Energy Efficiency Improvement in Commercial and High-Rise Residential Buildings in Vietnam

Technical Report – Component 5.7

EXECUTIVE REPORT ON THE ESTABLISHMENT OF SEC PROFILES, NATIONAL ENERGY BENCHMARKS, EE LABELLING SYSTEM AND M&V PROTOCOL FOR HIGH-RISE BUILDINGS IN VIETNAM

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TABLE OF CONTENTS

TABLE OF FIGURES & TABLES

ABBREVATIONS

EE	Energy Efficiency
EECB	Energy Efficiency Improvement in Commercial and High-Rise Residential Buildings in Vietnam
FEMP	Federal Energy Management Program
GEF	Global Environment Facility
GFA	Gross Floor Area
GHG	Greenhouse gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
HVAC	Heating, ventilation and Air Conditioning
IPMVP	International Performance Measurement and Verification Protocol
ISO	International Organization for Standardization
M&V	Monitoring & Verification
MoC	Ministry of Construction
MoIT	Ministry of Industry and Trade
PMU	Project Management Unit
SEC	Specific Energy Consumption
TCVN	Vietnam Standards, abbreviated TCVN for the Vietnamese “Tiêu Chuẩn Việt Nam”

1 PROJECT CONTEXT

In 2018, the total final energy consumption related to Viet Nam residential and commercial buildings represented 21% of total energy consumption, and 38% of total electricity consumption. The growing urban population, known to consume more energy than the rural one, will undoubtedly contribute to significantly increase the total energy and electricity consumption and then weigh heavier on the country's infrastructure.

Regarding GHG emissions, in the third 'National Communication of Viet Nam to the United Nations Framework Convention on Climate Change" released in 2014, Viet Nam was expected to emit 528 million Tons of CO_2 in 2020, an 86% increase compared to 2014, the year of reference. The residential and business (including commercial buildings) sectors were initially estimated to account for 7.8% of total national GHG emissions in 2014 (excluding related amounts of emissions linked to electricity generation and to the construction sector).

Demographic and urban population growth will contribute to gradually amplify building and construction sectors energy consumption and GHG emissions, if no drastic and coordinated measures are implemented as regards building design, construction and operations, as well as building materials and related equipment manufacturing.

The Ministry of Construction (MOC) decided to implement the Project "Energy Efficiency Improvement in Commercial and High-Rise Residential Buildings in Vietnam" (EECB), funded by GEF / UNDP and co-financed by Vietnamese agencies/institutions and enterprises. The overall project goal was to reduce intensity of GHG emissions from the building sector nationwide by improving the energy use of commercial and high-rise residential buildings in Vietnam.

The EECB project comprised a number of complementary activities designed to reinforce the revised Vietnamese building energy efficiency code (QCVN09:2017) and to promote the development of energy efficient technologies, systems, and practices in commercial and residential buildings.

This report summarizes conducted investigations, analysis, achievements and recommendations related to four essential energy efficiency (EE) tools, which have been developed during the project framework, and their potential applications in Viet Nam:

- Tool #1: Specific Energy Consumption (SEC) Profiles
- Tool #2: National Energy Benchmarking system
- Tool #3: Energy Efficiency (EE) Labelling / Certification Scheme
- Tool #4: Energy Monitoring & Verification (M&V) Protocol

The conducted reviews / analysis related to these tools, have resulted in customized and adapted definitions for Vietnam. Related defined methodologies and lessons learned along the way have laid ground for the development and implementation roadmap of four EE tools in Viet Nam and showed the need of an online energy data submission platform. The next section will briefly describe all EE tools and the online submission platform developed within the framework of this project, by which their roadmap will be summarized in the end.

2 SUMMARY OF ENERGY EFFICIENCY TOOLS

2.1 Definitions and Objectives

The four above mentioned tools were developed or customised by the EECB project for implementation in Vietnam. These ones are interraleted and complementary, and they all play an essential role as regards EE monitoring and improvement at both individual building and sectorial levels.

Tool #1: Specific Energy Consumption (SEC) profiles.

The **Specific Energy Consumption (SEC) profile** is used as an **energy performance indicator** to evaluate or measure energy efficiency of an individual building over a specific period (a year), under a defined climate zone.

It is expressed by a ratio between the building annual energy consumption and its Gross Floor Area (GFA):

$$\text{Building SEC} = \frac{\text{Yearly Energy Consumption (kWh or Btu or Joule or ...)}}{\text{Comparision parameter or GFA (m}^2\text{ or ft}^2\text{)}}$$

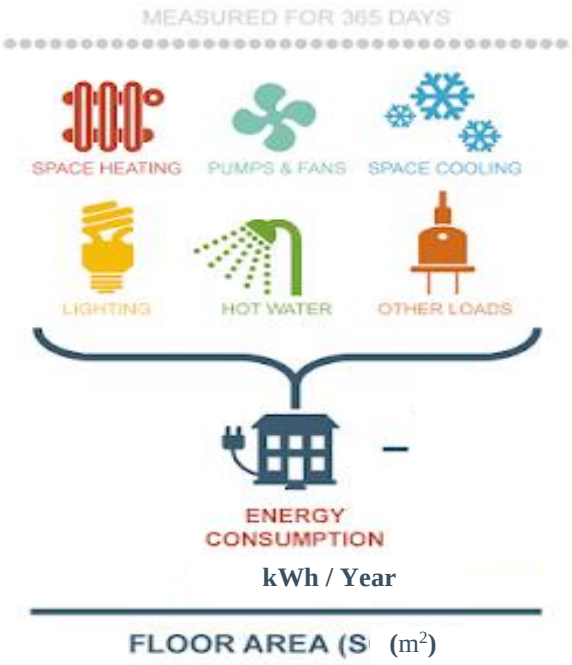

Figure 1 -Definition of a SEC profile

Such a calculation provides a "**raw" SEC** value for a building. However, differences in occupancy characteristics (e.g., operational hours, tenant's category, tenant's floor area in use, tenant/guest's schedule and/or quantity, etc.) can drastically vary from one building to another, leading to inconsistencies and preventing such raw SEC values to be compared in between each other's.

To later enable a relevant comparison in between them, such raw SEC values must be statistically processed though the normalization of some of their operational parameters, to finally obtain a **normalized SEC values** (also called **Energy Performance (EP)** value).

It is to be noted that some countries use another terminology: **EUI (Energy Usage Intensity)** instead of "raw" SEC profile.

Finally, the main objective of defining SEC profiles is to **establish a unified methodology** on how to assess the performance of one building type(s), so that it can be compared with other similar buildings.

Tool #2 – A National Building Energy consumption Benchmarking system:

The US department of Energy states that Building **energy consumption Benchmarking** is the practice of comparing the measured performance (SEC profile) of a building to itself, its peers, or established

norms, with the goal of informing and motivating performance improvement. It is specific to building typologies and climate zones.

This mechanism is used to measure energy performance of an individual building over time by comparing it to similar buildings (for building in operations) or to modelled simulations of a reference building (such as an EE building code compliant building) for a building at design stage.

Energy consumption benchmarking aims at supporting governmental entities, building owners, managers and operators, and designers to measure, plan, and improve energy performance of **buildings.**

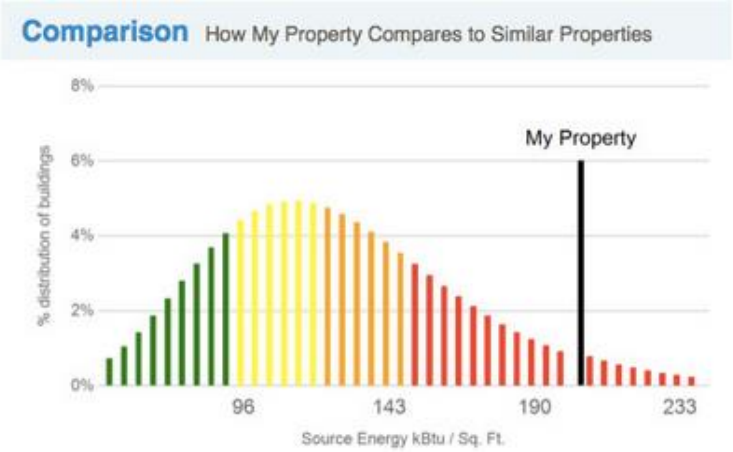

Figure 2 - Energy Benchmarking

Tool #3 – EE Labelling / Certification Scheme:

An **EE labelling / certification** (or **Energy Performance Certification** EPC) is an important policy intervention that can help raise awareness of energy consumption and address the market failures that cause sub-optimal uptake of energy efficiency in buildings. It provides an incentive to improve EE in buildings.

An EE certification is primarily based on the assessment of the value of an energy performance indicator by comparison against one or more reference values, possibly including a visualization of the position on a continuous or discrete scale (based on Stars, Classes (i.e. from A to G), etc.) depending on the country. It can be applied to both new and existing buildings, and be set as mandatory or voluntary.

The proposed EE Labelling / Certification Scheme is a performance-based rating one, established from the National Energy Benchmarking system and its SEC profiles distribution to assess the energy efficiency level of individual buildings.

It consists in 3 main steps:

- The assessment of the energy performance of a building.
- The issuance of a certificate rating the building's energy performance.

- The communication of this information to stakeholders through publication of the certificate.

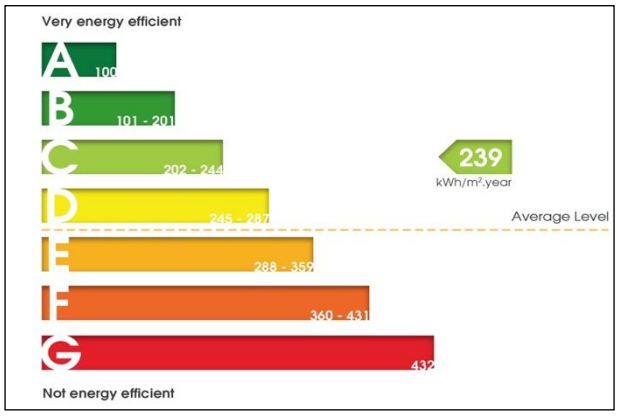

Figure 3 - EE label / Certificate representation

Tool #4 – M&V Protocol:

The **International Performance for Measurement and Verification Protocol (IPMVP)** core concepts states that "a M&V Protocol is a process of planning, measuring, collecting data, analyzing, verifying and reporting energy savings *within an individual facility resulting from the implementation of energy conservation measures (ECMs)".*

M&V activities consist of some or all of the following[Error! Reference source not found.]*:*

- *Meter installation calibration and maintenance,*
- *Data gathering and screening,*
- *Development of a computation method and acceptable estimates,*
- *Computations with measured data, and*
- *Reporting, quality assurance, and third-party verification of reports."*

Actual savings are then determined by comparing measured energy usages before and after retrofitting works implementation.

The promulgation of such a protocol is necessary for the market to set up a common "language" and how to record energy savings. It is the conducive to the development of ESCOs and the deployment Energy Performance Contracts.

Finally, this set of tools shall support building owners and other stakeholders in the building sector:

- Getting accurate figures of the energy performance of individual buildings of various building typologies in different climate zones through their respective SEC Profile;
- Assessing their energy consumption / performance by yearly comparing them with the National Energy Benchmarking system.
- Disclosing building energy performance information transparently in the real estate marketplace by applying for EE Labelling / Certification;
- Updating SEC Profiles, National Energy Benchmarks and EE Labelling / Certification to monitor the energy performance of the national building stock.
- Setting a commonly agreed methodology to calculate and secure energy savings over time and encouraging / facilitating ESCOs' implementation of Energy Performance Contracts / green loans attributions following a nationally endorsed energy savings M&V Protocol.

In addition, the implementation of the 3 first tools is expected to generate a virtuous circle that would allow MOC to be provided with a first concrete feedback on the actual energy efficiency performance of the national building stock. Such new data should later become key to increase code compliance and upgrade/ update the Building Energy Efficiency Code QCVN09:2017/BXD. Finally it shall increase national EE capacity of the construction industry, save electricity and cut Green House Gas emittions.=

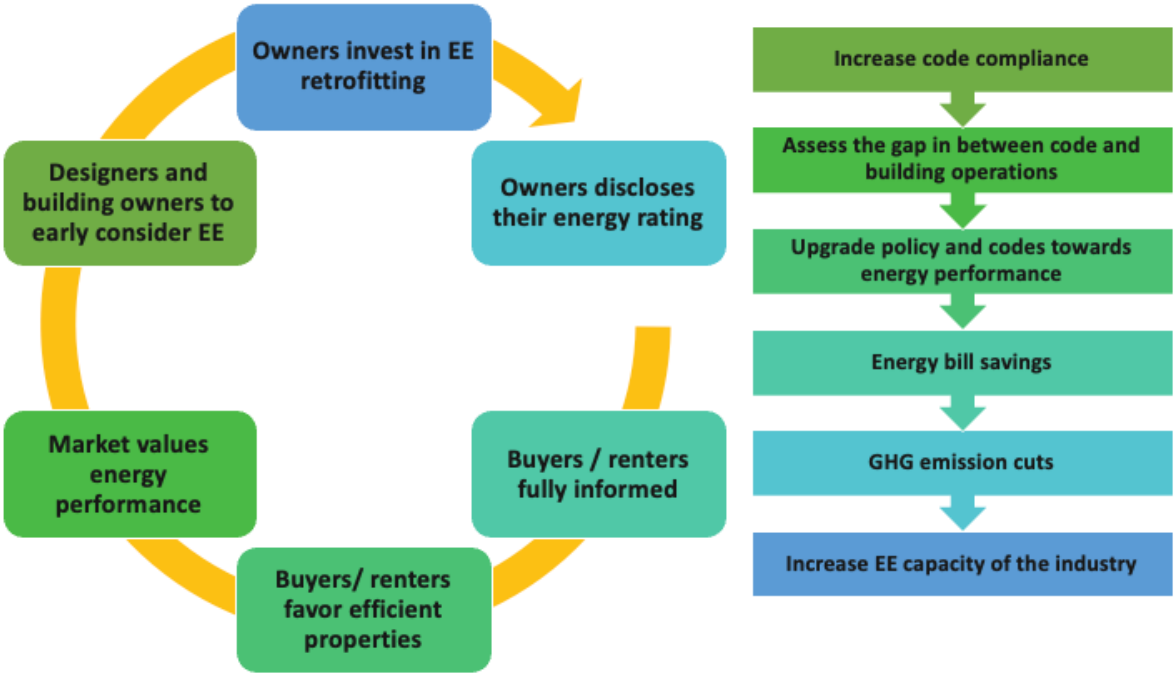

Figure 4– Overall Expected synergies from SEC, energy benchmarks, EE certification and M&V monitoring implementation for the construction industry

2.2 Development & outcomes

2.2.1 Tool #1: SEC Profiles – energy performance indicators among different building typologies and climate zones

Definition of building typologies & climate zones:

It had been decided to optimize the ratio level of confidence / sample size so that required sample sizes could still ensure a sufficient confidence level (i.e. 95%) while keeping the total number of buildings to survey within an acceptable range (from time and budget perspectives).

Firstly, regarding building typologies, the expected scope of buildings typologies to be covered within the project boundaries was initially rather exhaustive: “High-Rise Commercial and Residential Buildings”. It had been agreed by all parties that it would be too complicated to get accurate and relevant data within the residential sector. Surveying households is completely different from surveying office, malls, or hotels because there are many different types of daily routines among households which vary the energy consumption from one household to another, as well as from one residential building to another. It requires a completely different methodology (survey forms, training courses and supervision) to select and collect the characteristic data of each residential building. Therefore, it was decided to remove Residential buildings from the surveys. It was also decided to avoid mixed-use buildings, and to focus on appropriate building size (GFA ≥ 2,500m^2). Considering the different regulations and cost

norms for buildings managed by private and public entities, Governmental Administrative Office buildings were later separated from Commercial Office Buildings. Later on, based on the analysis of the data collected in the project phase 1 (2018-2020)[1], it was found that the sizes of commercial office buildings affected the building energy performance and thus two sub-typologies including Small Commercial Office (2,500m^2 ≤ GFA < 7,500m^2) and Large Commercial Office (GFA ≥ 7,500m^2) were defined. Besides, as different energy usages would be expected from different standards and occupants' demands, 2&3-star Hotel and 4&5-star Hotel were distinguished as two different typologies.

Secondly for climate zones, initially the three areas of Hanoi, Ho Chi Minh City and Da Nang were to be considered. However, due to lbudget contraints, and to the fact that there might not have enough representative units for each typology in Da Nang, finally all typologies except 2&3-star hotels, were removed for Da Nang.

The finally selected typologies and climate zones for data collection were decided to be:

(1) Governmental Administrative Office buildings in Hanoi and Ho Chi Minh City

(2) Small Commercial Office buildings in Hanoi and Ho Chi Minh City

(3) Large Commercial Office buildings in Hanoi and Ho Chi Minh City

(4) Malls in Hanoi and Ho Chi Minh City

(5) 2&3-star Hotels in Hanoi, Da Nang and Ho Chi Minh City

(6) 4&5-star Hotels in Hanoi and Ho Chi Minh City

Data collection

Data collection is indeed the basis for defining SEC Profiles and therefore National Energy Benchmarks (Tool #2), which should then be also used also to establish the EE Labelling / Certification Scheme (Tool #3). The purpose of these surveys was not to provide a list of potential savings and actions to be conducted (i.e. not linked to the Tool #4 – M&V Protocol), therefore it did not consist in an energy audit as per MoIT regulation. Because of the limited building performance data available in Vietnam, data collection was implemented through building surveys. The building surveys were thus designed to focus on collecting general energy consumption and physical data of buildings.

The surveys focused on simply collecting field data, including:

(1) Electricity consumption;

(2) Gross Floor Areas (GFA);

(3) Occupancy: operating hours (for malls & office buildings), number of guests / rooms per night (for hotels).

at both building and tenants levels for the selected typologies of buildings and climate zones. Several evidences to confirm collected data were requested to survey firms, in order to crosscheck the collected data, thus ensuring accuracy of these 3 key data fields[2]. In order to prevent any 'abnormal" buildings from being selected during energy surveys and then ensure the finally expected number of buildings

[1] Refer to *Section 3.1.1*, *Technical Report – Component 5.6: FINAL REPORT ABOUT SEC AND ENERGY BENCHMARKS FINAL REPORT ABOUT SEC PROFILES AND ENERGY BENCHMARKS*

[2] Refer to *Section 3.1.4*, *Technical report – Component 4.2 – BUILDING ENERGY SURVEYS SCOPE, METHODOLOGY AND FORMS*

for the development of SEC Profiles and National Energy Benchmarks, the appointed survey firms had to provide a list of buildings to the consultant team for prior assessment and approval, before implementing the surveys.

Generally, a SEC value is directly calculated from total energy consumption and gross floor area data (to be more precise, these values shall be called "raw SEC values" henceforward). However, that simple calculation may be not applicable in certain building typologies which are occupied by many individual occupants. As a matter of fact, occupancy characteristics (e.g. tenant's category, tenant's floor area in use, tenant / guest's schedule and / or quantity) are irregular and change from one building to another. The difference in occupancy characteristics may lead to significant variation between raw SEC values. If raw SEC values are used, SEC Profiles developed by them may become inaccurate for certain existing buildings, thus reducing its representation level[3].

Consequently, a tailored methodology was developed solely based on statistical and regression analysis to minimize those variations and determine the representative and normalized SEC Profiles for office buildings and malls. For hotels, a simplified process[4] was applied due to their different building characteristics in comparison with office buildings and malls.

The building surveys were successfully carried out by two third-party energy survey firms (one in Northern Vietnam and another in Southern Vietnam) following guidelines and data collection forms prepared by National Consultant (NC). All data collected were then reviewed by the National Consultant (NC). Eventually, the sufficient number of buildings surveyed (15 buildings for each typology in each climate zone) was successfully set to achieve a 95% of confidence level for the calculated energy benchmarks developed from collected[5] data.

Development of SEC Profiles

With the aim of realistic and accurate SEC Profiles, two different development processes[6] have been developed for Office buildings & Malls (5-stage-process) and Hotels (3-to-4-stage-process) in consideration of different characteristics between these building typology groups. In the end, the final SEC Profiles[7] proved their consistency and accuracy by analyzing the Energy Benchmarks generated from them.

[3] For instance, the benchmarks for malls with 100% of tenants are not applicable for all malls in the same climate zone

[4] Refer to *Appendix 1*, *Technical Report – Component 5.6: FINAL REPORT ABOUT SEC AND ENERGY BENCHMARKS FINAL REPORT ABOUT SEC PROFILES AND ENERGY BENCHMARKS*

[5] Refer to *Section 3.1.2*, *Technical Report – Component 5.6: FINAL REPORT ABOUT SEC AND ENERGY BENCHMARKS FINAL REPORT ABOUT SEC PROFILES AND ENERGY BENCHMARKS*

[6] Refer to *Section 3.1.3*, *Technical Report – Component 5.6: FINAL REPORT ABOUT SEC AND ENERGY BENCHMARKS FINAL REPORT ABOUT SEC PROFILES AND ENERGY BENCHMARKS*

[7] Refer to *Section 3.2*, *Technical Report – Component 5.6: FINAL REPORT ABOUT SEC AND ENERGY BENCHMARKS FINAL REPORT ABOUT SEC PROFILES AND ENERGY BENCHMARKS*

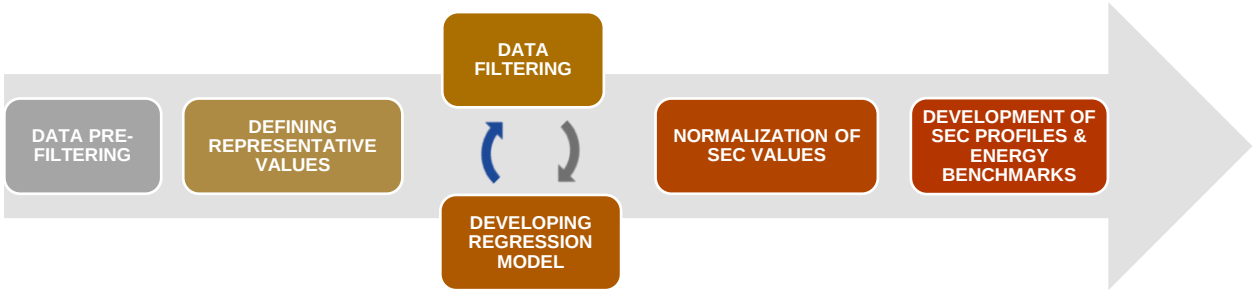

Figure 5 – Overall SEC profile development process for Office buildings & Malls

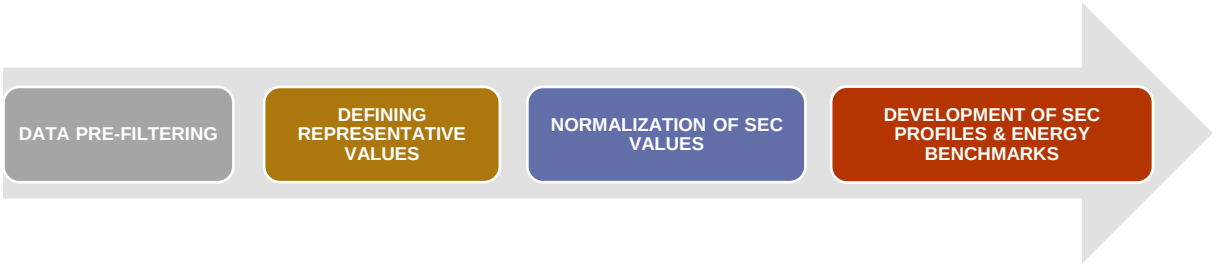

Figure 6– Overall SEC profile development process for 2&3-star Hotel (North & South

Figure 7 – Overall SEC profile development process FOR 2&3 star Hotel (Center and 4&5 star

More details of the development of SEC Profiles can be found in *Section 3 and 4, Technical Report – Component 5.6: FINAL REPORT ABOUT SEC AND ENERGY BENCHMARKS FINAL REPORT ABOUT SEC PROFILES AND ENERGY BENCHMARKS*.

Final outcomes

Annex A of *this report* provides the summary of calculated SEC Profiles for three years (2017 – 2019) per building typology and climate zone. More detailed graphs can be found in *Section 4.3, Technical Report – Component 5.6: FINAL REPORT ABOUT SEC AND ENERGY BENCHMARKS FINAL REPORT ABOUT SEC PROFILES AND ENERGY BENCHMARKS*.

The final results of SEC Profiles were evaluated following 2 criteria:

(1) Representativeness of sampling sets: In order to quantify the representativeness of SEC Profiles, the level of confidence was calculated for each building typology and each climate zone based on

the sampling sizes. The results show that all SEC Profiles have finally achieved the initially targeted moderately high confidence level of 95%[8].

(2) Compatibility of distribution models: As the SEC Profiles were developed from a representative set of sampled buildings and an assumed distribution model, it was necessary to determine the differences between the data calculated based on the selected distribution function (Normal Distribution) and the actual statistical data from the calculated SEC values. The results show that most of the SEC Profiles have been consistent. However, for the specific Governmental Administrative Office typology, few data points belonging to office buildings feature very low SEC values, indicating a moderate inconsistency (the percentage of difference is higher than 15%) with the curve profile generated[9].

In conclusion, final SEC Profiles are sufficiently representative and accurate to develop National Energy Benchmarks although further actions can be implemented to further improve their accuracy in the future (as referred in *section 2.4* of *this report*).

2.2.2 Tool #2: National Energy Consumption Benchmarking system – setting national comparative references to assess energy performance level for different building typologies and climate zones

Statistical analysis

The statistical analysis of SEC Profiles was conducted to work out this benchmarking system based on SEC profile statistical distribution. They are quartiles[10] of normalized SEC Profiles for Office buildings & Malls (exceptionally in case of certain Hotel typologies[11], the raw SEC Profiles were used):

(1) Top quartile: values below the 25th percentile* value (≤ Q1)

(2) 2nd quartile: values between the 25th and the 50th percentile* value (> Q1 & ≤ Q2)

(3) 3rd quartile: values between the 50th and 75th percentile* value (> Q2 & ≤ Q3)

(4) Bottom quartile: values above the 75th percentile* value (> Q3)

* *A percentile is a measure used in statistics indicating the value below which a given percentage of observations in a group of observations fall. For example, the 25th percentile is the value below which 25% observations may be found*.

[8] Refer to *Section 3.3.4*, *3.3.5* and *3.3.6*, *Technical Report – Component 5.6: FINAL REPORT ABOUT SEC AND ENERGY BENCHMARKS FINAL REPORT ABOUT SEC PROFILES AND ENERGY BENCHMARKS*

[9] Refer to *Section 3.1.5.1*, *Technical Report – Component 5.6: FINAL REPORT ABOUT SEC AND ENERGY BENCHMARKS FINAL REPORT ABOUT SEC PROFILES AND ENERGY BENCHMARKS*

[10] Refer to *Section 2.3.2*, *Technical Report – Component 5.6: FINAL REPORT ABOUT SEC AND ENERGY BENCHMARKS FINAL REPORT ABOUT SEC PROFILES AND ENERGY BENCHMARKS*

[11] Refer to *Section 3.1.3*, *Technical Report – Component 5.6: FINAL REPORT ABOUT SEC AND ENERGY BENCHMARKS FINAL REPORT ABOUT SEC PROFILES AND ENERGY BENCHMARKS*

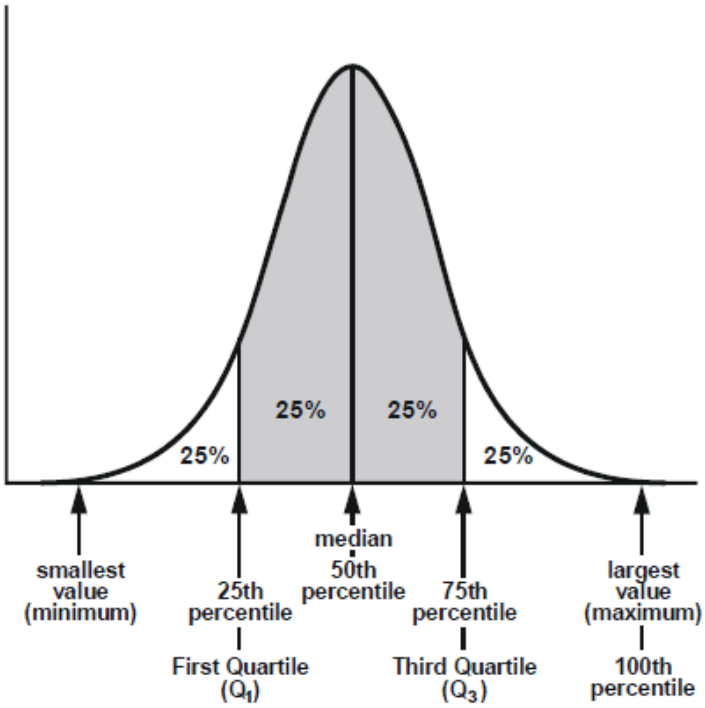

Figure 8– Illustration of quartiles on a distribution curve

Final outcomes

Annex A of *this report* provides the summary of National Energy Benchmarks for three years (2017-2019) per building typology and climate zone. These first National Energy Benchmarks calculated feature the following characteristics:

- The different office building categories (Governmental Administrative Office, Small & Large Commercial Offices) prove a strong consistency with Singaporean Benchmarks[12];
- Most recorded differences in Energy Benchmarks values between climate zones can be logically explained by the collected data[13];
- Levels of confidence of all SEC Profiles and Energy Benchmarks were designed to reach 95%[14].

However, some actions can be implemented to furthermore improve the effectiveness of National Energy Benchmarks (refer to *section 2.4* of *this report*).

[12] Refer to *Section 3.3.2*, *Technical Report – Component 5.6: FINAL REPORT ABOUT SEC AND ENERGY BENCHMARKS FINAL REPORT ABOUT SEC PROFILES AND ENERGY BENCHMARKS*

[13] Refer to *Section 3.3.3*, *Technical Report – Component 5.6: FINAL REPORT ABOUT SEC AND ENERGY BENCHMARKS FINAL REPORT ABOUT SEC PROFILES AND ENERGY BENCHMARKS*

[14] Refer to *Section 3.3.4*, *3.3.5* and *3.3.6 Technical Report – Component 5.6: FINAL REPORT ABOUT SEC AND ENERGY BENCHMARKS FINAL REPORT ABOUT SEC PROFILES AND ENERGY BENCHMARKS*

2.2.3 Tool #3: EE Labelling / Certification Scheme – building performance ranking system for individual buildings

Definition of EE labelling classes

As the EE Labelling / Certification Scheme is a rating system, the definition of EE labelling classes remaned the main focus. Following the fact that the National Energy Benchmarking system provides a representative energy performance index for individual building typologies and regions, data from these National Energy Benchmarks (i.e. median values) were used as reference values to define EE labelling classes. The definition process had been developed based on the recognized EE Labelling Schemes of Singapore and some European countries, in strict accordance with ISO 52003-1:2017 standard.

Annex B of *this reports* provides the brief definition of EE labelling classes for Vietnam.

It was necessary to determine appropriate modulation coefficients to define class ranges for each typology and climate zone. After several tests performed with different values for each typology and climate zone, the most appropriate value for Rm was selected to be 0.7. T,his same coefficient shall be applied to all building typologies and climate zones for this first pilot test of EE Labelling / Certification Scheme in Vietnam

More details related to the definition/calculation of coefficient tests can be found in *Section 3.2, Technical Report – Component 1: PILOT TEST OF THE EE LABELLING SCHEMES FOR ALL SURVEY BUILDINGS*.

Definition of EE labelling procedure

In the *Construction Law (revised in 2020)*, the government stated that it strongly encourages the development of EE buildings. It is then expected that the Ministry of Construction shall soon issue a circular related to "*Guiding the certification activities of buildings using efficient energy and natural resources and environmental protection*". This one shall state that the assessment, ranking and certification of energy performance of buildings shall be the mission of accredited certification bodies.

In addition, it is expectded that the final draft of the Standard *"TCVN xxxxx-1:2020 - …"*, which is. based on *"ISO 52003-1:2017 - Energy performance of buildings. Indicators, requirements, ratings and certificates. General aspects and application to the overall energy performance"* shall also been soon approved ans promulgated. This one specifies that the procedure to define an energy efficiency certification system for a building shall be undertaken in five steps (as follows) to ensure the transparency and accessibility in the real estate marketplace (limited to existing buildings):

- Step #1: The building owner / operator shall prepare submital documents and register the building with the accredited certifying organization to apply for the certification.
- Step #2: The accredited certifying organization shall receive the submital documents and evaluate whether the building is eligible for the certification by preliminarily checking building's information in submital documents. The acceptance of certification application will be notified to the building owner / operator.
- Step #3: On the basis of the application for certification, the accredited certifying organization will carry out the procedure as follows:
    - A building site survey shall then be jointly organized by the certification body, building developer(s) and building operator(s). Relevant data related to electricity consumption within one year, number of building operation hours (per week, per month and per year), level of building occupation or vacancy within the survey time, etc. shall be collected. The building energy performance boundary shall be examined in fact and used for the assessment of energy efficiency.

- Step #4: Based on the calculations of energy consumption within one year per square metre of the building, the accredited certifying organization shall then determine the achieved energy efficiency level.
- Step #5: The accredited certifying organization shall award an energy efficiency certification which shall be valid for five years. At the same time, a report on the assessment outcomes of the building along with a formal certification as requested in this standard shall be sent to the local Department of Construction.

Final outcomes

Thanks to the optimised class ranges definitions, the distribution of collected building datasets are evenly falling in Classes C, D and E[15]. However, there are still few barriers left to address to fully enable the implementation of the EE Labelling / Certification Scheme (refer to *section 2.4* of *this report*).

2.2.4 Tool #4: M&V Protocol – Process to plan, measure, analyse, verify and report energy savings

Analysis and selection of an M&V Protocol

To date, Vietnam still has not promulgated any standardized guideline and methodology to calculate energy savings). In order to find out the most adapted M&V system for a local use, ten different existing international M&V protocols were reviewed[17] and among them, only the four following protocols were carefully considered.

- ASHRAE Guideline 14;
- Measurement and Verification for Federal Energy Projects – FEMP;
- International Performance Measurement and Verification Protocol (IPMVP);
- ISO 17741:2016.

Finally , the IPMVP (used as an official reference in ISO 17741:2016) was identified as the most appropriate protocol for implementation in Vietnam. In order to better suit the local context, M&V specific guidelines for Vietnam were also developed. The ISO standards for Energy Management, including ISO 17741:2016, are being translated and adapted in the Vietnamese Standard *"TCVN …"* (standard's name has not been decided yet). It is suggested that this dedicated TCVN shall be used as a basis for a local M&V Protocol.

The IPMVP – Core Concept4 introduces energy savings as "cannot be directly measured", because savings represent the absence of energy consumption or demand. Instead, savings are determined by comparing measured consumption or demand before and after implementation of a program, making suitable adjustments for changes in conditions. The comparison of before and after energy consumption or demand should be made on a consistent basic, using the following general M&V equation:

*Savings = (Baseline Period Energy - Reporting Period Energy) ± Adjustments**

* The "Adjustments" term in this equation brings energy consumption or demand in the two time periods to the same set of conditions. Conditions commonly affecting energy use are weather, occupancy, and equipment operations required by these conditions".

[15] Refer to *Appendix 4, Technical Report – Component 1: PILOT TEST OF THE EE LABELLING SCHEMES FOR ALL SURVEY BUILDINGS*

More details of the development of M&V Protocol can be found in *Technical Report – Component 1: STUDY AND ANALYSIS OF BUILDING ENERGY M&V SCHEMES / SYSTEMS WORLDWIDE AND POSSIBLE IMPLEMENTATION IN VIETNAM*.

Final outcomes

Based on developed M&V guidelines for Vietnam, there are usually three parties involved in energy savings M&V, as follows:

(1) Energy service provider (ESCO) – M&V planner & performer who shall take responsibility for planning and implementing the M&V;

(2) Project's owner – M&V beneficiary who shall benefit the most from the M&V savings;

(3) Third-party agent – M&V adviser / verifier who shall provide advice during the planning of the M&V and / or conduct the M&V savings determination processes.

In situations where no third-party agent involved, such responsibilities are usually taken by the ESCO unless the project's owner directs the ESCO otherwise.

Below is an illustration of the ten proposed major steps for in conducting M&V in the developed Guidelines.

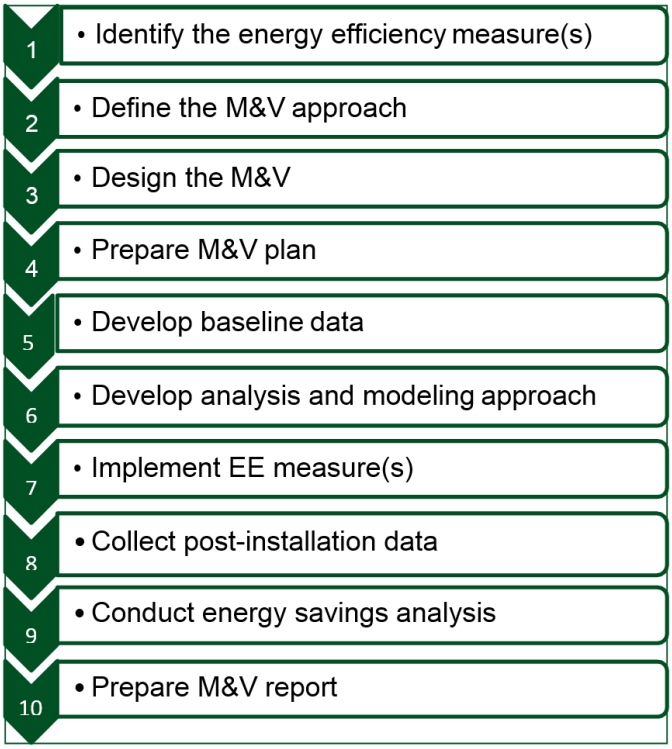

Figure 9 – Major steps in conducting M&V

The details of the M&V approach, plan and report can be found in *Section 3, 4 and 5, Technical Report – Component 1: ENERGY MEASUREMENT AND VERIFICATION GUIDELINES FOR EXISTING BUILDINGS IN VIETNAM*.

In conclusion, the selected M&V guidelines are well suited and adapted, featuring detailed protocols and instructions in consideration of the Vietnam local context. However, implementing such a M&V system is still to be tested as there has not been any completed pilot test locally performed yet. At this stage, only a few barriers for implementation of M&V Protocol have been identified and need to be addressed (refer to *section 2.4* of *this report*).

2.3 Links and synergies among the four EE tools – introduction of Online Data Submission Platform

The diagram hereafter presents briefly the global scheme and links between the four EE tools.

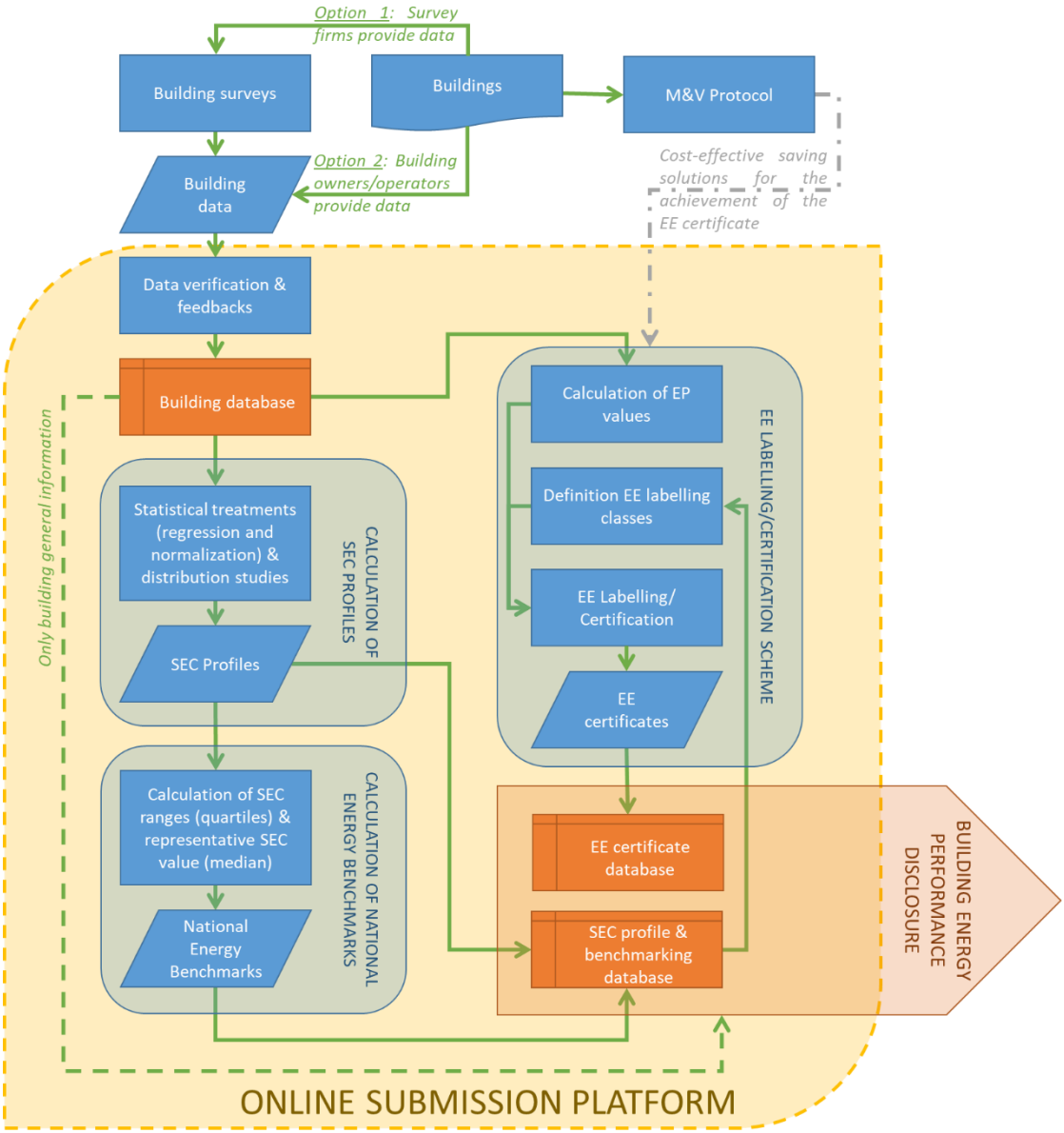

Figure 10– Global scheme and links between the four EE tools

As featured on the above diagram, there are strong links and interdependances (data processes and transfers) between the four developed EE tools listed as follows:

- SEC Profiles are individual energy performance indicators defined for various building typologies in different climate zones, and constitute the base on which the National Energy consumption Benchmarking is defined;
- The National Energy Benchmarking system forms the basis to set up the EE labelling class intervals of the EE Labelling / Certification for existing buildings;

- An Energy saving M&V Protocol is an essential and cost-effective tool for building owners / operators who look for third-party involvement and/or investment to implement energy saving solutions in their own buildings.

In addition, during the calculation of SEC Profiles, National Energy Consumption Benchmarks and EE Labelling / Certification, three different databases are generated as follows:

(1) Building database where all necessary data for the calculation of SEC Profile and EE Labelling / Certification are stored, including general information (e.g. building name, address, construction and operation years, building owner's contact, etc.), building sizes (e.g. number of floors, gross floor area and its breakdown, room capacity, etc.), building operation (e.g. operating hours, monthly average number of room occupied per night, etc.) and energy consumption (i.e. monthly electric uses) are stored;

(2) SEC profiles and energy consumption benchmarking database where annual SEC Profiles and National Energy Benchmarks are stored;

(3) EE certificate database where information about EE certificate (i.e. EE class, issue date, expiration date) are archived.

The two latter databases and building general information shall be disclosed to the public to:

- Promote high performing buildings and related retrofitting works.
- Allow potential buyers, renters, and investors to make informed transactional decisions that take building energy performance into consideration.

More details about building energy performance information disclosure can be found in *Technical Report – Component 1: PATHWAY AND ROADMAP FOR THE IMPLEMENTATION OF BUILDING ENERGY PERFORMANCE INFORMATION DISCLOSURE SYSTEM IN VIETNAM*.

In order to secure these databases and facilitate data processing and transfers between EE tools (as showed on the above diagram), an Online Submission Platform has been developed and its final version is expected to be completed by mid 2021. It shall feature the following functions:

- *Function #1*: Record and verify building data from building surveys and provide feedback to data collector (survey firm or building owner / operator) if needed;
- *Function #2*: Calculate and update annually SEC Profiles & National Energy Benchmarks;
- *Function #3*: Upload annual SEC profiles & national energy benchmarking reports;
- *Function #4*: Calculate buildings' respective EP values and identify building EE labelling classes / certificates (EE Labelling / Certification);;
- *Function #6*: Publish annual SEC profiles & national energy benchmarking reports and the up-to-date list of certified buildings with their general information and EE labelling levels;
- *Function #7*: Store buildings data, SEC profiles, benchmarking and EE certificate databases every year.

2.4 Lessons learned / recommendations

Below is the summary of lessons learned / recommendations for the development of four EE tools.

Table 1 – Lessons learned / recommendations for the development of four EE tools

ID	Subject	Status	Lesson learned / recommendation for the future development	Application timeline for lesson learned / recommendation
General				
#1.1	Assign / establish an EE excellence center	No decision has been made as regards the entity responsible for the development of SEC Profiles, National Energy Benchmarks, EE Labelling / Certification Scheme and Online Data Submission Platform in the future.	Assign / establish a specific department responsible for the development of SEC Profiles, National Energy Benchmarks, EE Labelling / Certification Scheme and Online Data Submission Platform to facilitate the data collection and verification works, and ensure that there shall not be any conflict of interest.	2021-2022
Tool #1: SEC Profiles				
#2.1	Quantify the actual building stock	The calculation of necessary sample sizes for the targeted confidence level (95%) was conducted following few assumptions without knowing the actual size of the building stock[16]. The results of calculation were thus less realistic than the direct statistical analysis of the actual building stock.	Conduct an assessment / quantification of the building stock (number of buildings per building typology, per year of built and per GFA range) to enable the improvement of the level of confidence of calculated Energy consumption benchmarking.	2021-2023
#2.2	Standardise definition of data collection methodologies for other future similar projects / typologies	It was impossible to use collected data during other previous projects, as collected data widely differ / were found inconsistent from one project to another (e.g. VCEP /USAID).	Consider applying defined data collection methodologies for this project for any similar future project / campaign that requires building energy data collection in the future can be considered	2021 and beyond

[16] Refer to *Appendix 2*, *Technical Report – Component 5.6: FINAL REPORT ABOUT SEC AND ENERGY BENCHMARKS FINAL REPORT ABOUT SEC PROFILES AND ENERGY BENCHMARKS*

ID	Subject	Status	Lesson learned / recommendation for the future development	Application timeline for lesson learned / recommendation
			homogeneou, keyed in the existing database and be processed accordingly.	
#2.3	Establish and promulgate a building energy consumption disclosure policy	The data collection was easily and successfully implemented by survey firms thanks to their relationship with building owners. In fact, they are energy audit firms and most of the building owners participating in this project were their current or past clients. In general, it is rather difficult to approach building owners without having any official mandate. Building owners hardly share their data without incentive gifts or mandatory demand from Vietnamese authorities.	Establish and promulgate a building energy consumption disclosure policy (At first on a voluntary and later on a mandatory basis) for the annual development of National Energy Benchmarking, to facilitate data collection and expand ,sampling sizes.	2022-2023
#2.4	Launch the online submission database	The building surveys were successfully carried out by two third-party energy survey firms (one in Northern Vietnam and another in Southern Vietnam) following guidelines and data collection forms prepared by National Consultant (NC). All data collected were reviewed by the National Consultant (NC).	Launch the online submission platform (linked to *section 2.3* of *this report*) for data collection, SEC profiles and energy benchmarks definition. developement. Besides ensure that the EE excellence center has been established and relevant staff trained.	2021 and beyond
#2.5	Collect additional data during surveys & upgrade calculation methodologies for SEC Profiles if needed.	For most typologies, calculation methodolgies have been set and should be kept the way they are. During the development of Mall SEC Profiles, SEC values have been successfully normalized without knowing a few additional characteristics,	For the Mall typology, collect the information regarding the availability of considerable functional areas included in the non-tenant area and considerable energy use of tenant included in the non-tenant consumption by	2021 and beyond

ID	Subject	Status	Lesson learned / recommendation for the future development	Application timeline for lesson learned / recommendation
		but it took a lot of time to define the appropriate regression models. Several other data would have been useful to facilitate the definition of regression models, such as:: • Is there any considerable functional area included in the non-tenant area such as a supermarket / hypermarket in Malls or a large working office of building's owner in Commercial Office buildings? • Is there any considerable energy use of tenant included in the non-tenant consumption such as plug load, lighting, HVAC system?	adding simple tick boxes in the data collection list. Divide buildings within a building typology into subgroups based on those characteristics during the definitions of regression models (e.g. malls including their supermarket and HVAC consumption in the non-tenant consumption, malls including only lighting consumption in the non-tenant consumption, etc.) while ensuring that the sampling size in each subgroup shall be higher than 5 buildings to allow running the regression process. However, in the end, SEC Profiles shall be developed for each building typology, not subgroup. This lesson learned shall help save more time and efforts on defining the regression models.	
#2.6	Increase number of encompassed building typologies & climate zones.	The EECB initially focused on 6 building typologies and 3 climate zones for SEC Profiles.	Define calculation methodology and establish SEC Profiles for more building typologies, (such as high rise residential buildings, schools, hospitals, etc.) and more climate zones (to be studied further).	2026 and beyond
Tool #2: National Energy Benchmarks				
#3.1	Yearly update, promulgate, and advertise National Energy	National Energy consumption Benchmarks have been successfully defined for 6 building typologies in 3 climate	Keep on updating, promulgating, and advertising annually the National Energy consumption Benchmarks	2022 and beyond

ID	Subject	Status	Lesson learned / recommendation for the future development	Application timeline for lesson learned / recommendation
	consumption Benchmarks	zones for three years (2017 – 2019)	on the online submission platform.	
#3.2	Define and , promulgate national energy performance targets and a transparent penalty and reward system	The Government has not established yet national energy performance targetsfor existing buildings.	Study SEC Profiles and National Energy Benchmarks in the period 2017-2019 (final results of Tool #1 & Tool #2), then define the national energy performance target for the period 2021-2024; Publish the national energy performance targets under the form of government policy (or integrate it in the Vietnamese building energy code) based on a transparent penalty and reward system Analyze SEC Profiles and National Energy Benchmarks in each 5-year period, then redefine the national energy performance target every 5 years.	2026 and beyond
Tool #3: EE Labelling / Certification Scheme				
#4.1	Pilot and broaden the implementation of the EE certification system	EE certificates will be awarded to 5 pilot performing buildings by the EEBC project.	Train the EE excellnce center to supervise the roll out of the EE certification programme.	2022-2023
#4.2	Promulgate, and advocate an official EE Labelling / Certification Scheme	EE certification Scheme for existing building has only been tested and piloted by the EECB project. It has not yet been released to the public. MOC has not yet endorsed the proposed EE certification system	Endorse, promulgate and advertise the EE certification Scheme for existing buildings, based on the online developed platform .	2022 and beyond

ID	Subject	Status	Lesson learned / recommendation for the future development	Application timeline for lesson learned / recommendation
			Beside, in a near future, MOC shall work on defining EE certificate for new buildings, that should be based on energy modelling. This could happen through the definition of a performance based compliance pathway, that should be created alongside the existing prescriptive pathway.	
#4.3	Define incentives for highly performing EE certificate	At that satge no financial nor financial incentives have been defined to encourage building owners to improve and excel in terms of energy performance .	Associate with energy providers and departments related to land taxes in order to determine out the most appropriate form of incentives for buildings achieving high level EE certificate (Level A or B).	2022-2023
Tool #4: M&V Protocol				
#5.1	Conduct pilot tests of the M&V Protocol	There has not been any completed pilot test of M&V Protocol in Vietnam.	Run at least 2 pilot tests for new constructions and 2 pilot tests for existing buildings. The results of pilot tests shall be used to finalize Standard *"TCVN …"* related to M&V Protocol and guidelines.	2021-2023
#5.2	Promulgate the selected energy saving M&V Protocol and guidelines	M&V Protocol and guidelines was successfully developed by the EECB project, based on ISO 17741:2016 which is based on the IPMVP. The technical standard has been translated into Vietnamese.	Officially promulgate and publish the related Standard *"TCVN …"* with the related M&V guidelines as an appendix after the completion of pilot tests. Update M&V Protocol and guidelines every 4 years if necessary.	2024 and beyond

ID	Subject	Status	Lesson learned / recommendation for the future development	Application timeline for lesson learned / recommendation
Online Data Submission Platform				
#6.1	Promulgate and improve the Online Data Submission Platform	The dedicated Online Submission Platform has been tested with initially collected data. However, it only contains data for the years 2017-18-19.	Collect feedbacks from users during the operation Online Data Submission Platform so that the platform interface can be further optimised. Ensure the EE excellence centers always have the capacity to run, supervise and improve the plateform	2021 and beyond

3 OVERALL CONCLUSION & DEVELOPMENT AND IMPLEMENTATION ROADMAP

In conclusion, this project successfully developed strong foundations (in terms of methodologies, technical guidelines and pilot applications) for all key EE tools necessary to promote building energy efficiency in Vietnam. However, such an endeavour requires a continuous implementation, update/upgrade of such tools, to improve their accuracy and relevance as well as the development of other ones to further broaden their scope of implementation. Based on the lessons learned / recommendations detailed in *section 2.4* the proposed roadmap (2021-2030) for the development and application of such EE tools is summarized as follows.

Subject	Year									
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
#1.1: Assign / establish a EE excellence center #2.1: Quantify of the actual building stock	■	■								
#5.1: Conduct pilot tests of M&V Protocol	■	■	■							
#2.2: Standardise defined data collection methodologies for other future similar projects / typologies #6.1: Implement and improve the Online Data Submission Platform	■	■	■	■	■	■	■	■	■	■
#2.3: Establish and promulgate a building energy consumption disclosure policy		■	■							
#2.4: Launch the online submission database	■	■	■							
#4.1: Pilot and broaden the implementation of the EE certification system #4.3: Define incentives for highly performing EE certificate		■	■							

Subject	Year									
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
#2.5: Collect additional data during surveys & update calculation methodologies for SEC Profiles when needed. #3.1 & #4.2: Yearly update, promulgate, and advertise National Energy consumption Benchmarks & Promulgate, and advocate an official EE Labelling / Certification → Using Online Data Submission Platform (function *#2 – #7* in *section 2.3* of *this report*)										
#5.2: Promulgate the selected energy saving M&V Protocol and guidelines										
#2.6 Increase number of encompassed building typologies & climate zones. #3.2: Define and , promulgate national energy performance targets and a transparent penalty and reward system Besides, at that later stage additional rating indicators can also be considered, such as: • Carbon footprint indicator (this would need to develop a Carbon footprint calculator earlier in the process); • Net Zero and positive Energy Building label or rating schemes.										

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ANNEX A: SEC PROFILES & NATIONAL ENERGY BENCHMARKS

Table 2 –SEC Profiles & National Energy Benchmarks for 3 years (2017-2019) for 6 building typologies in 3 climate zones

Building type	Climate zone	Year	Quantity of finally selected / qualified buildings	Energy Benchmarks - Median SEC	Energy Benchmarks – SEC ranges [kWh/m^2]			
					Top quartile (≤ 25%)	2nd Quartile (25% - 50%)	3rd Quartile (50% - 75%)	Bottom Quartile (> 75%)
Governmental Administrative Office	North	2017	15	54	≤ 53	[53 – 54]	[54 – 56]	> 56
		2018	15	55	≤ 54	[54 – 55]	[55 – 56]	> 56
		2019	15	56	≤ 56	[56 – 56]	[56 – 57]	> 57
	South	2017	15	47	≤ 46	[46 – 47]	[47 – 47]	> 47
		2018	15	47	≤ 46	[46 – 47]	[47 – 48]	> 48
		2019	15	46	≤ 45	[45 – 46]	[46 – 48]	> 48
Small Commercial Office	North	2017	15	121	≤ 112	[112 – 121]	[121 – 130]	> 130
		2018	15	122	≤ 114	[114 – 122]	[122 – 129]	> 129
		2019	15	128	≤ 121	[121 – 128]	[128 – 135]	> 135
	South	2017	15	120	≤ 110	[110 – 120]	[120 – 130]	> 130
		2018	15	121	≤ 111	[111 – 121]	[121 – 130]	> 130
		2019	15	127	≤ 118	[118 – 127]	[127 – 135]	> 135
Large Commercial Office	North	2017	15	105	≤ 87	[87 – 105]	[105 – 123]	> 123
		2018	15	105	≤ 84	[84 – 105]	[105 – 126]	> 126
		2019	15	107	≤ 90	[90 – 107]	[107 – 124]	> 124
	South	2017	15	201	≤ 191	[191 – 201]	[201 – 211]	> 211
		2018	15	205	≤ 194	[194 – 205]	[205 – 215]	> 215
		2019	15	200	≤ 190	[190 – 200]	[200 – 210]	> 210
Mall	North	2017	15	249	≤ 236	[236 – 249]	[249 – 261]	> 261

Building type	Climate zone	Year	Quantity of finally selected / qualified buildings	Energy Benchmarks - Median SEC	Energy Benchmarks – SEC ranges [kWh/m^2]			
					Top quartile (≤ 25%)	2nd Quartile (25% - 50%)	3rd Quartile (50% - 75%)	Bottom Quartile (> 75%)
		2018	15	245	≤ 232	[232 – 245]	[245 – 258]	> 258
		2019	15	244	≤ 238	[238 – 244]	[244 – 250]	> 250
	South	2017	15	289	≤ 281	[281 – 289]	[289 – 297]	> 297
		2018	15	286	≤ 278	[278 – 286]	[286 – 294]	> 294
		2019	15	293	≤ 284	[284 – 293]	[293 – 302]	> 302
2&3-star Hotel	North	2017	15	113	≤ 93	[93 – 113]	[113 – 133]	> 133
		2018	15	108	≤ 88	[88 – 108]	[108 – 128]	> 128
		2019	15	113	≤ 93	[93 – 113]	[113 – 133]	> 133
	Centre	2017	15	63	≤ 57	[57 – 63]	[63 – 70]	> 70
		2018	15	69	≤ 61	[61 – 69]	[69 – 76]	> 76
		2019	15	70	≤ 62	[62 – 70]	[70 – 78]	> 78
	South	2017	15	115	≤ 92	[92 – 115]	[115 – 137]	> 137
		2018	15	118	≤ 92	[92 – 118]	[118 – 144]	> 144
		2019	15	113	≤ 88	[88 – 113]	[113 – 138]	> 138
4&5-star Hotel	North	2017	15	201	≤ 166	[166 – 201]	[201 – 236]	> 236
		2018	15	198	≤ 167	[167 – 198]	[198 – 229]	> 229
		2019	15	200	≤ 170	[170 – 200]	[200 – 229]	> 229
	South	2017	15	198	≤ 167	[167 – 198]	[198 – 230]	> 230
		2018	15	192	≤ 163	[163 – 192]	[192 – 221]	> 221
		2019	15	192	≤ 164	[164 – 192]	[192 – 220]	> 220

ANNEX B: EE LABELLING / CERTIFICATION SCHEME

Table 3 – Definition of the EE labelling classes for Vietnam

Class	Description
Class A	if EP < 0.5·Rm
Class B	if 0.5·Rm ≤ EP < Rm
Class C	if Rm ≤ EP < 0.5·(Rm + Rs)
Class D	if 0.5·(Rm + Rs) ≤ EP < Rs
Class E	if Rs ≤ EP < 1.25·Rs
Class F	if 1.25·Rs ≤ EP < 1.5·Rs
Class G	if 1.5·Rs ≤ EP

Notes:

- EP (Energy Performance) value is an energy performance indicator expressed in kWh/m² that is used only for EE Labelling / Certification. Based on the baseline building operating characteristics (i.e. occupancy ratio and number of working hours) defined during the development of SEC Profiles, EP values are calculated by normalizing raw SEC values[17]. However, this normalization (called EE Labelling Normalization) is different from the normalization used for the SEC profile calculation (called SEC Profile Normalization) because the goal of EE Labelling Normalization is to normalize the operating characteristics of one building according to the base the while SEC Profile Normalization focuses on generating the representative energy performance of all buildings in the building stock.

  Rs is the median value (50 %) of the National Energy Benchmarks and Rm is the modulated value of Rs (Rm = coefficient of modulation × Rs). There are 2 EE levels of the coefficient value which are the moderate level (0.7 ≤ Coef. ≤ 1) and the ambitious level (0.5 ≤ Coef. ≤ 0.7). Selecting appropriate coefficient will provide a balanced distribution of buildings between the different classes, stimulating for energy performance improvements but keeping realistic ambitions. Based on the European countries' examples and on the above statement, the coefficient value shall range from 0.5 to 0.9, depending on the typologies, sub-typologies and climate zones for existing buildings in Vietnam.

[17] Refer to *Section 2.2, Technical Report – Component 1: PILOT TEST OF THE EE LABELLING SCHEMES FOR ALL SURVEY BUILDINGS*

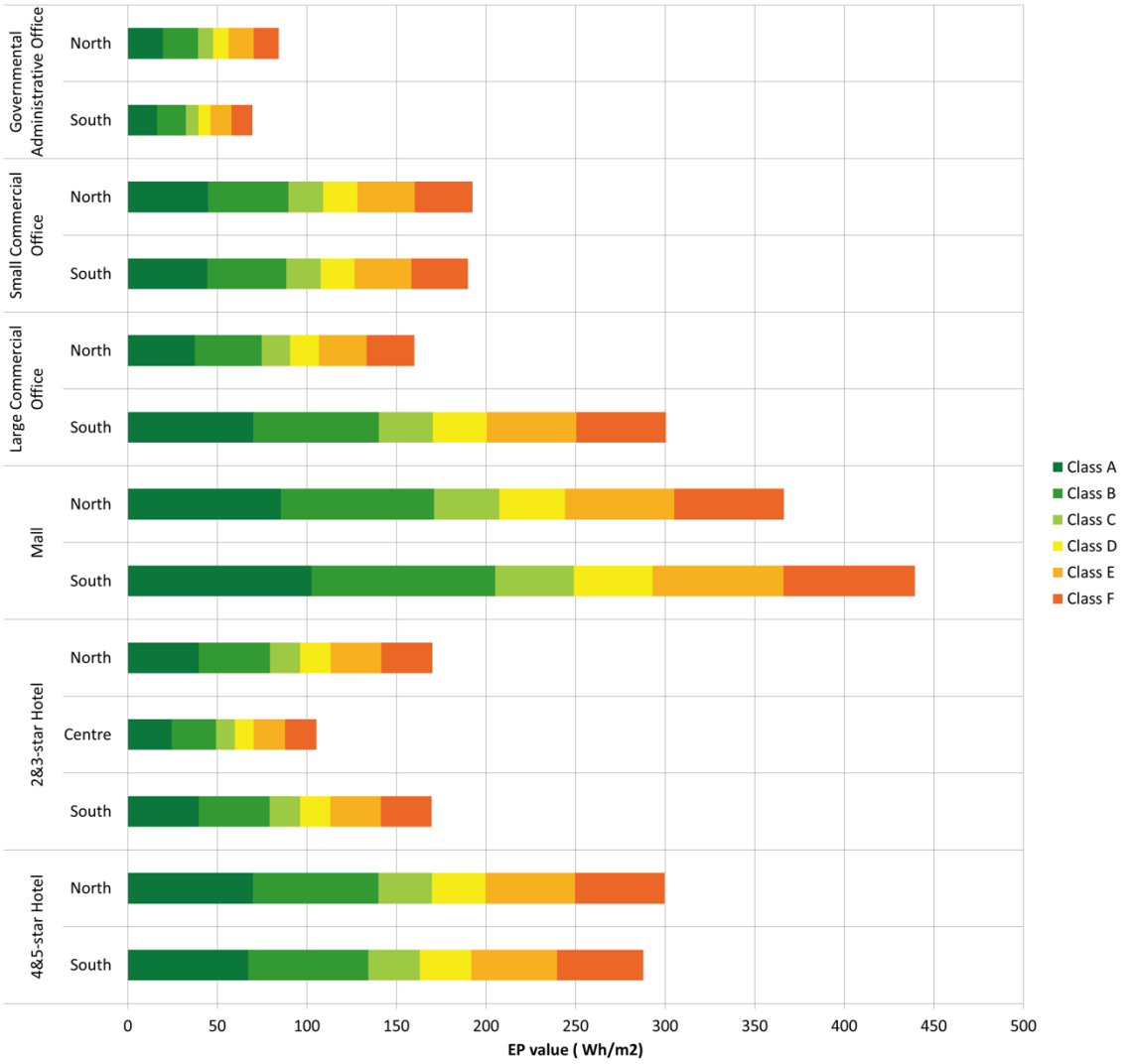

Figure 11– EE labelling class intervals for 6 building typologies in 3 climate zones

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