conclusions related to the project's achievements and shortfalls (comprehensive and balanced statements which highlight the strengths, weaknesses and results of the project, including summary of evaluation criteria³⁴: <ul style="list-style-type: none"> Relevance Effectiveness Efficiency Sustainability Impacts What lessons can be learnt from the project regarding efficiency What recommendations, if any, can be made to follow up or reinforce initial benefits from the project; Proposals for future directions related to the main objectives 	<ul style="list-style-type: none"> Ratings of evaluation criteria Lessons that have been learned regarding achievement of outcomes and efficiency (implementation) Recommendations for post-project and future actions 	<ul style="list-style-type: none"> Interviews with project staff and partners Desk review of project docs and reports as well as external policy and other docs 	<ul style="list-style-type: none"> Interviews with project partners and stakeholders and analysis thereof Document and report analysis

³⁴ Relevance: How does the project relate to the main objectives of the GEF focal area, and to the environment and development priorities at the local, regional and national levels? Effectiveness: To what extent have the expected outcomes and objectives of the project been achieved? Efficiency: Was the project implemented efficiently and cost-effectively, in line with international and national norms and standards? Sustainability: To what extent are there financial, institutional, social-economic, and/or environmental risks to sustaining long-term project results? Impacts: Are there indications that the project has contributed to, or enabled progress toward, reduced environmental or other impacts?

ANNEX E. CONSULTANT CODE OF CONDUCT FORM

Evaluators/reviewers:

1. Must present information that is complete and fair in its assessment of strengths and weaknesses so that decisions or actions taken are well founded
2. Must disclose the full set of evaluation findings along with information on their limitations and have this accessible to all affected by the evaluation with expressed legal rights to receive results.
3. Should protect the anonymity and confidentiality of individual informants. They should provide maximum notice, minimize demands on time, and respect people's right not to engage. Evaluators must respect people's right to provide information in confidence, and must ensure that sensitive information cannot be traced to its source. Evaluators are not expected to evaluate individuals and must balance an evaluation of management functions with this general principle.
4. Sometimes uncover evidence of wrongdoing while conducting evaluations. Such cases must be reported discreetly to the appropriate investigative body. Evaluators should consult with other relevant oversight entities when there is any doubt about if and how issues should be reported.
5. Should be sensitive to beliefs, manners, and customs and act with integrity and honesty in their relations with all stakeholders. In line with the UN Universal Declaration of Human Rights, evaluators must be sensitive to and address issues of discrimination and gender equality. They should avoid offending the dignity and self-respect of those persons with whom they come in contact in the course of the evaluation. Knowing that evaluation might negatively affect the interests of some stakeholders, evaluators should conduct the evaluation and communicate its purpose and results in a way that clearly respects the stakeholders' dignity and self-worth.
6. Are responsible for their performance and their product(s). They are responsible for the clear, accurate and fair written and/or oral presentation of study limitations, findings, and recommendations.
7. Should reflect sound accounting procedures and be prudent in using the resources of the evaluation.

Evaluation/reviewer Consultant Agreement Form

Agreement to abide by the Code of Conduct for Evaluation in the UN System

Name of Consultant: J.H.A. VAN DEN AKKER (Team Leader)

Name of Consultancy Organization (where relevant): _____

I confirm that I have received and understood and will abide by the United Nations Code of Conduct for Evaluation.

Signed at Westerhoven, Netherlands

Signature: _____



ANNEX F. ABOUT THE REVIEWERS

Mr. Jan van den Akker is a technology management scientist with a Master's degree from Eindhoven University of Technology (Netherlands), specializing in international development cooperation. He is an expert on sustainable energy policy and technologies. Mr. Van den Akker specializes in studies and analytical work, project design and development, project coordination and implementation, project monitoring and evaluation, knowledge management, capacity strengthening and public-private partnerships in the field of sustainable energy strategies, energy efficiency, energy technologies and supply, climate change and the Clean Development Mechanism. He has lived and worked abroad for over 7 years in Zambia, Mexico, and Thailand. In addition, has undertaken numerous short missions to about 45 countries in Africa, Latin America, and Asia & the Pacific.

In 2003/2004, he founded ASCENDIS, as an independent office, and has been providing consultancy on sustainable energy and climate change, specializing in development issues. ASCENDIS is based in Westerhoven, Netherlands, but offers services in Africa, Asia and the Pacific, Europe and Latin America & the Caribbean, often by associating itself with local freelance experts, professionals, and organizations. As a long-term expert with the United Nations system, Mr. Van den Akker has provided advice to governments and organizations on the design of investment and capacity building programs for UNEP, UNDP and UNIDO (mostly in GEF-funded activities), UNFCCC, European Commission and for NGOs/consultancy companies (e.g., Practical Action Consulting, Winrock, GFA) in the area of renewable energy, energy efficiency and sustainable transportation.

As an independent consultant, he has reviewed and evaluated about 40 GEF-funded sustainable energy projects and assisted in the design of 42 sustainable energy projects, mostly for UNDP. He worked as UNDP Regional Technical Advisor on climate change mitigation (in Eastern and Southern Africa) during 2007-2009 and as Key Expert in the European Union Technical Assistance Facility for Sustainable Energy for All (2015-16). He also worked as Technical Advisor in the implementation of individual projects in Guatemala, Peru, and in Malawi and as Renewable energy expert in the EU project on off-grid electrification in Zambia (2018).

Ms. Dang Ngoc Dung has more than twenty-year experiences in planning, monitoring and evaluation, project management, public financial management, project finance and financial projection. Her monitoring and evaluation services are focusing on the design, implementation of monitoring & evaluation system, and evaluation of project relevance, implementation processes, effectiveness, efficiency, impact and sustainability of the projects/programmes. She has a Master's Degree in Business Administration from the Asian International Institute and holds a Bachelor's degree in English. Ms. Dung has built her working experience in various parts of Vietnam as well as in Australia, Philippines and Switzerland.

Ms. Dung has participated in number of evaluation assignments, mid-term reviews (MTR) or the design of monitoring & evaluation system for projects/programmes relating to climate change and disaster mitigation, energy efficiency, energy (hydropower) and construction or infrastructure development programmes funded by SECO, EU, CIDA, Ausaid, DANIDA and Netherlands, and administered by UN/UNDP/ UNICEF, WB, ADB and EU. Examples include the Midterm Review of the UNDP/ GEF "Project on Energy Efficiency Improvement in Commercial and High-Rise Residential Buildings in Viet Nam (EECB)", UNDP/GEF Terminal Evaluation of the "Promoting Climate Resilient Infrastructures in Northern Mountain Provinces of Viet Nam", UNDP Project Final Evaluation of "Strengthening Local Government Capacities in Planning, Budgeting and Managing Public Resources (SLGP)", UNICEF Final Evaluation of the "Project on Strengthening the Capacity in Child-sensitive Planning, Monitoring and Evaluation of Socio-economic Development Plans", UN Equity-focused evaluation of One Plan 2012-2016, Country-led Evaluation of One UN Initiatives, Review of UN Programme Coordination Groups. Non-UN evaluative assignments include ADB/ GEF/MONRE "Greater Mekong Sub-region Biodiversity Conservation Corridors – Viet Nam component Project", NORAD/ITAD Capacity Development Evaluation, the Child Fund Australia in Vietnam – Final Evaluation of Recovery after flood Project in Bac Kan Province, and the JICA/Local Capacity Assessment of Lai Chau Province in Planning and Implementation of Infrastructure Development.

ANNEX G. AUDIT TRAIL

Annexed in a separate document