DEPARTMENT OF CLIMATE CHANGE

UNEP Sustainable Buildings and Climate Initiative

Promoting Policies and Practices for Sustainability

DEVELOPMENT OF A FULL-SCALE NAMA FOR THE BUILDING SECTOR

NAMA DESIGN DOCUMENT & NAMA PROPOSAL

Final Report

December 2017

Contents

List of Acronyms

AC	Air- Conditioners
ADB	Asian Development Bank
ADF	Asian Development Fund
AETF	Asia Energy Transition Fund
BCA	Building and Construction Authority
BIDV	Bank for Investment and Development of Viet Nam
BMU	German Federal Ministry of Environment, Nature Conversion and Nuclear Safety
BREEAM	BRE Energy Assessment Method
CCF	Climate Change Fund
CDKN	Climate and Development Knowledge Network
CDM	Clean Development Mechanism
CEF	Clean Energy Fund
CEFPF	Clean Energy Financing Partnership Facility
CER	Certified Emission Reduction
CFPS	Canadian Climate Fund for the Private Sector in Asia
CO_2	Carbon Dioxide
COP	Coefficient of Performance
CPEE	Vietnam Clean Production and Energy Efficiency Project
CPF	Carbon Partnership Facility
CTF	Clean Technology Fund
CVD	Chemical Vapor Deposition
DAC	Development Assistance Committee
DC	Direct Current
DFI	Development Financial Institution

EBRD	European Bank for Reconstruction and Development
EDGE	Excellence in Design For Greater Efficiencies
EE	Energy Efficiency
ESCO	Energy Saving Company
EVN	Vietnam Electricity Cooperation
EWH	Electric Water Heater
FACET	End-User Finance for Access to Clean Energy Technologies in South and South-East Asia
FCF	Future Carbon Fund
FRD	Fund for Recovery & Destruction of ODSs refrigerants
GBCA	Green Building Council of Australia
GBCI	Green Building Certification Institute
GCF	Green Climate Fund
GEF	Global Environment Fund
GEF	Global Environment Facility
GHG	Greenhouse Gas
G-SEED	Green Standard of Energy and Environmental Design
GWh	Gigawatt Hour
GWP	Global Warming Potential
HC	Hydrocarbon
HCFC	Hydrochlorofluorocarbon
HFC	Hydrofluorocarbon
HFO	Hydrofluoroolefin
HVAC	Heating, Ventilation and Air conditioning
HWH	Hot Water Heater
ICI	International Climate Initiative
ICI	International Climate Initiative

IFC	International Finance Corporation
JCM	Joint Crediting Mechanism
KICT	South Korea Institute of Construction Science
kW	Kilowatt
LCEE	Low Carbon Transition in Energy Efficiency Sector
LECB	Low Emission Capacity Building Programme
LECBP	Low-Emission Capacity Building Programme
LEED	Leadership in Energy and Environmental Design
Low-E	Low Emissivity
LPG	Liquefied Petroleum Gas
MDG	Millennium Development Goal
MLF	Multilateral Fund for the implementation of the Montreal Protocol
MOC	Ministry of Construction
MOF	Ministry of Finance
MOHURD	Ministry of Housing and Urban Development
MONRE	Ministry of Natural Resources and Environment
MOST	Ministry of Science and Technology
MPI	Ministry of Planning and Investment
MRV	Measurement, Reporting and Verification
NAMA	Nationally Appropriate Mitigation Action
NATIF	National Technology Innovation Fund
NCF	Nordic Climate Facility
NDC	Nationally Determined Contribution
NDF	Nordic Development Fund
O&M	Operational and Maintenance
ODA	Official Development Assistance

ODS	Ozone Depleting Subtance
OLS	ODS Neutral and Low Carbon Labeling System
PIR	Polyisocyanurate
PM	Prime Minister
PMR	Partnership for Market Readiness
PUR	Polyurethane
RE	Renewable Energy
SCB	Saigon Commercial Bank
SCCF	Special Climate Change Fund
SHGC	Solar Heat Gain Coefficient
SP-RCC	Support Program to Respond to Climate Change
SSFA	Small Scale Funding Agreement
SWH	Solar Water Heater
TAE	Tourist Accommodation Establishment
TOE	Tonne ne of Oil Equivalent
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
USD	United States Dollar
USGBC	US Green Building Council
VCS	Verified Carbon Standard
VDB	Vietnam Development Bank
VEEIE	Energy Efficiency for Industrial Enterprises
VEPF	Vietnam Environment Protection Fund
VGBC	Vietnam Green Building Council

VISRAE	Vietnam Society of Refrigeration and Air Conditioning
VLT	Visual Light Transmittance
VNAT	Viet Nam Agency for Tourism
VRV	Variable Refrigerant Volume
WB	World Bank Group
WBCSD	World Business Council For Sustainable Development
WRI	World Resources Institute
WWR	Window to Wall Ratio

List of Figures

List of Tables

EXECUTIVE SUMMARY

The Building sector is one of the fast growing sectors and the largest energy consumers in Viet Nam, accounting for approximately 30% of the total energy consumption, in which residential and commercial buildings are the most prominent energy users.

According to the Ministry of Construction, the annual expansion rate of residential and commercial buildings is 6-7% and they are recognized as a significant GHG emitter in Viet Nam. In addition, approximately 95% of the commercial and high buildings in Viet Nam are not yet considered efficient use of energy. There is thus huge potential for GHG emission reduction from the building sector by applying different measures such as improved energy efficiency of housing cooling and heating systems through technical solutions and comprehensive institutional support from government authorities in environment, buildings and energy sectors with collaboration from private sectors.

Under the scope of its support and involvement in the region, the UN Environment (the former called United Nations Environment Programme) has developed a project as part of the International Climate Initiative supported by the German Federal Ministry for the Environment, Nature Conversion, Building and Nuclear Safety to assist four priority countries in the Asia and the Pacific Region (Indonesia, the Philippines, Thailand and Viet Nam) to adopt mitigation actions in the building sector. Under this project, a NAMA Design Document have been developed for Viet Nam to lay foundation for a NAMA proposal to the UNFCCC NAMA Registry in order to call for support for implementation.

The NAMA aims to focus on three mitigation actions: i) promoting up-scaled use of high energy efficiency air-conditioning systems; ii) promoting up-scaled use of solar water heating systems; and iii) recovery and destruction of refrigerants of high Global Warming Potential. The targeted buildings include apartment buildings from eight storeys and above and hotels from three stars and below (the rating is in accordance with Viet Nam legislation).

The proposed actions are expected to achieve 22-25% energy savings compared to Business- As- Usual scenario. Together with emission reduction from recovery and destruction of high Global Warming Potential refrigerants, total emission reduction from the NAMA is expected at 7,572,857 tCO_{2e} over 2021-2032 period, i.e. an annual reduction of 631,071 tCO_{2e}/year.

The NAMA is scheduled to be implemented in three phases: i) preparation (2020); ii) pilot implementation (2021-2022); and full-scale implementation (2023-2032) in which mid-term implementation (2023-2027) and long-term implementation (2028-2032).

Co-benefits of the NAMA will cover economic, social, environmental and technological benefits which include lower demand for electricity and fossil fuel, enhanced technology transfer, and job creation and improved air quality.

The NAMA includes establishment and operation of a system for recovery and thermal destruction of high Global Warming Potential refrigerants for the first time in Viet Nam. This is a fundamental change compared to the normal practice of free discharge to the environment. The financial mechanism for NAMA includes fee and tax system based on the labelling system and payment for recovery and thermal destruction services for the first time in Viet Nam. This will induce vital transformational change to raise the awareness of the consumers and technical workers on GHG emission reduction and carbon pricing for equipment for the first time in Viet Nam.

The implementation roadmap for the NAMA and relevant targets in percentage and number of units as well as corresponding budget requirement is provided in below table:

	Preparation (2020)	**Pilot (2021-2022)**	**Implementation**	
			Mid-term (2023-2027)	**Long-term (2028-2032)**
	I. Conversion to high energy efficiency Air-conditioning systems			
Progress (%)	0%	10%	50%	100%
Quantity (unit)	0	198,160	1,653,000	1,826,000
Cost (USD)	0	42,764,832	356,939,221	394,074,802
	II. Installation of Solar water heating systems			
Progress (%)	0%	10%	50%	100%
Quantity (m^2)	0	141,760	481,410	855,400
Cost (USD)	0	40,015,578	135,890,177	209,453,781
	III. Recovery and destruction of refrigerants with high Global Warming Potential			

Progress (%)	0%	50%	50%	50%
Quantity (tonne ne)	0	59	496	548
Cost (USD)	0	297,248	2,480,994	2,739,114

The enabling activities of the NAMA include:

- Creating policies, incentives and providing technical assistance;
- Performing demonstration activities;
- Designing financial mechanisms and market-based approaches;
- Setting up NAMA Operating system and NAMA Monitoring, Reporting and Verification system;
- Capacity building and awareness rising.

Full cost of implementation of the NAMA is 1,187,829,746 USD including the following cost items:

- Investment in conversion to energy efficiency air- conditioning systems: 793,778,855 USD
- Investment in installation of solar water heating systems: 385,359,535 USD
- Cost for recovery and destruction program: 5,517,356 USD
- Cost for enabling activities: 3,174,000 USD

It should be considered that the investment cost for conversion and installation of energy saving equipment, i.e. energy efficiency air-conditioning systems and solar water heating systems can be compensated by the revenue from electricity saving of 570,386,973 USD. This means within the period of 5.69 years the initial cost will be fully paid back.

Therefore, international financial support is only required for carrying out enabling activities for the NAMA.

Besides, different financial mechanisms including Energy Saving Company Model, Fund and fee collection system for recovery and destruction program sources, Carbon labelling system, etc. are also proposed to help overcome financial barriers for the NAMA implementation.

CHAPTER 1. INTRODUCTION

1.1. Background

The building sector is responsible for approximately one-third of all Greenhouse gas (GHG) emission. In rapidly developing Asia, energy efficiency (EE) measures, enactment of sustainable building policies, technologies and innovative approaches to financing offer the potential for significant GHG emission reductions. Under the scope of its support and involvement in the region, the UN Environment (the former called United Nations Environment Programme or UNEP) has developed a project as part of the International Climate Initiative (ICI) supported by the German Federal Ministry for the Environment, Nature Conversion, Building and Nuclear Safety (BMUB) to assist four priority countries in the Asia and the Pacific Region (Indonesia, the Philippines, Thailand and Viet Nam) to adopt mitigation actions in the building sector (UNEP project).

In Viet Nam, the building sector is one of the fast-growing sectors and the largest energy consumers, accounting for approximately 30% of the total energy consumption, in which residential and commercial buildings are the most prominent energy users. According to the Ministry of Construction (MOC), the annual expansion rate of residential and commercial buildings is 6-7% and they are recognized as a significant GHG emitter in Viet Nam. In addition, approximately 95% of the **commercial** and **high buildings** in Viet Nam are not yet taken into consideration of energy efficiency measures during project design and operation.

The previous steps of the UNEP project have identified high potential for GHG emission reduction through promoting the use of Solar Water Heaters (SWH) and EE Air- Conditioners (AC) in residential and commercial buildings, which is expected to achieve 8-10% energy savings, equivalent to about 3,600-4,500 Gigawatt hours (GWh)/year or about 2-2.5 million tonnes of carbon dioxide (CO_2) emission reductions equivalent/year. Financial barriers have been identified as one of the biggest challenges to upscale the use of SWH and EE AC in these target buildings.

In November 2015, Viet Nam submitted the Nationally Determined Contribution (NDC) to the United Nations Framework Convention on Climate Change (UNFCCC) which defines high efficiency residential ACs and SWHs among the mitigation measures that can be implemented by domestic resources.

1.2. About the Assignment

The current Assignment on "Development of a full-scale NAMA for the building sector" is conducted under the Small Scale Funding Agreement (SSFA) between UNEP and the Center for Technology Responding to Climate Change, Department of Climate Change under the Ministry of Natural Resources and Environment (MONRE) of Viet Nam with the overall objective of developing, in cooperation with relevant line ministries and stakeholders in Viet Nam, a full-scale Nationally Appropriate Mitigation Action (NAMA) including a suitable financial mechanism to promote the use of SWHs and EE ACs in commercial and residential buildings in Ha Noi, Da Nang and Ho Chi Minh city.

It is expected that the development and implementation of the NAMA will help the building sector in Viet Nam overcome critical barriers to enhance energy efficiency and GHG mitigation in order to contribute to the achievement of NDC targets.

1.3. Nationally Appropriate Mitigation Action

NAMA was introduced in the Bali Action Plan agreed in 2007 by the thirteenth Conference of Parties (COP13) of the UNFCCC. UNFCCC (2007) defines it as follows: "Nationally appropriate mitigation actions implemented by developing countries Parties in the context of sustainable development, supported and enabled by technology, financing and capacity-building, in a measurable, reportable and verifiable manner". NAMAs have been introduced in order to allow developing countries to take voluntary actions against climate change while respecting the principle of common but differentiated responsibilities and respective capabilities. The sixteenth Conference of Parties in Cancun (2010) identified two types of NAMA:

- **Unilateral NAMA**, which is developed through domestic resources and finance and implemented unilaterally; and
- **Supported NAMA**, that receives support (finance/technology or capacity building) from international donor(s).

A NAMA could seek support through the use of market mechanisms by generating and selling carbon credits: this type of NAMAs has been labelled **"credited" NAMA**. This type of NAMA is not officially defined under the UNFCCC. However, the market mechanisms enshrined in the Paris Agreement (Article 6) principally provide this possibility. Rules for these mechanisms remain to be defined.

1.4. Selection of targeted buildings for NAMA

As earlier mentioned, according to MOC, the annual expansion rate of **residential** and **commercial** buildings is 6-7% and they are recognized as a significant GHG emitter in Viet Nam. In addition, approximately 95% of the **commercial** and **high buildings** in Viet Nam are not yet taken into consideration of EE measures during project design and operation. Therefore, in order to achieve transformational changes and high emission reduction potential in the buildings sector, the NAMA focuses on **commercial and high residential buildings** to be targeted for application of EE and GHG mitigation interventions. Further narrowing down of the scope of the targeted sub-groups of buildings is presented in below section.

1.4.1. Residential buildings

In residential building sub-sector, development of **apartment buildings** is paid special attention for development by the Government of Viet Nam as indicated in the National Strategy for House Development up to 2020 with vision to 2030 by the Prime Minister (PM) (2011). Accordingly, the ratio of apartment buildings in house development projects is expected to increase to above 90%, 60% and 40% of new housing construction for specialized cities (Hanoi & Ho Chi Minh City), from grade I to grade II, and for grade III- city respectively by 2020.

According to Circular 03/2016/TT-BXD (MOC, 2016), buildings can be categorized in different grades according to their number of storeys: buildings of **1** one storey belongs to Grade IV; buildings from **2-7** storeys belongs to Grade III; and high buildings are considered to have from **8** storeys and above, which falls into Grade I and II.

Therefore, high rise apartment buildings from 8 storeys and above are selected to be the targeted sub-group for NAMA development for the following reasons:

- Apartment buildings are expected to have high growth rate and represent dominant share in the new building development in the future, which is in line with the national strategy. Most of newly constructed apartment buildings will be high-rise since the low-rise ones often fall into detached houses or social buildings, according to expert interviews;

- High rise buildings have high potential for energy saving through the application of EE ACs and SWHs as resulted in studies and data survey in previous phase of the Project.

1.4.2. Commercial buildings

Hotels are among the type of commercial buildings that have specific high energy consumption in Viet Nam (IFC, 2011). The Government of Viet Nam is paying great attention to promote the development of tourism sector through several solutions, including increasing the quantity and quality of tourism accommodation, which can be seen in the National Strategy for Tourism Development (PM, 2011).

According to data from Viet Nam Agency for Tourism (VNAT), the number of hotels from 3 stars and below accounts for 98.5% of total hotels in Viet Nam. Therefore hotels of 3 star and below are selected to be the targeted sub-group for NAMA development for the following reasons:

- Low star hotels (3 stars and below) represent lion share in the number of hotels in Viet Nam and are expected to be developed at high growth rate to serve the national objectives for tourism development;
- Low star hotels have high potential for energy saving through the application of EE ACs and SWHs as resulted in studies in previous phase of the Project.

1.4.3. Further considerations

The NAMA is designed to firstly focus on transformational energy saving through the use of high EE equipment, i.e. EE ACs and SWHs, in buildings in Viet Nam. Therefore, several measures and mechanisms are identified for this general objective and can be applied on the large scale in the whole buildings sector. However, in order to be more efficient in the use of resources, the sub-sectors of higher energy saving and GHG emission mitigation potential, i.e. apartment buildings from 8 storeys and above and hotels from 3 stars and below, are identified and further targeted in the specific assessment and analysis of this NAMA.

CHAPTER 2. POLICY AND REGULATORY FRAMEWORK

For the NAMA development in the building sector together with the financial mechanism to promote the use of SWHs and EE ACs in apartment buildings and hotels, this Chapter will focus on review of the existing policy and regulatory framework, gap analysis and proposed details for NAMA Design in the following particular areas:

- Building sector (including both existing buildings and new construction);
- Energy efficiency that is relevant to the building sectors, including regulations for ACs and SWHs;
- Incentives for low emission buildings.

2.1. Policies and regulations for the building sector

2.1.1. Categorization of Buildings and NAMA Scoping

Buildings in Viet Nam can be categorized in different ways to serve different purposes. For the purpose of State management of construction investment activities, buildings are categorized in accordance with Circular 03/2016/TT-BXD dated 10 March 2016 of the MOC. For the particular types of buildings targeted under this NAMA, i.e. hotels and residential buildings, the most commonly used categorization is based on the height, the storeys or total floor area.

Table 1: Categorization of buildings for management purpose

Categorization criteria	Building grade				
	Special	I	II	III	IV
Height (m)	> 200	> 75 ÷ 200	> 28 ÷ 75	> 6 ÷ 28	≤ 6
Number of storeys	> 50	> 20 ÷ 50	8 ÷ 20	2 ÷ 7	1
Total floor area (thousand m^2)		> 20	> 10 ÷ 20	> 1 ÷ 10	< 1

Source: MOC, 2016

Besides, **apartment buildings** can also be categorized in accordance with Circular 31/2016/TT-BXD of MOC dated 30 December 2016, which defines apartment buildings into Group A, B, or C against 04 groups of criteria:

- The group of criteria on planning- architecture.
- The group of criteria on technical system and equipment;
- The group of criteria on social services and infrastructure;
- The group of criteria on quality, management and operation.

However, this type of categorization is more for assessment of the living standards in the buildings for marketing and trading purposes of real estates on the exchange floors.

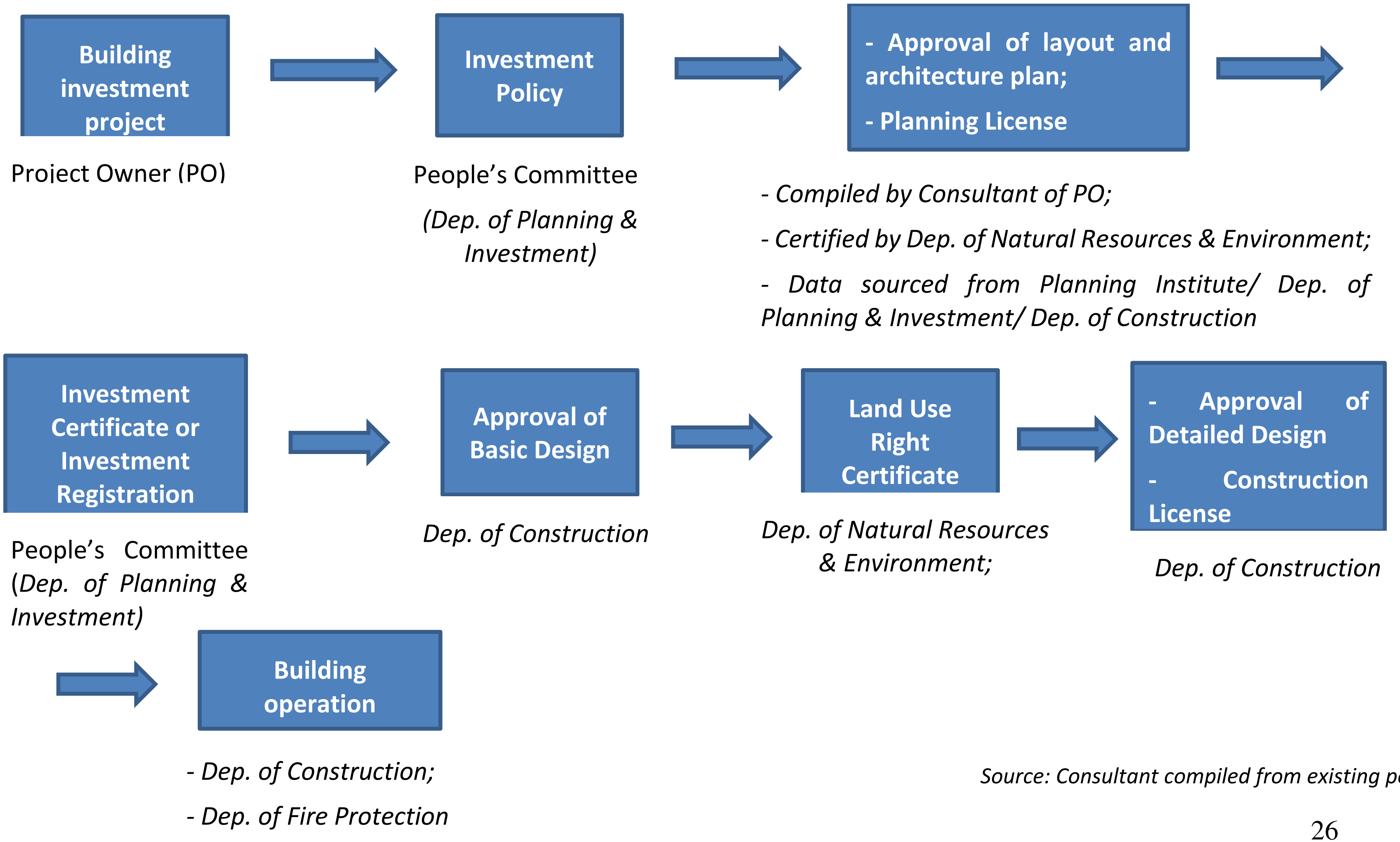
In these categorization documents, there is no particular content related to the use of AC and SWH in buildings.

Hotels, on the other hands, can be categorized in to 5 rates from 1 to 5 stars in accordance with Vietnam Technical Standards TCVN 4391:2015 developed by VNAT and published by Ministry of Science and Technology of Viet Nam. The standards prescribe conditions for star rating for hotels. Accordingly, hot water and ACs are required to be supplied in hotel rooms of all stars. There is also a requirement for ACs to be equipped in the service areas of hotels from 3 stars above.

2.1.2. Buildings' lifetime and relevant stage for NAMA interventions

The building sector in Viet Nam is generally regulated by the Law on Construction (2014) (Residential buildings are also subjected to the Law on Residential Buildings (2014)). According to this Law, the different stages in the development and operation of a building are generally illustrated in the following figure:

Figure 1: General stages in the development and operation of a normal building



Source: Consultant compiled from existing policies

Through careful studying the general stages in the development and operation of a normal building in the above Figure, it can be seen that main NAMA interventions for reduction of GHG emission from buildings can be performed in the two stages:

- Development of detailed technical design for buildings, which is the responsibility of the project owner and the architects; and
- Operation of building, which is the responsibility of the building management board and the inhabitants.

2.1.3. Buildings Development Strategy

a) Development strategy of apartment buildings

Based on the socio-economic development plan, the Prime Minister issued Decision No. 2127/QD-TTg dated 30 November 2011 to approve the National Strategy for House Development up to 2020 with vision to 2030. The Strategy aims to increase the ratio of apartment buildings and invest in construction of new houses of about 100 million m^2 floor each year.

Detailed target up to 2015:

- The ratio of apartment buildings in house development projects is above 80%, 50% and 30% of new housing construction for specialized cities (Ha Noi & Ho Chi Minh City), from grade I to grade II, and for grade III- city respectively.

Detailed target up to 2020:

- The ratio of apartment buildings in house development projects is above 90%, 60% and 40% of new house construction for specialized cities (Ha Noi & Ho Chi Minh City), from grade I to grade II, and for grade III- city respectively.

It is required that based on the National Strategy for House Development, the provincial level People's Committees will develop and approve the House Development Plan in their local area. Accordingly, the People's Committee of

Ha Noi city has approved the House Development Plan for Ha Noi city in 2015 and the following years (2016-2020)[1].

The House Development Programme for Ho Chi Minh City in 2016-2020 period with vision to 2020 has also been submitted for approval[2].

b) Development strategy of hotels

The Prime Minister approved the Strategy for Tourism Development in Viet Nam up to 2020 with vision to 2030[3] with the following specific targets for hotels:

- Year 2015: having the total of 390,000 hotel rooms with 30-35% meeting the standards for from 3- 5 stars.
- Year 2020: having the total of 580,000 hotel rooms with 35-40% meeting the standards for from 3- 5 stars.
- Year 2030: doubling the number of tourists.

Based on the National Strategy, Ha Noi's People's Committee also issued Decision No. 4597/QD-UBND dated 16 October 2012 on approval of the Tourism Development Plan for Ha Noi up to 2020 with vision to 2030. According to this, demand for hotels is 58,100 rooms and 98,600 rooms in 2020 and 2030 respectively. It is also informed that Da Nang and Ho Chi Minh City are in the process of developing hotels development plan.

2.1.4. Building Code and related provisions to ACs and HWHs/ SWHs

The National Technical Regulation on Energy Efficiency Buildings QCVN 09:2013/BXD (Building Code) is applicable to civil buildings including apartment buildings and hotels of total floor area from 2500m^2 and above. The Building Code prescribes the minimum Coefficient of Performance (COP) of each type of ACs in accordance with their refrigerating capacity. It also prescribes thermal efficiency requirement for hot water heaters (HWHs) and prioritizes SWH combined with heat pump/electric water heating the second after water heating from heat recovery ACs.

---

[1] Decision 6336/QD-UBND of Hanoi's People's Committee dated 28 November 2014 on approval of House Development Plan for Hanoi in 2015 and the following years (2016-2020)

[2] https://www.baomoi.com/tp-hcm-len-ke-hoach-phat-trien-nha-o-2016-2020/c/21563416.epi

[3] Decision 2473/QD-TTg of the Prime Minister dated 30 December 2011 on approval of the Strategy for Tourism Development in Viet Nam up to 2020 with vision to 2030.

2.2. Policy and regulations on Energy Efficiency with focus on ACs and HWHs/SWHs

When buildings come into operation, the buildings themselves and equipment therein are subjected to law and regulations on energy efficiency.

2.2.1. Energy Efficiency for Buildings

According to the Law on Energy Efficiency and Conservation (Law No. 50/2010/QH12 dated 17 June 2010 of the National Assembly) and Decree No. 21/2011/ND-CP of the Government on 29 March 2011, major energy users, *including residential buildings and hotels*, having total energy consumption of more than 500 tonnes of oil equivalent (TOE) per annum, shall be regulated under provisions on energy consumption management such as:

- Developing and implementing annual plan and 5 year- plan on energy efficiency and conservation;
- Assigning responsibilities for energy efficiency and conservation at the entities;
- Assigning energy manager at the entities;
- Perform obligatory energy auditing every 3 years.

According to the latest list of major energy users in 2016 (Decision No. 1305/QD-TTg of the Prime Minister on 03 September 2017), there are currently 123 buildings (most of which are commercial buildings) and 63 hotels subjected to these regulations.

2.2.2. Green Building Certification Systems

There are 7 Green Building Certification Systems that are considered for Viet Nam under the Study under the framework of the Vietnam Clean Energy Program of the United States Agency for International Development (USAID).

Table 2: Certifying Bodies and Rating Systems

	Country	Administrative Body	Organization Type	Rating System
1	United Kingdom	BRE Trust	Non-profit	BRE Energy Assessment Method (BREEAM)

2	United States	US Green Building Council (USGBC) and Green Building Certification Institute (GBCI)	Non-profit	Leadership in Energy and Environmental Design (LEED)
3	Australia	The Green Building Council of Australia (GBCA)	Non-profit	Green Star
4	Singapore	Building and Construction Authority (BCA)	Government body	Green Mark
5	China	Ministry of Housing and Urban Development (MOHURD)	Government body	Green Building Label-3 (Three Star)
6	South Korea	The South Korea Institute of Construction Science (KICT)	Government body	Green Standard of Energy and Environmental Design (G-SEED)
7	Viet Nam	The Vietnam Green Building Council (VGBC)	Non-profit	LOTUS

Source: USAID Vietnam Clean Energy Program

As assessed by the International Finance Corporation (IFC), currently only a small volume of buildings is designed and certified as green. Government regulations are often not in place to require green building practices, and voluntary standards are complex and not widely applied. Therefore, IFC has developed Excellence in Design for Greater Efficiencies (EDGE) green building standard which identifies low-cost, high-return design options through easy-to-use software that encourages architects and engineers to choose the best design practices and solutions, combined with a fast, inexpensive certification system to verify that the standard has been met.

Viet Nam is the first market in East Asia IFC has introduced EDGE. Currently in Viet Nam there are 12 projects certified with EDGE.

2.2.3. Green Lotus Label

Figure 2: Green Lotus Label

Source: VNTA

Green Lotus Label is a standard form of environmental protection and sustainable development for tourist accommodation establishments (abbreviated as TAEs). The TAEs awarded with the "Green Lotus Label" are those who have made efforts to protect the environment, to make efficient use of resources and energy, to contribute to the preservation of its heritage, socio- economic and cultural development of the locality and sustainable tourism development.

Green Lotus Label has 5 levels, from the lowest level of 1 green lotus to the highest level of 5 green lotuses. The number of green lotuses shows the level of efforts of TAEs in environmental protection and sustainable development, regardless of the type or class that the TAEs have been accredited. For example, a TAE of a 2 star rating can achieve a total of 4 green lotuses if the TAE has achieved the required score for level 4 blue lotuses.

The registration of the Green Lotus Label is voluntary.

The Green Lotus Label is valid for 2 years. TAEs granted with Green Lotus Label can use it for brand advertising purposes.

2.2.4. Energy Efficiency for ACs

A part from provisions in the Building Code (QCVN 09:2013/BXD), there are technical standards for ACs in residential, industrial and commercial sub-sectors that provide Minimum Energy Performance Standards (MEPS) and energy labelling for ACs as well as methods for determining, testing and rating the energy efficiency grade.

Energy efficiency labelling for residential ACs has become mandatory from 01 January 2013. The application of MEPS for residential ACs, i.e. no permission for import and production of residential ACs having energy performance below the prescribed MEPS takes effect from 25 April 2017.

The key relevant regulations on energy efficiency for ACs are summarized in the following table.

Table 3: Key relevant regulations on energy efficiency for ACs

Sub-sector	Building Code: QCVN 09:2013/BXD	Technical standards	EE labeling & MEPS
AC in residential subsector AC/chiller in industrial and commercial subsector	Providing detailed requirements for the AC system in buildings, including: Coefficient of performance or COP, cooling power, thermal insulation for refrigerant pipes, etc.	***TCVN 7830:2015:*** the MEPS and Energy Labeling for ACs (EE grades for non-ducted ACs) ***TCVN 7831:2012*** Methods for determining EE ***TCVN 6576:2013*** Testing and rating for non-ducted ACs	Labeling for residential ACs has become mandatory from 01/01/2013 According to Decision No. 04/2017/QD-TTg on promulgating the list of devices and equipment subject to energy labeling and application of the minimum energy efficiency, and the road map for implementation, MEPS for ACs shall be applied from 25 April 2017:

Source: Author compiled from existing policies

Interviews with experts from Vietnam Society of Refrigeration and Air Conditioning (VISRAE) confirm that the regulatory framework for energy efficiency of ACs is quite developed in Viet Nam. They however concern about general public awareness for application of energy efficiency ACs as well as the training and certification of maintenance technicians in the sector.

In addition, the Low Carbon Technology Assessment Facilitating Effectiveness of Viet Nam's Nationally Determined Contributions pointed out that there is currently no incentive for private sector to move for collection and destruction of F-gas from ACs in Viet Nam. Thus establishment of policy and legal framework that enhances stakeholder incentives to adopt F-gas collection and destruction is needed.

2.2.5. Energy Efficiency for HWHs/SWHs

Similar to ACs, a part from provisions in the Building Code (QCVN 09:2013/BXD), there is also technical standard TCVN 7898:2009 prescribing MEPS and energy efficiency grades for electric water heaters for households and other purposes with storage volume of up to 40 litter. The standard also provides methods for determining, testing and rating the energy efficiency grade.

Storage water heaters are allowed under voluntary energy labelling up to 31 December 2019 and the compulsory scheme will be applied from 01 January 2020.

Regarding SWHs, there is TCVN 8251:2009 providing details on technical requirements and testing methods.

The key relevant regulations on energy efficiency for HWH/SWHs are summarized in the following table.

Table 4: Key relevant regulations on energy efficiency for HWHs/SWHs

Sub-sector	Building Code: QCVN 09:2013/BXD	Technical standards	EE labeling & MEPS
Electric Water Heaters	Providing general requirements, prioritization order, energy efficiency, insulation, management of water heating systems	***TCVN 7898:2009*** Storage water heaters- Energy efficiency	According to Decision No. 04/2017/QD-TTg on promulgating the list of devices and equipment subject to energy labeling and application of the minimum energy efficiency, and the road map for implementation, Storage water heaters are allowed under voluntary energy labelling up to 31 December 2019 and the compulsory scheme will be applied from 01 January 2020.
Solar Water Heater		***TCVN 8251:2009*** Solar water heaters- Technical requirements and testing methods	

Source: Author compiled from existing policies

2.3. Incentives for energy efficiency in the building sector

Under the Law on Energy Efficiency and Conservation and Decree No. 21/2011/ND-CP, there are financial incentives for application of energy efficiency measures, including:

- Incentives on import and export duties and enterprise income tax under the tax law;
- Incentives under the land law;
- Concessional loans from the development bank, the fund for science and technology development support, the national fund for

technological renovation and the environment facility and supports from the national programs on hi-tech development and energy efficiency and conservation;
- Other financial support from the national program on energy efficiency.

Regarding incentives for the building sector, the MOC has issued the Circular No. 04/2016/TT-BXD dated 10 March 2016 providing for Awards on quality of construction works, according to which, buildings can be considered for:

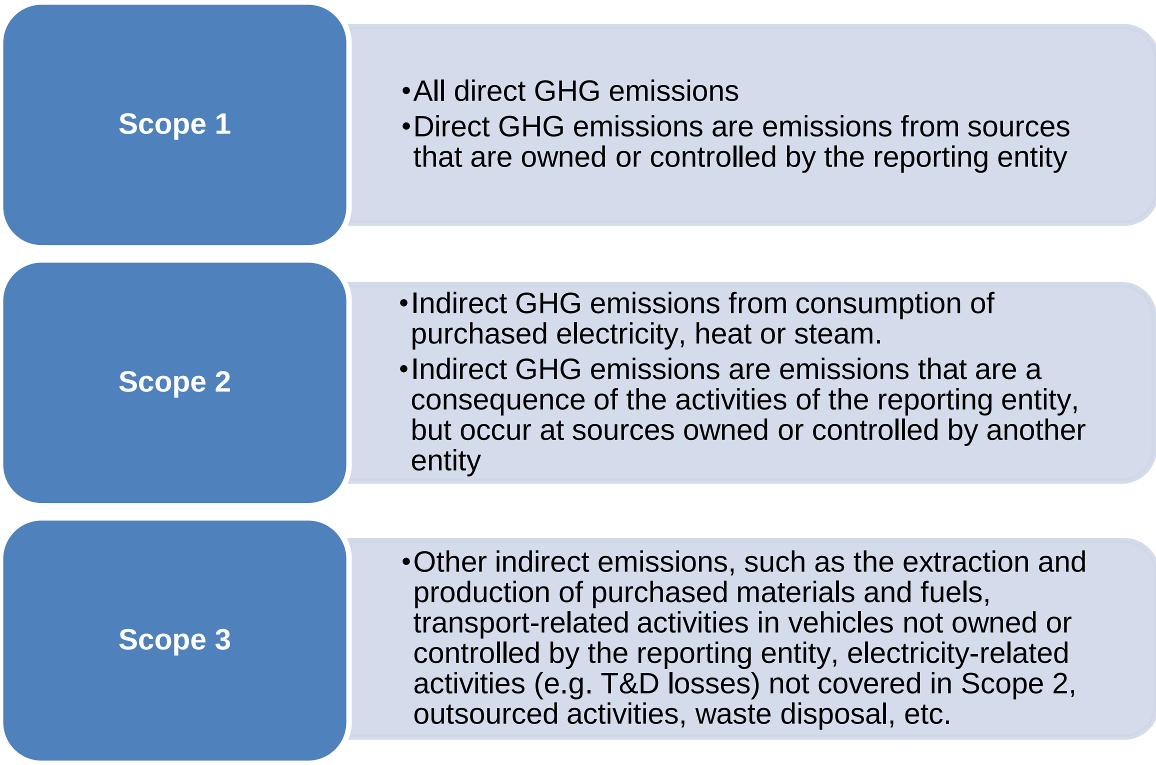
- Award for Construction Work of High Quality;
- Award for Construction Package of High Quality;
- Gold Medal for High Quality;
- Flag for High Quality; as well as
- National Award on Quality of Construction Works (provided by the Prime Minister).

CHAPTER 3. BASELINE EMISSION SCENARIO

3.1. Emission and project boundary

According to the definition of emission scopes as per the Greenhouse Gas Protocol (WBCSD & WRI, 2004), there are 3 Scopes as follows:

Figure 3: Scopes of GHG emissions

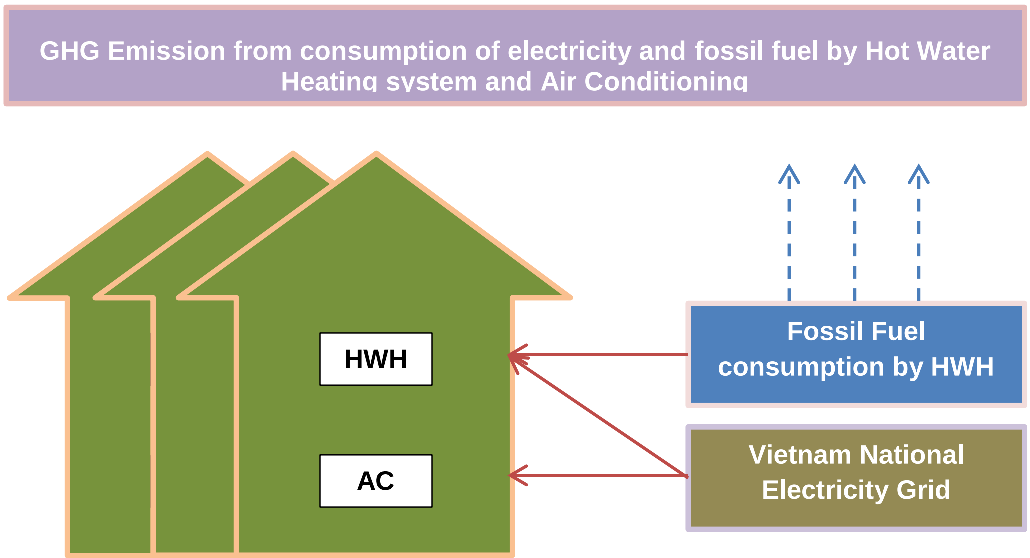


Source: WBCSD & WRI, 2004

The Viet Nam Building NAMA covers Scope 1 – direct emission from fossil fuel consumption by hot water heating system and Scope 2 – indirect emission from electricity consumption by both ACs and HWH systems.

The project boundary is shown in the figure below:

Figure 4: Project boundary



Source: Author compiled

The emission sources included in or excluded from the project boundary are shown in the table below:

Table 5: GHG emission sources from the project boundary

Source	Gas	Included	Justification/Explanation
Electricity consumption from Air Conditioning system and Hot Water Heating system	CO_2	Yes	Main emission source
Fossil fuel consumption from Hot Water Heating system	CO_2	Yes	Main emission source
Leakage of refrigerant(s) in AC system	HFCs/ HCFCs	No	The emission source is excluded from the project boundary for simplification

3.2. Baseline emission calculation methodology

The following methodologies of the Clean Development Mechanism (CDM) have been referred to calculate the baseline emission of the NAMA:

- AM0091: Energy efficiency technologies and fuel switching in new and existing buildings
- AMS-II.C: Demand-side energy efficiency activities for specific technologies
- AMS-I.J: Solar water heating systems

The baseline emissions are calculated based on the formula below:

$$BE_y = EC_y * EF_{grid,y} + \sum FC_{i,y} * NCV_{i,y} * EF_i$$

Where:

Item	Description	Unit
BE_y	Total baseline emission from ACs and HWHs in year *y*	[tCO_2/yr]
EC_y	Total electricity consumption by ACs and HWHs in year *y*	[MWh/yr]
$EF_{grid,y}$	Emission factor of Vietnam national electricity grid in year *y*	[tCO_2/MWh]
i	Type of fossil fuel in HWHs	-
$FC_{i,y}$	Fuel consumption type *i* by HWHs	[tonne/yr]
$NCV_{i,y}$	Net calorific value of fuel type *i*	[TJ/tonne]
EF_i	Emission factor of fuel type *i*	[tCO_2/TJ]

3.3. Data collection approach

3.3.1. Secondary collection

Desk review shows that certain data for calculation of baseline emission are already available at national level, and that can be collected from different authorities and published sources of information. Therefore, in order to meet the data requirement for calculation of the baseline emission from the current consumption of ACs and HWHs, the following sources of secondary data have been utilized:

Table 6: Secondary data collection approach

No.	Secondary data	Data sources
	A. Residential buildings	
A.I	***Total apartment area***	
A.I.1	Area of residential apartment floors constructed in the year	2012-2015 data from General Statistics Office of Vietnam (GSO), estimation for the period from 2016-2030
A.I.2	Total floor area of residential apartments	2012-2015 data from General Statistics Office of Vietnam (GSO), estimation for the period from 2016-2030
A.I.3	Growth rate of residential building	Decision No.134/QD-TTg issued by the Prime Minister on 26/01/2015 regarding "Approving the project on re-structuring of construction sector in association with conversion of growth model toward enhancement of quality,

		efficiency and competitiveness in 2014 - 2020 period". The growth rate of residential buildings is from 8% - 12% in the period 2016 - 2020.
A.I.4	Average housing floor area by resident	2012-2015 data from the Annual Report of MOC, estimation for 2016-2020 based on Decision No.2127/QD-TTg issued by the Prime Minister on 30/11/2011 regarding to "Approving the national strategy on housing development through 2020, with a vision toward 2030" The average floor area in 2020 and 2030 are 25 and 30 m^2/person, respectively
A.I.5	Total population	GSO
A.I.6	Total housing floor area	Calculation based on A.I.4 and A.I.5
A.I.7	Residential floor area to total housing floor ratio	Calculation based on A.I.2 and A.I.6
B.	**Hotels**	
B.I	***Total numbers of rooms***	
B.I.1	Number of hotel in the whole country	VNAT
B.I.2	Number of hotel from 1 star to 3 stars in the whole country	2012-2016 data from VNAT, estimation for 2017-2030
B.I.3	Number of rooms in hotels	2012-2016 data from VNAT, estimation for 2017-2030

Source: Author compiled

3.3.2. Primary data collection

As above mentioned, data on total area of apartment buildings and the total numbers of rooms in hotels can be sourced from different authorities or published sources. Energy consumption in residential buildings and hotels is however more difficult to collected. Some published energy consumption data can be available for buildings and hotels from 500 TOE per year only as provided in the list of key energy consumption facilities. All of the buildings subjected to this NAMA, i.e. apartment buildings and hotels from 3 stars and below, however do not fall in to the list.

Therefore, primary data collection through questionnaire survey has been performed for collection of total electricity consumption by apartment building and hotel as well as input data for estimation of the energy consumption by ACs and HWHs in each subsector in order to fill in the data gap for estimation of baseline emission.

In further details, the primary data collection has covered the following data and information:

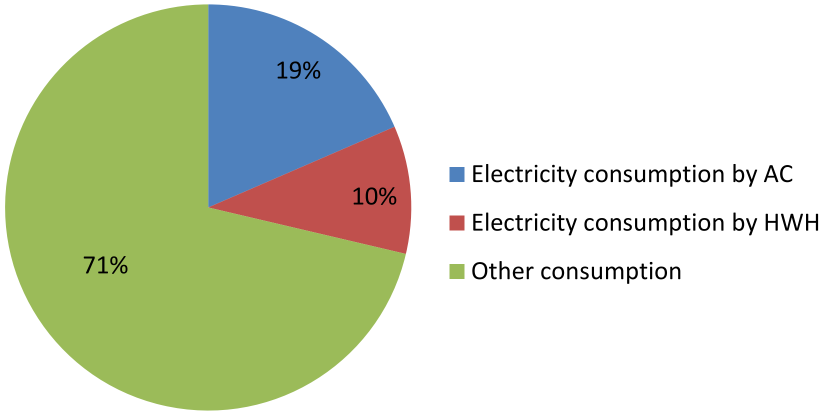
- General information: Name, location, address, contact persons and contact details, class of the buildings, operation year and category of the building, number of apartments in the building, number of floors, total floor area as well as occupation rate of the building;
- Total energy consumption by apartment buildings and hotels (based on electricity invoice provided by electric power companies). This is to calculate the specific electricity consumption, GHG emissions, etc. by the buildings.
- Data on consumption of other fuel such as coal, liquefied petroleum gas (LPG), diesel oil, etc. are also collected. However, since the NAMA focuses on the use of ACs and HWHs, there is no consumption of other fuels for the purpose of the NAMA design.
- Data on ACs: including type of the AC, quantity of ACs used by capacity in individual building, and average annual operation hours. This is to estimate the specific energy consumption, electricity consumption ratio, GHG emissions, etc. by ACs in apartment buildings and hotels;
- Data on HWHs: including quantity of HWHs by capacity, brand as well as average annual operation hours. This is to estimate the specific energy consumption, electricity consumption ratio, GHG emissions, etc. by HWHs in apartment buildings and hotels.

3.4. Calculation results and baseline emissions

3.4.1. Share of electricity consumption by ACs and HWHs in buildings

Based on the collected data from primary data collection and secondary data collection, electricity consumption by ACs and HWHs generally accounts for 19% and 10% respectively of total electricity consumption in apartment building.

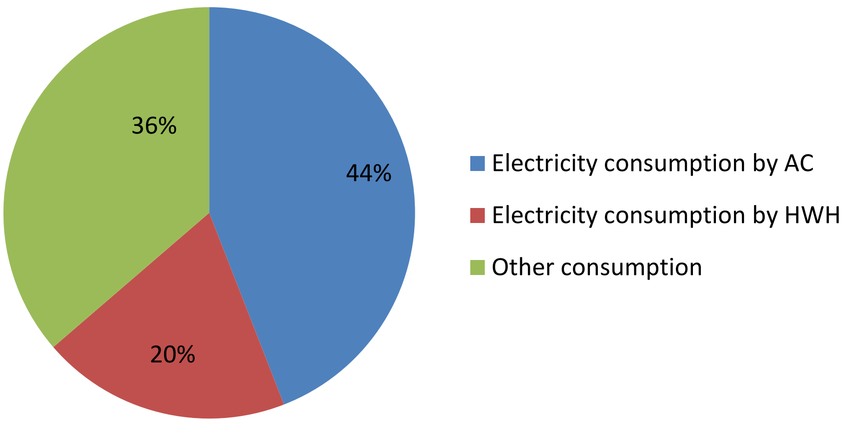
Figure 5: Share of electricity consumption by ACs and HWHs in apartment buildings



Source: Author compiled from Data Survey

In hotels, the share of electricity consumption for ACs and HWHs is much higher, at 44% and 20% respectively.

Figure 6: Share of electricity consumption by ACs and HWHs in hotels



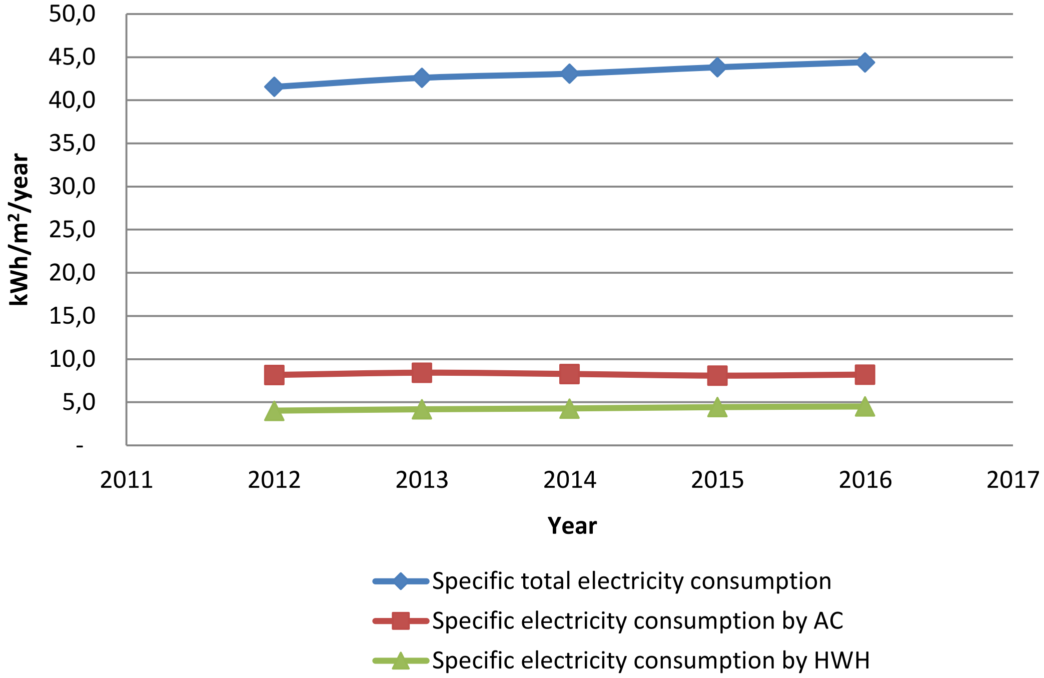
Source: Author compiled from Data Survey

3.4.2. Specific electricity consumption by ACs and HWHs in buildings

There is a slight increasing trend of 1%-3% in the specific electricity consumption by apartment buildings. The specific electricity consumption averaged over 2012-2016 period for apartment building is estimated at **43.24 kWh/m^2/year** in total while the average specific electricity consumption for ACs is at **8.21 kWh/m^2/year** and for HWHs **4.52 kWh/m^2/year**.

The specific electricity consumption in apartment buildings is illustrated in below figure:

Figure 7: Specific electricity consumption in apartment buildings

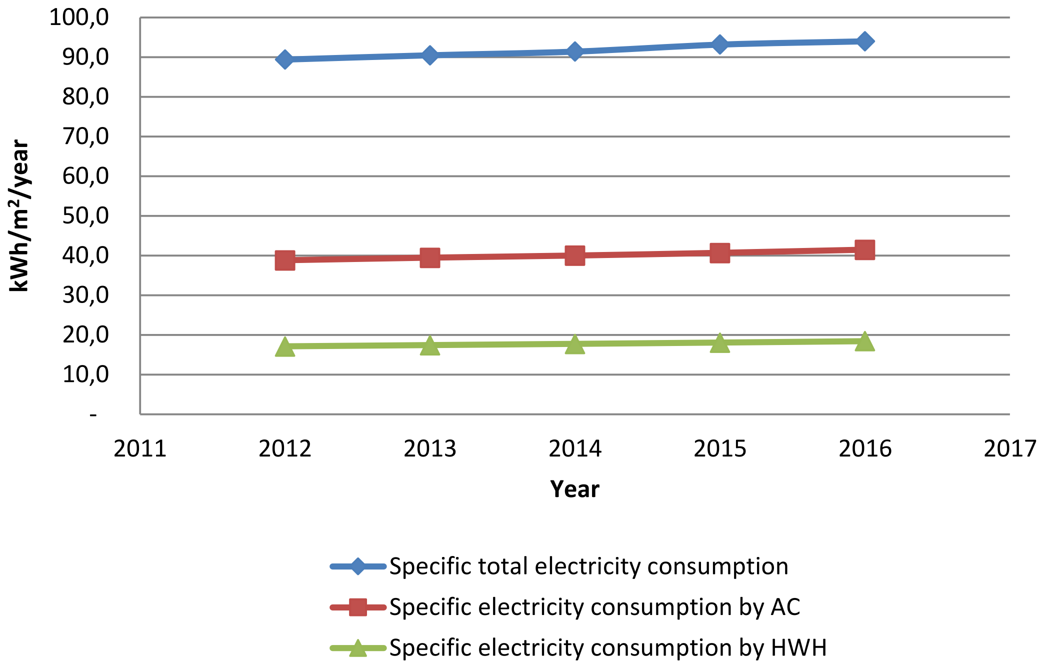


Source: Author compiled from Data Survey

There is a slight increasing trend of 1%-2% in the specific electricity consumption by hotels. The specific electricity consumption averaged over 2012-2016 period for hotels is estimated at **91.84 kWh/m²/year** in total while the average specific electricity consumption for ACs is at **41.44 kWh/m²/year** and for HWHs **18.42 kWh/m²/year**.

The specific electricity consumption in hotels is illustrated in below figure:

Figure 8: Specific electricity consumption in hotels



Source: Author compiled from Data Survey

3.4.3. Emission in BAU scenario

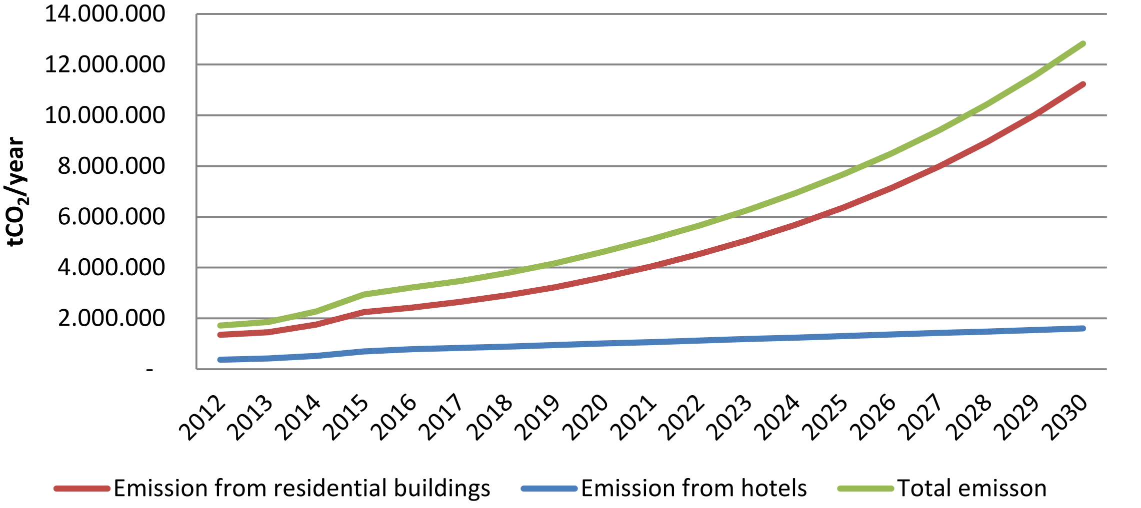
Baseline emission is estimated based on historical data from 2012-2016. In 2016, emission from apartment buildings and hotels is **2,425,626 tCO_2** and **785,629 tCO_2** respectively. Total emission of the two sub-sectors is therefore 3,211,255 tCO_2.

The projected growth rate of residential buildings from 8% - 12% is applied for projection of Business- As- Usual (BAU) scenario up to 2030, which is based on Decision No.134/QD-TTg of the Prime Minister dated 26/01/2015 on approval of the national strategy on housing development through 2020, with a vision toward 2030.

The projected growth rate of hotels up to 2030 is based on historical data from 2012-2016.

The resulted baseline emission under BAU scenario for apartment buildings, hotels and total baseline emission of the two sub-sectors under this NAMA is provided in below Figure.

Figure 9: Emission under BAU scenario



Source: Author compiled from Data Survey

CHAPTER 4. UP-SCALED USE OF ENERGY EFFICIENCY AIR CONDITIONERS AND SOLAR WATER HEATERS

4.1. Current technologies

4.1.1 Equipment

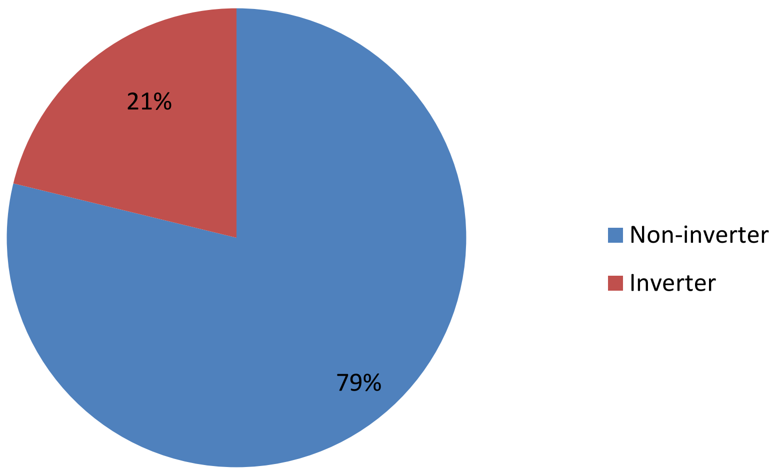
a. Air conditioning

The data survey in three biggest cities in Viet Nam, i.e. Ha Noi , Ho Chi Minh city and Da Nang in 2015 and 2017, resulted in an overwhelming percentage of non-Inverter ACs over Inverter ACs in both sub-sectors.

Inverter vs. non-Inverter

For apartment buildings from 8 storeys and above, non-Inverter ACs accounts for 79% of total surveyed ACs while the Inverter ones account for about 21%.

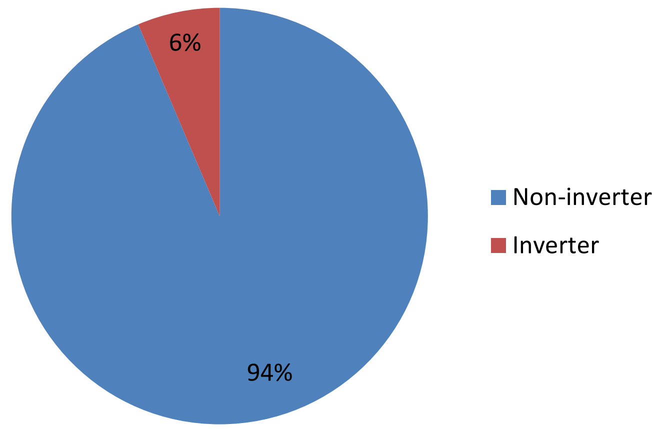
Figure 10: Share of non-Inverter ACs in surveyed apartment buildings



Source: Data survey, 2017

The percentage of non-Inverter ACs is even much higher for hotels with 3 stars rating and below, at 94% of total AC surveyed in hotels while the Inverter ones account for only 6%.

Figure 11: Share of non-Inverter ACs in surveyed hotels



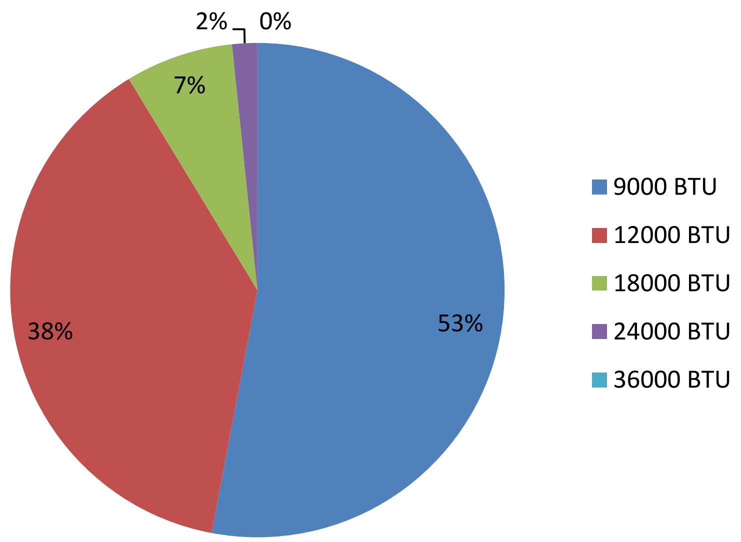
Source: Data survey, 2017

<u>Capacity range</u>

In both sub-sector, medium capacity ACs of 9,000 BTU and 12,000 BTU are the most popularly be used. The percentage of the large capacity ACs is however different in each sub-sector, that is due to demand for ACs in hotels is higher than in apartment buildings.

In apartment buildings, the ACs of 9,000 BTU accounts for higher percentage (53%) compared with ACs of 12,000 BTU (38%). ACs of large size capacity, e.g. 24,000 BTU or 36,000 BTU, account for modest percent of about 2%.

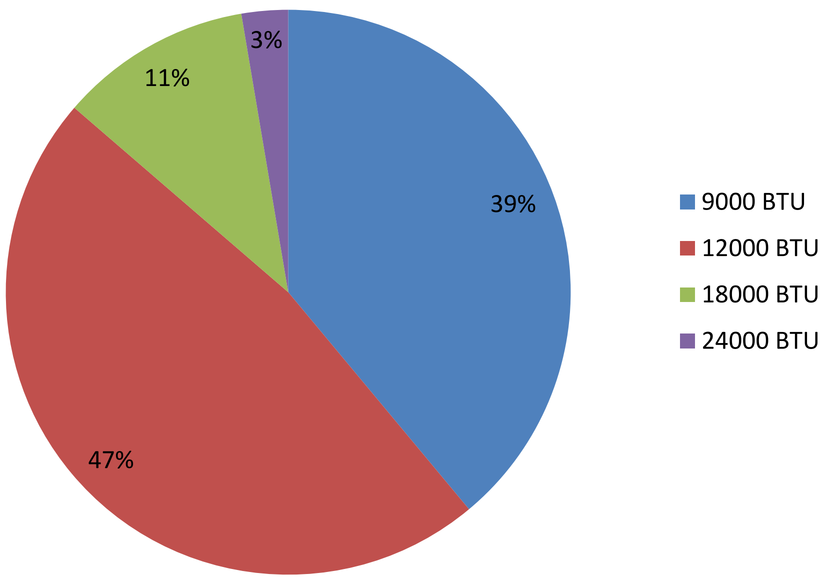
Figure 12: Share of ACs by capacity in apartment buildings



Source: Data survey, 2017

In hotels, on the other hand, ACs of 12,000 BTU represents 47%, which is about 8% higher than the percentage of ACs of 9,000 BTU. ACs of large size capacity, i.e. 18,000 BTU and 24,000 BTU, are also in use in hotels, accounting for 11% and 3% respectively.

Figure 13: Share of ACs by capacity in hotels



Source: Data survey, 2017

<u>Cooling (one- way) ACs vs. cooling & heating (two- way) ACs</u>

The use of one-way or two-way ACs very much depends on the climate pattern of the area. As Viet Nam is a tropical country, there is significant use of one-way ACs (about 90%) while the use of two-way ACs is at small percentage (about 10%) in residential buildings. Two-way ACs are mainly used in the northern area where there is cold winter with monsoon season.

In the surveyed hotels from 3 stars and below, all ACs in use are of cooling type.

<u>Split ACs vs. Multi or Central ACs</u>

All ACs used in the surveyed buildings, including both apartment building-subsector and hotel- subsector, are of split type. There is no multi or central ACs recorded in the data survey.

<u>Brand names</u>

The brand name of ACs is not a key concern of the data survey, thus there is no information recorded. GFK Report (2015) however provides that major brands in Viet Nam's ACs market including Daikin (25.5%), Panasonic (24.1%), LG (11.2%), Mitsubishi (6.5%) and Toshiba (5.3%).

<u>Price</u>

Price is one of the key considerations in investing in energy efficiency measures. Price of ACs in the market however is different depending on brands, types of technology, capacity, etc. The following table provides the retail price of one-way ACs using Inverter and non-Inverter technology. It can be seen that the cost of the higher energy efficiency ACs is at least 1.3 higher than that of conventional (non- Inverter) ACs.

Table 7: The average retail prices of cooling air conditioner

No.	Capacity (BTU)	Retail price (USD/unit)		Ratio between Inverter with Non-Inverter
		Inverter	Non-Inverter	
1	9,000	451.8	300.5	1.5
2	12,000	548.9	319.5	1.7
3	18,000	797.6	589.7	1.4
4	24,000	1,164.4	884.1	1.3

Source: Author compiled

<u>Operating hours</u>

Data survey shows average operating hours of ACs in apartment buildings is much lower than in hotels. While apartment buildings operate ACs for about 632 hours per year, hotels use ACs for more than 1,000 hours per year (about 1.6 times higher).

b. Hot Water Heaters

Data survey in both sub-sectors shows that all hot water supply systems in the surveyed buildings use electric water heaters (EWH).

About 90% of the surveyed apartment buildings use EWHs of 2.5 kilowatt (kW) capacity while only 10% use EWHs of 1.5 kW capacity or below.

The ratio of 2.5kW capacity EWHs in hotels is a little higher than in apartment buildings, at about 95% while the EWHs of 1.5 kW or lower capacity accounts for only 5%.

While hotels use EWHs for 190-250 hours per year (about 220 hours on average), the average operating hours of EWHs in apartment buildings is about 195 hours per year.

The average retail price of EWHs by types and volumes is provided in below Table:

Table 8: Average retail price of EWHs

No.	Type of EWH	Rating power (W)	Volume (l)	Average retail price (USD/unit)
1	Instant EWHs	4500	0	114.9
2	Indirect EWHs	2500	15	103.1
3	Indirect EWHs	2500-4500	20	117.1
4	Indirect EWHs	2500	30	123.9
5	Indirect EWHs	2500	50	148.1

Source: The Consultant compiled

4.1.2. Refrigerants in Air Conditioning

At present, HCFC-22 is the most popular refrigerant used in ACs in the market. HFC-410a is also used in recent years but with a minor share. For higher energy efficiency ACs, i.e. Inverter type, HFC-410a was first introduced to Viet Nam's market, followed by HFC-32.

ACs using HCFC-22 are manufactured in Viet Nam, while HFC-410a and HFC-32 using ones are imported only.

4.2. Alternative technologies

The assessment and selection of EE ACs and SWHs under this NAMA is based on EDGE[4] which, as earlier mentioned, is a green building certification system that allow inputs and selection of energy efficiency measures and provide results of projected operational savings and reduced carbon emissions.

According to EDGE's User Guide for Homes (version 2.0), the measures related to energy efficiency ACs and SWHs in apartment buildings include:

- HME11- Air Conditioning System- Coefficient of Performance (COP) of 3.5;
- HME14- Heat Pump for Hot Water Generation; and
- HME19- Solar Hot Water Collectors.

Since the purpose of this NAMA is to promote the up-scaled use of energy efficiency ACs and SWHs, the alternative measures for apartment buildings will focus on:

- Air Conditioning System with COP higher than 3.5;
- Solar Hot Water Collectors.

According to EDGE's User Guide for Hotels (version 2.0), the measures related to energy efficiency ACs and SWHs in hotels include:

- HTE09-Variable Refrigerant Volume (VRV) Cooling System
- HTE10- AC with Air Cooled Screw Chiller;
- HTE11- AC with Water Cooled Chiller;
- HTE12- (Geothermal) ground source heat pump;
- HTE13- Absorption chiller powered by waste heat;
- HTE30- Solar Hot Water Collectors

Since the targeted sub-sector under this NAMA include hotels of equal or below 3 stars, which according to experts' opinion, are not recommended to use central ACs like Chillers or VRV/VRF since they are not of large size, have limited number of rooms and do not require high level of luxury like the 4 star- or 5 star- ones[5].

---

[4] https://www.edgebuildings.com/

[5] https://hvacvn.com/khach-san-nen-dung-thong-dieu-hoa-nao/

The alternative measures for hotels of equal or below 3 stars therefore are the same as the above-mentioned alternative measures for apartment buildings.

Apart from equipment-related measures, the measure for conversion from refrigerants of high Global Warming Potential (GWP) to low GWP ones is also covered under the NAMA for the following reasons:

- Several manufacturers have already considered the combination of high energy efficiency technologies with low GHG emission refrigerant;
- Conversion to low GWP refrigerants will significantly contribute to reduce GHG emission from AC sub-sector, which help Viet Nam to achieve its GHG emission reduction targets committed in the NDC to the UNFCCC; and
- Conversion to low GWP refrigerants will help Viet Nam to achieve the targets set in the HCFC Phase out Management Plan as well as the Kigali Amendment to the Montreal Protocol once it is ratified by the Government.

4.2.1. High energy efficiency air conditioners

EDGE uses COP to measure the efficiency of AC systems. Savings can thus be achieved if the AC system provides a COP greater than 3.5.

In the Vietnamese regulation systems for ACs, the energy efficiency of the equipment is classified into 5 grades: grade 1 has the lowest energy efficiency and grade 5 has the highest energy efficiency. It is also required that energy efficiency is not allowed to be lower than the prescribed value.

Below table provides COP for ACs from grade 1 to grade 5 according to the National Standards TCVN 7830:2015.

Table 9: COP for energy efficiency grade

AC type	Rated cooling capacity (f) W (BTU/h)	Grade				
		1	2	3	4	5
Unitary	-	≥ 2.80	≥ 3.00	≥ 3.20	≥ 3.40	≥ 3.60
Split	f < 4 500 (f< 15 000)	≥ 3.10	≥ 3.40	≥ 3.60	≥ 3.80	≥ 4.20
	4 500 ≤ f < 7 000 (15 000 ≤ f < 24 000)	≥ 3.00	≥ 3.20	≥ 3.40	≥ 3.60	≥ 4.00
	7 000 ≤ f < 12 000 (24 000 ≤ f < 41 000)	≥ 2.80	≥ 3.00	≥ 3.20	≥ 3.40	≥ 3.80

Source: TCVN 7830:2015

It can be seen from the above table that ACs of COP higher than 3.5 will mainly fall in to the high energy efficiency of grade 4 or grade 5.

As assessed by experts, the application of inverter technology usually ensures ACs in the market reaching the high energy efficiency of grade 4 and grade 5.

<u>Inverter technology</u>

The Inverter technology is the latest evolution of technology concerning the electro motors of the compressors. An Inverter is used to control the speed of the compressor motor, so as to continuously regulate the temperature. The Direct Current (DC) Inverter units have a variable-frequency drive that comprises an adjustable electrical inverter to control the speed of the electromotor, which means the compressor and the cooling / heating output. The drive converts the incoming alternating current to DC and then through a modulation in an electrical inverter produces current of desired frequency. A microcontroller can sample each ambient air temperature and adjust accordingly the speed of the compressor. The Inverter AC units have increased efficiency in contraction to traditional air conditioners, extended life of their parts and the sharp fluctuations in the load are eliminated. This makes the inverter AC units quieter, with lower operating cost and with less broke downs. The inverter AC units might be more expensive than the constant speed air conditioners.

4.2.2. Solar Water Heaters

SWH is a device using solar thermal energy to supply hot water. A SWH system normally has three main components, namely: i) Solar Collector; ii) Insulated hot water storage tank; and iii) Cold water tank with required insulated hot water pipelines and accessories[6].

In the case of smaller systems (100 – 2,000 litres per day), the hot water reaches the user end, by natural (thermo – siphon) circulation for which the storage tank is located above the collectors. In higher capacity systems, a pump may be used for forced circulation of water.

Currently SWH systems are not yet used in the surveyed buildings. However, as Viet Nam has high solar energy potential, the use of SWHs in parallel with existing EWHs will result in significant energy saving and GHG mitigation potential.

Different from the measure with ACs that is to replace low energy efficiency ACs with higher energy efficiency ACs using advanced technology like Inverter, the NAMA recommends to use SWHs as supplement to the existing EWHs in order to ensure fast, reliable and sufficient hot water supply even in unfavorable conditions.

a. Type of Solar Water Heaters

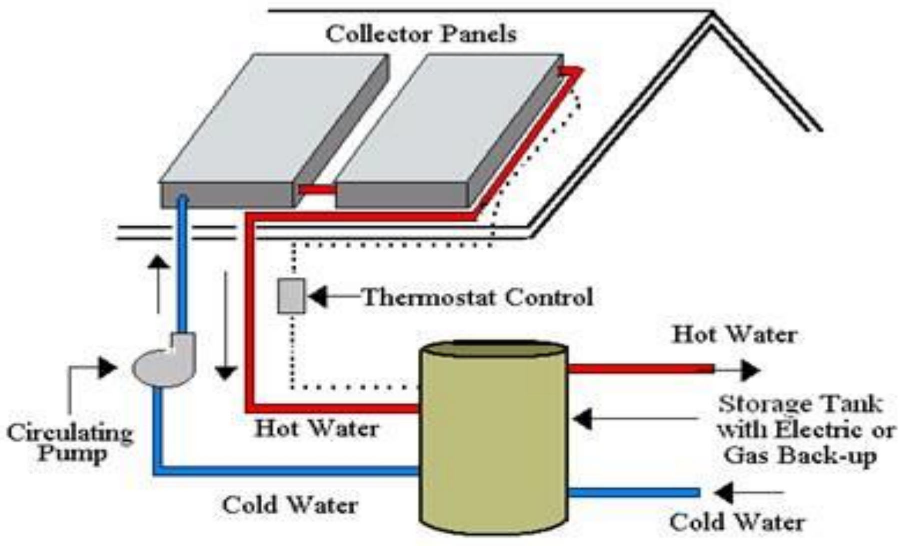
There are two main types SWHs: active which uses a pump to circulate the water between the tank and the collectors, and passive, which relies on natural convection to circulate the water.

Active SWHs

Active systems can be either direct circulation or indirect circulation. Direct circulation systems circulate domestic water through the collectors and to the storage tank. These are best-suited for mild climates where temperatures seldom drop below freezing. Indirect circulation systems circulate a non-freezing heat transfer fluid through the collectors and then through a heat exchanger in the storage tank. These are preferred in cold climates where the pipes in a direct circulation system might freeze

[6] http://kredlinfo.in/solaroffgrid/solar%20water%20heater.pdf

Figure 14: Active Solar Water Heating System

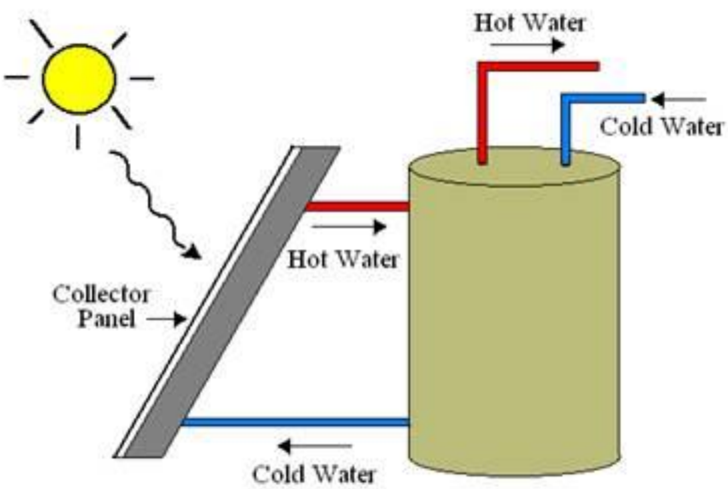


Source: https://www.energydepot.com/RPUres/library/Swaterheater.asp

Passive SWHs:

Passive systems are usually less expensive but less efficient. They can be either integral collector/storage systems or thermosyphon systems. The integral collector/storage type is typically used to preheat water for a conventional water heater, and is best-suited to climates where temperatures seldom fall below freezing. Thermosyphon systems rely on natural convection to circulate the water, so the tank must be located higher than the collector panels - the heated water from the panels flows upward to the tank and the cooler water returns to the collector for heating.

Figure 15: Passive Solar Water Heating System



Source: https://www.energydepot.com/RPUres/library/Swaterheater.asp

b. Types of solar collectors

The common types of collectors include flat-plate collector panels and evacuated tube collectors.

Flat Plate Collectors

The solar radiation is absorbed by Flat Plate Collectors which consist of an insulated outer metallic box covered on the top with glass sheet. Inside there are blackened metallic absorber (selectively coated) sheets with built in channels or riser tubes to carry water. The absorber absorbs the solar radiation and transfers the heat to the flowing water.

Below table provide the capacity of SWHs and the recommended respective area of Flat Plate Collectors.

Table 10: Capacity of SWH and recommended area of Flat Plat Collectors in passive SWH systems

Capacity (l)	Recommended Collector Area (m^2)
100	2
200	4
300	6
500	8

Source: Author compiled from SWH manufacturers

Evacuated Tube Collectors

Evacuated Tube Collector is made of double layer borosilicate glass tubes evacuated for providing insulation. The outer wall of the inner tube is coated with selective absorbing material. This helps absorption of solar radiation and transfers the heat to the water which flows through the inner tube.

Figure 16: An Evacuated Tube Collector

Source: http://www.alternative-energy-tutorials.com/

Tube size for different capacity and the corresponding area of collectors are provided in below table.

Table 11: Capacity of SWH, tube size and area of Evacuated Tube Collectors in passive SWH systems

Capacity (l)	Tube size			Collector area (m^2)
	Dia: 47 mm Length: 1500mm	Dia: 47 mm Length: 1800 mm	Dia: 58 mm Length: 1800 mm	
100	14	12	10	1.5
125	18	15	13	1.93
150	21	18	15	2.25
200	28	23	19	3.0
250	34	28	23	3.75
300	40	33	27	4.5
400	52	43	35	6

Source: Author compiled from SWH manufacturers

According to experts' interviews, the most significant barrier to up-scale the use of these SWH is the high price. The below table presents the cost of SWHs that are currently available in the market:

Table 12: Specific cost for absorber size (USD/m^2) of SWHs

Technology	Flat plate	Flat plate	ETC
Configuration	Forced circulation	Natural circulation	Evacuated tubes
Maximum efficiency	0.68	0.68	0.46
Specific cost for absorber (USD/m2)	395.63	249.93	126.41

Source: Author compiled

Another considerations for use of SWHs include: i) the nature of the roof and ii) the stability of the systems. Detailed technical solutions to overcome these barriers are is provided in CHAPTER 6 BARRIER ANALYSIS.

4.2.3. Low GWP refrigerants

As earlier mentioned, most of the normal residential/low capacity ACs that are targeted under this NAMA in the market in general and in the surveyed buildings under this Project in particular are using HCFC-22 as refrigerant, only a minor share of ACs in the market use HFC-410a.

Regarding the higher energy efficiency ACs using Inverter technology, the refrigerants in use in Viet Nam include HFC-410a and HFC-32 (which makes up 50% of R410A).

Since HFC-410a also have high GWP, the available alternative refrigerant in Viet Nam is only HFC-32 while in the other countries like China, India, HC-290 (propane) is already popularly used. There is also a possibility of using HFC-32 and HFO blends that are under study and testing but not yet commercialized.

Detailed information of current refrigerants and proposed alternative refrigerants with low GWP are provided in below table.

Table 13: Current refrigerants in Viet Nam's AC sector and potential alternatives

Refrigerant	GWP_{100yr}	Typical features	Market availability
Current situation			
HCFC-22	1,810	Negative impacts on the Ozone layers -> Being phase-out under Montreal Protocol	Very popular in Viet Nam
HFC-410a	2,088	Low flammability, no toxicity, requirement of purity and high working pressure	Quite popular in Viet Nam
Alternative measures			
HC-290	3	High flammability-> restriction of charging volume and high safety requirements	Popular in China, India

HFC-32	675	High flammability, high safety requirements	Imported and quite popular in Viet Nam Popular in Thailand, China, Japan, EU, India
HFC32-HFO blends	350	High flammability	Under study and testing

Source: World Bank, National Survey of Ozone Depleting Substance (ODS) Alternatives, 2017

4.3. Other measures

Apart from the above-mentioned technology measures that are directly related to ACs and HWHs in buildings, the EDGE's User Guide also provides other measures that are significant in reducing energy consumption for ACs and HWHs in apartment buildings and hotels. According to the results of stakeholders' consultation meeting for finalization of the NAMA, these measures should be discussed as reference. Detailed analysis is however not provided since they are not directly targeted for the building NAMA in Viet Nam.

4.3.1. Other measures for apartment buildings

According to EDGE's User Guide for Homes (version 2.0), other relevant measures for increasing energy efficiency in cooling and water heating for residents include the followings:

HME01- Reduced Window to Wall Ratio

The Window to Wall Ratio (WWR), which is the window or other glazing area (including mullions and frames) divided by the gross exterior wall area, which includes opaque and transparent elements, such as doors, windows, and walls from the outside. Windows generally transmit heat into the building at a higher rate than walls do. As such, a building with a higher WWR will transfer more heat than a building with a lesser WWR.

If the WWR is higher than the default value, then other measures such as shading or the lower solar heat gain coefficient (SHGC) of the glass should be considered to offset the energy loss due to cooling when increasing the WWR. In cold climates, when the WWR is higher than the default, the insulation of glass using double or triple glazing should be considered.

With regards to daylight, there are two basic strategies for using the sun for lighting while minimizing heat gain. The first is to use a small window opening (15% WWR) to illuminate a surface inside the space that then spreads the light out over a large area. The second is to use a moderately sized window (30% WWR) that "sees" an exterior reflective surface but is shaded from the direct sun. To increase the daylight availability, the selection of higher visual light transmittance (VLT>50) for the glass is also important.

HME02- Reflective paint/Tiles for roof – Solar reflectivity

EDGE uses the solar reflectivity of the roof finish as the indicator of best practice. Significant differences in heat gain from light and dark-colored roof surfaces is obviously available. The key consideration of the material or finish is its color. Ideally in warm climates a white finish should be selected as this will maximize reflectivity. If a white finish is not possible then the designer should select a very light color.

Table 14: Solar Reflectivity of General Roof

Generic Roofing Materials	Solar Reflectivity
Gray EPDM	23%
Gray Asphalt Shingle	22%
Unpainted Cement Tile	25%
White Granular Surface Bitumen	26%
Red Clay Tile	33%
Light Gravel on Built-Up Roof	34%
Aluminum	61%
White-Coated Gravel on Built-Up Roof	65%
White Coating on Metal Roof	67%
White EPDM	69%
White Cement Tile	73%
White Coating - 1 Coat, 8 mils*	80%
PVC White	83%
White Coating - 2 Coats, 20 mils* * mil is equal to .001 inches or .0254 millimeter	85%

Source: EDGE's User Guide for Homes (version 2.0)

HME03- Reflective paint for external walls – Solar reflectivity

Similarly, specifying a reflective finish for the walls can reduce the cooling load in air-conditioned spaces and improve thermal comfort in un-cooled spaces. Due to the reduction in surface temperate, the service life of the finish can also be improved and the impact on the urban heat island effect can be reduced.

Table 15: Solar reflectivity of typical wall finishes

Generic Wall Materials	Solar Reflectivity
New concrete	35-45%
New white Portland cement concrete	70-80%
White acrylic paint	80%
Fired clay bricks	17-56%

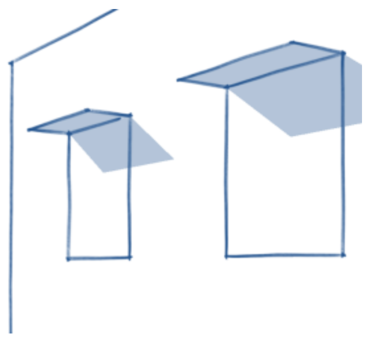
Source: EDGE's User Guide for Homes (version 2.0)

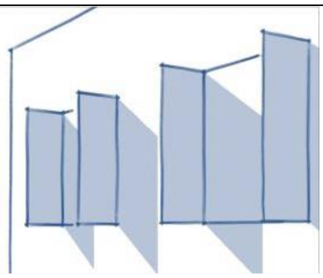
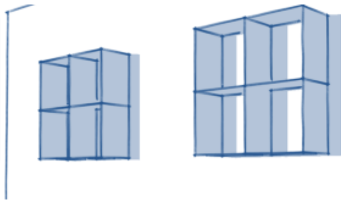
HME04- External shading devices

Shading of the house and outdoor spaces reduces summer temperatures, improves comfort and saves energy. Direct sun can generate the same heat as a single bar radiator over each square meter of a surface. Effective shading — which can include eaves, window awnings, shutters, pergolas and plantings — can block up to 90% of this heat. Shading of glass to reduce unwanted heat gain is critical, as unprotected glass is often the greatest source of heat gain in a building. However, poorly designed fixed shading can block winter sun. By calculating sun angles for the building location, and considering climate and building orientation, shading can be used to maximize thermal comfort.

There are three basic types of solar shading: horizontal, vertical, and combined (egg crate)

Table 16: Typical shading devices

Shading type	Image	Description
Horizontal shading devices (overhangs)		These are useful for building façades where the sun's rays are at a high angle of incidence, in short, where the sun appears high in the sky. Examples include summer mid-day sun on either northern or southern façades of a building for higher latitudes, or east and west façades for equatorial latitudes.
Vertical shading devices (fins)		These applications are useful where the sun's rays are at a low angle of incidence (where the sun appears low in the sky). Examples include eastern sun on eastern façades, western sun on western façades, and winter sun on southern or northern

		façades in high latitudes.
Combined shading devices (egg crate)		"Egg crate" devices are used for conditions where different times of the year warrant different shading needs.
Moveable shading devices – louvers or shutters	 	These devices are used to control sunlight during the day as well as reduce heat losses at night. They are moveable and can be mechanical or manual. They often provide maximum shading as they fully cover the window. A shading factor with shutters can be 1 if the shutters are fully closed. These shading devices also protect from inclement weather (hail, wind, or rain) as well as provide privacy and security.

Source: EDGE's User Guide for Homes (version 2.0)

In Vietnam, almost all modern high-rise buildings have no shading devices for their windows, so the ratio of solar radiation transmitted by window is high. And, very small amount of high-rise buildings including most of old buildings (constructed before 2000) use horizontal shading devices only.

HME05- Insulation of roof

Insulation is used to prevent heat transmission from the external environment to the internal space (for warm climates) and from the internal space to the external environment (for cold climates). Insulation aids in the reduction of heat transmission by conduction. A well-insulated building has lower cooling and/or heating energy requirements.

Insulating the roof is among the most cost-effective ways to reduce the energy used for heating a building. Therefore, in cold or temperate climates there is a strong case for maximizing the insulation before designing the heating ventilation and air conditioning equipment. In hot climates insulating the roof can reduce heat gain, but the effect is relatively minor.

There are different types of insulation available and the appropriate type will depend on the application as well as cost and availability. Insulation types can be grouped into four main categories, as shown in the following table:

Table 17: Roof insulation types and typical conductivity range

Insulation type	*Description*	*Typical Conductivity Range*
Matting, Blanket or Quilt Insulation	This type of insulation is sold in rolls of different thickness and is typically made from mineral wool (fiber made from glass or rock). Some common uses include insulating empty lofts, stud walls, and under suspended timber floors. Other materials such as sheep's wool are also available	0.034-0.044
Loose-fill Material	Loose-fill material, made of cork granules, vermiculite, mineral wool, or cellulose fiber is usually poured between the joists to insulate lofts. It is ideal for loft spaces with awkward corners or obstructions, or if the joists are irregularly spaced.	0.035-0.055
Blown Insulation	This is made from cellulose fibers or mineral wool. Spray foam insulation is made from Polyurethane (PUR). Blown insulation should only be installed by professionals, who use special equipment to blow the material into a specific, sectioned-off area, to the required depth. The material may remain loose if used for loft insulation, but can also bond to a surface (and itself) for insulating stud walls and other spaces	0.023-0.046
Rigid Insulation Boards	They are mostly made from foamed plastic such as polystyrene, PUR, or polyisocyanurate (PIR), which can be used to insulate walls, floors, and ceilings. PUR and PIR board are among the best insulation materials commonly used, and so are useful where space is limited. Rigid board has to be cut to size, so fitting is often a skilled job	0.02-0.081

Source: EDGE's User Guide for Homes (version 2.0)

HME06- Insulation of external walls

Insulating the external walls is also among the most cost-effective ways to reduce the energy used for heating a building. Therefore, in cold or temperate climates there is a strong case for maximizing the insulation before designing the heating ventilation and air conditioning equipment. In hot climates insulating the wall can reduce heat gain, but the effect is relatively minor.

There are different types of insulation available and the appropriate type will depend on the application as well as cost and availability. Insulation types can be grouped into four main categories, as shown in the following table:

Table 18: Wall insulation types and typical conductivity range

Insulation type	***Description***	***Typical Conductivity Range***
Matting, Blanket or Quilt Insulation	This type of insulation is sold in rolls of different thickness and is typically made from mineral wool (fiber made from glass or rock). Some common uses include insulating empty lofts, stud walls, and under suspended timber floors. Other materials such as sheep's wool are also available	0.034-0.061
Loose-fill Material	Loose-fill material, made of cork granules, vermiculite, mineral wool, or cellulose fiber is usually poured between the joists to insulate lofts. It is ideal for loft spaces with awkward corners or obstructions, or if the joists are irregularly spaced.	0.038-0.067
Blown Insulation	This is made from cellulose fibers or mineral wool. Spray foam insulation is made from PUR. Blown insulation should only be installed by professionals, who use special equipment to blow the material into a specific, sectioned-off area, to the required depth. The material may remain loose if used for loft insulation, but can also bond to a surface (and itself) for insulating stud walls and other spaces	0.020-0.038
Rigid Insulation Boards	They are mostly made from foamed plastic such as polystyrene, PUR, or PIR, which can be used to insulate walls, floors, and ceilings. PUR and PIR board are among the best insulation materials commonly used, and so are useful where space is limited. Rigid board has to be cut to size, so fitting is often a skilled job	0.02-0.081

Source: EDGE's User Guide for Homes (version 2.0)

HME07- Low emissivity coated glass

The purpose of adding a Low Emissivity (Low-E) coating to glazing is that it reduces the transference of heat from one side to the other by reflecting thermal energy. Low-E coatings are microscopically thin metal or metallic oxide layers that are deposited on a glass surface to help keep heat on the same side of the glass from which it originated. In warm climates the intention is to reduce heat gain and in cold climates the intention is to reflect heat indoors.

There are two types of Low-E coating: hard coat and soft coat. Only hard coat (pyrolytic coating) should be used in single-glazed units as it is more durable than soft coat (sputter coating).

- Hard Coat Low-E: Hard coat Low-E, or pyrolytic coating, is a coating applied at high temperatures and is sprayed onto the glass surface during the float glass process. The coating process, known as Chemical Vapor Deposition (CVD), uses a variety of different chemicals including silicon, silicon oxides, titanium dioxide, aluminum, tungsten, and many others. The vapor is directed at the glass surface and forms a covalent bond with the glass, so the result is hard wearing.
- Soft Coat Low-E: Soft coat Low-E, or sputter coating, is applied in multiple layers of optically transparent silver sandwiched between layers of metal oxide in a vacuum chamber. This process provides the highest level of performance and a nearly invisible coating, however it is highly susceptible to damage from handling (recommended in double glazing units).

HME08- Higher performance glass

Low-E coating reduces the SHGC and thermal resistance (U Value) of the glazing.

All Low-E glass will have a reduced U Value however it is the product's solar heat gain performance that determines whether it is appropriate for a certain climate. For warm climates, Low-E glass with a low SHGC helps reduce unwanted solar gains but in cold climates, Low-E glazing that has minimal impact on solar gains is required. In both warm and cold climates, the lower U Value of Low-E glazing is an advantage. Manufacturers often provide separate U Values for summer and winter (or the heating and cooling seasons). A simple approach is to calculate the average of these two values. If an alternative approach is used to calculate the seasonal average, then this must be clearly justified. One example of an acceptable justification is if there is no heating season where the building is located.

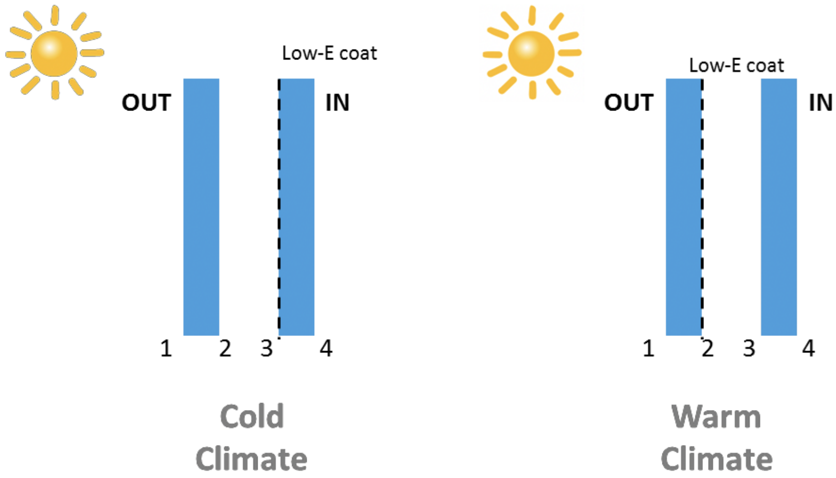


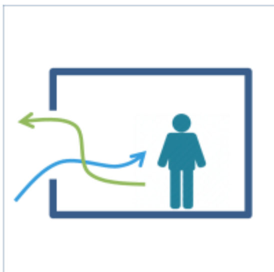
Figure 17: Proposed Low-E coating position in warm and cold climate

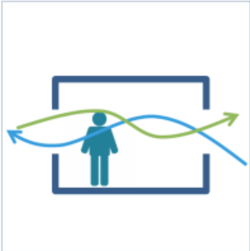
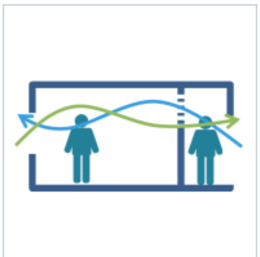
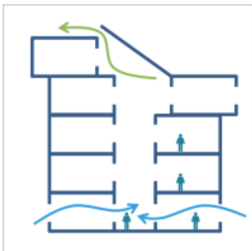
HME09- Natural ventilation

Natural ventilation is a kind of passive cooling, which is the least expensive way to cool the building. To be effective, natural ventilation needs to cool both the building and the people in it – with elements such as air movement. Natural ventilation can be applied to new homes as well as renovations, across a range of different climate zones.

There are two basic approaches to the design of cross ventilation: single-sided and two-sided. Two-sided ventilation is used to ventilate single spaces (which have openings on both windward and leeward sides) and double-banked rooms that rely on openings in corridors between rooms. Single-sided ventilation is used where two-sided ventilation is not possible, but the room depth that can be ventilated in this way is much lower.

Table 19: Type of cross ventilation

Type	Image	Description
Single-sided Ventilation		Single-sided ventilation relies on the pressure differences between different openings within a single space. It is more predictable and effective than if there is only a single opening, and can therefore be used for spaces with greater depth. For spaces that only have a single opening the ventilation is driven by turbulence. This turbulence creates a pumping action on the single opening, causing small inflows and outflows. As this is a less predictable method, the room depth for single opening, single-sided ventilation is reduced.

Cross-ventilation - Single Spaces		Cross ventilation of single spaces is the simplest and most effective approach. Cross-ventilation is driven by pressure differences between the windward and leeward sides of the space.
Cross-ventilation - Double-Banked Spaces		Cross-ventilation with banked rooms can be achieved by creating openings in the corridor partition. It is only acceptable where a residential unit has ownership of both windward and leeward sides of the building, as the ventilation of the leeward space relies on the occupant of the windward space. The openings also provide a route for noise to travel between spaces. One potential solution is to provide a channel which bypasses the windward space, allowing the occupant of the leeward space complete control of air flow.
Stack Ventilation		Stack ventilation takes advantage of the temperature stratification and associated pressure differentials of the air. Warm air becomes less dense and rises and the cooler air replaces the air that has risen. This type of ventilation requires atriums or height differences.

Since employing natural ventilation can significantly reduce the cooling load, the impact of more efficient cooling systems is sometimes reduced to an insignificant level. As with all passive design solutions, cross ventilation should therefore be considered before the detailed design of any Heating, Ventilation and Air conditioning (HVAC) equipment.

HME10- Ceiling fans in all habitable rooms

Ceiling fans are used to increase air movement that aids human comfort by promoting the evaporation of perspiration (evaporative cooling).

Ceiling fans are normally used to reduce cooling energy requirements by introducing higher air velocity. The increased air movement increases the range of temperatures considered to be comfortable by occupants. In order to work in this way, the fan must be installed with the raised edge of the blade on the leading edge. In this mode, the effect is on perceived comfort, so if a room is unoccupied the fans should be switched off. The installation of ceiling fans to reduce cooling requirements improves occupant comfort without actually cooling the air. They are therefore only beneficial in spaces that have a demonstrable cooling load.

4.3.2. Other measures for hotels

Other relevant measures for hotels, according to EDGE's User Guide for Hotels (version 2.0), are quite similar to the ones for apartment buildings, detailed as follows:

HTE01- Reduced Window to Wall Ratio

This measure is similar to the one described for apartment buildings, i.e. measure HME01.

HTE02- External shading devices

This measure is similar to the one described for apartment buildings, i.e. measure HME04.

HTE03- Insulation of roof

This measure is similar to the one described for apartment buildings, i.e. measure HME05.

HTE04- Insulation of external walls

This measure is similar to the one described for apartment buildings, i.e. measure HME06.

HTE05- Low emissivity coated glass

This measure is similar to the one described for apartment buildings, i.e. measure HME07.

HTE06- Higher performance glass

This measure is similar to the one described for apartment buildings, i.e. measure HME08.

HTE07- Natural ventilation - Corridors

This measure is similar to the one described for apartment buildings, i.e. measure HME09.

As the heat gain in a hotel corridor is relatively small, the window area should be at least 10% of floor area of corridor.

HTE08- Natural ventilation – Guest Rooms with Auto Control

This measure is similar to the one described for apartment buildings, i.e. measure HME09.

In order to achieve acceptable natural ventilation flow, different methodologies should be considered: i) maximum ratio of floor depth to ceiling height, and ii) the heat gains to be dissipated, which determine the total area of the opening. In EDGE, the latter is simplified by providing the % of floor area as operable area.

CHAPTER 5. EX-ANTE CALCULATION OF ENERGY SAVING AND GHG MITIGATION POTENTIAL

5.1. Ex-ante estimation of energy saving potential

The energy saving potential from the NAMA includes energy saving from conversion to EE ACs and installation of SWHs.

5.1.1. Energy saving from conversion to EE ACs

In order to estimate the energy saving potential from conversion to EE ACs, information about specific energy consumption of 190 models has been collected from famous brand names in the market like: Daikin, Panasonic, Toshiba, LG, Sharp, Midea, Reetech, Hoa Phat – Funiki, and Nagakawa. The selected models include different capacity scale and belongs to normal ACs (non-Inverter type) and high energy efficiency ACs (Inverter type), one-way (cooling) type and two-way (cooling & heating) type. Based on the comparison of the specific energy consumption of these ACs, the electricity saving potential of Inverter ACs compared with non-Inverter ACs is generalized for the purpose of estimation of GHG mitigation potential.

Table 20: Energy saving potential from the use of energy efficiency ACs

No.	Capacity	a. Cooling			b. Cooling and heating			Average electricity saving potential (%)
		Specific electricity consumption (W)		Saving potential (%)	Specific electricity consumption (W)		Saving potential (%)	
		Non-inverter	Inverter		Non-inverter	Inverter		
1	9,000	806.7	490.0	39.3%	809.6	490.0	39.5%	
2	12,000	1,190.0	820.0	31.1%	1,150.0	810.0	29.6%	
3	18,000	1,739.6	1,300.0	25.3%	1,723.7	1,315.0	23.7%	
4	24,000	2,168.1	1,580.0	27.1%	2,398.6	1,520.0	36.6%	
5	**Average**			30.7%			32.3%	**31.5%**

Source: Author compiled

Electricity saving from conversion to EE ACs is calculated based on electricity saving potential (%) of EE ACs and electricity consumption of current ACs as follows:

$$\boldsymbol{ES_{AC,y} = EC_{AC,y} * ESP_{AC}}$$

Where:

Item	Description	Unit
$\boldsymbol{ES_{AC,y}}$	Electricity saving from conversion to EE ACs in year *y*	[kWh/yr]
$\boldsymbol{EC_{AC,y}}$	Electricity consumption of ACs in year *y*	[kWh/yr]
$\boldsymbol{ESP_{AC}}$	Electricity saving potential	%

5.1.2. Energy saving from installation of SWHs

According to the Solar resource map (GHI) the potential solar absorption of different regions in Viet Nam is provided in below table:

Table 21: Potential solar absorption in Viet Nam

No.	Climate region	Yearly solar irradiation potential (kWh/m^2)
1.	North West	1,168
2.	North East	1,314
3.	North Delta	1,461
4.	North Central	1,607
5.	South Central	1,753
6.	Central Highlands	1,899
7.	South	2,045
	Average	**1,606.7**

Source: http://globalsolaratlas.info/downloads/vietnam?c=11.523088,8.4375,3

According to Table 12: Specific cost for absorber size (USD/m^2) of SWHs, the energy efficiency of SWHs ranges from 46%-68%. The estimation of energy saving from upscale-use of SWHs uses the value of 46% for estimation of energy saving potential of SWHs in the NAMA.

Electricity saving from installation of SWHs is calculated based on the potential installation area of SWHs, average solar irradiation potential and energy efficiency of SWHs (%) as follows:

$$\boldsymbol{ES_{SWH,y} = IA_{SWH,y} * SIP * EE_{SWH}}$$

Where:

Item	Description	Unit
$ES_{SWH,y}$	Electricity saving from installation of SWHs in year *y*	[kWh/yr]
$IA_{SWH,y}$	Potential installation area of SWHs in year y	[m^2]
SIP	Solar irradiation potential	[$kWh/m^2/year$]
$EE_{SWH,y}$	Energy efficiency potential of SWHs	[%]

5.1.3. Results of ex-ante estimation of energy saving potential from NAMA measures

Based on the above assumptions as well as inputs from data survey, the results of estimation of energy saving potential from conversion to EE ACs and extended installation of SWHs in Viet Nam under this NAMA is presented in below Table:

Table 22: Estimation of energy saving potential from the NAMA

No.	Item	NAMA pilot		NAMA full implementation	
		2020	2022	2027	2032
I	***Apartment buildings***				
I.1.	Conversion factor of ACs	5%	10%	50%	100%
I.2	Electricity saving from ACs	9,360	29,389	298,391	651,158
I.3	New installation rate of SWHs	5%	10%	50%	100%
I.4	Electricity saving from SWHs	3,880	8,691	76,580	269,921
II	***Hotels***				
II.1.	Conversion factor of ACs	5%	10%	50%	100%
II.2	Electricity saving from ACs	7,481	22,631	173,941	252,567
II.3	New installation rate of SWHs	5%	10%	50%	100%

II.4	Electricity saving from SWHs	3,639	7,704	49,163	119,614

Source: Author compiled

5.2. Ex-ante estimation of emission reduction potential

Emission reduction potential from the NAMA is resulted from electricity consumption saving from the use of EE ACs and SWHs and from conversion of high GWP refrigerants to low GWP refrigerants.

5.2.1. Ex-ante estimation of emission reduction potential from electricity consumption saving

The emission reduction from electricity saving is calculated as follows:

$$ER_y = ES_y * EF_y$$

Where:

Item	Description	Unit
ER_y	Emission reduction potential from the NAMA in year *y*	[tCO_2/yr]
ES_y	Energy saving potential from the NAMA in year *y*	[MWh/yr]
EF_y	Emission factor from the national grid in year *y*	tCO_2/MWh

The resulted estimation of emission reduction potential from electricity consumption saving from the NAMA is provided in below table:

Table 23: Resulted estimation of emission reduction potential from electricity consumption saving from the building NAMA

No.	Item	NAMA pilot		NAMA full implementation	
		2020	2022	2027	2032
I	*Conversion to EE ACs*				
I.1.	Electricity saving from use of energy efficiency ACs in apartment buildings and hotels (MWh)	16,840	52,019	472,332	903,725
I.2	Emission reduction from use of energy efficiency ACs in apartment buildings and hotels (tCO_2e)	13,732	42,417	385,140	736,898
II	*Installation of SWHs*				

II.1.	Electricity saving from use of SWHs in apartment buildings and hotels (MWh)	7,518	16,394	125,743	389,535
II.2	Emission reduction from use of SWHs in apartment buildings and hotels (tCO_2e)	6,131	13,368	102,531	317,627

Source: Author compiled

5.2.2. Ex-ante estimation of emission reduction potential from conversion to low GWP refrigerants

The emission reduction from recovery and destruction of high GWP refrigerants is calculated as follows:

$$ER_y = RR_y * GWP_y$$

Where:

Item	Description	Unit
ER_y	Emission reduction from recovery and destruction of high GWP refrigerants under the NAMA in year *y*	[tCO_2/yr]
RR_y	Volume of refrigerant recovered and destructed in year *y*	[tonne]
GWP_y	Global Warming Potential of refrigerant (R22 because of its dominant use)	[tCO_2/tonne]

The resulted estimation of emission reduction potential from recovery and destruction of high GWP from the NAMA is provided in below table:

Table 24: Resulted estimation of emission reduction potential from recovery and destruction of high GWP from the NAMA

No.	Item	NAMA pilot		NAMA full implementation	
		2019	2020	2025	2030
I	***Recovery and destruction of high GWP refrigerant***				
I.1	Volume of refrigerant recovered and destructed (tonne)	19.2	59.5	164.4	239
I.2	Emission reduction from recovery and destruction of high GWP refrigerant (tCO_2e)	34,694	72,910	224,680	207,973

Source: Author compiled

5.2.3. Summary of ex-ante estimation of emission reduction potential from the NAMA

In summary, the NAMA deploys three main technological measures for GHG mitigation that include:

- Conversion to high EE ACs;
- Installation of SWHs; and
- Recovery and destruction of high GWP refrigerant.

Emission reductions from the NAMA thus come from:

- Reduction of electricity consumption for ACs and HWHs compared to BAU case; and
- Reduction/avoidance of emission of high GWP refrigerant to the environment.

The potential emission reductions resulted from implementation of the NAMA measures are summarized in below table:

Table 25: Resulted estimation of emission reduction potential from NAMA

No.	Item	NAMA pilot		NAMA full implementation	
		2020	2022	2027	2032
I	***Conversion to EE ACs***				
I.1.	Electricity saving from use of energy efficiency ACs in apartment buildings and hotels (MWh)	16,840	52,019	472,332	903,725
I.2	Emission reduction from use of energy efficiency ACs in apartment buildings and hotels (tCO_2e)	13,732	42,417	385,140	736,898
II	***Installation of SWHs***				
II.1.	Electricity saving from use of SWHs in apartment buildings and hotels (MWh)	7,518	16,394	125,743	389,535
II.2	Emission reduction from use of SWHs in apartment buildings and hotels (tCO_2e)	6,131	13,368	102,531	317,627
III	***Recovery and destruction of high GWP refrigerant***				
III.1	Volume of refrigerant recovered and destructed (tonne)	19.2	59.5	164.4	239

III.2	Emission reduction from recovery and destruction of high GWP refrigerant (tCO_2e)	34,694	72,910	224,680	207,973
IV	***Summary of emission reduction***				
IV.1	Annual emission reduction from NAMA (tCO_2e)	54,556	128,695	712,351	1,262,498
IV.2	Total accumulated emission reduction from NAMA (tCO_2e)	54,556	183,251	2,492,399	**7,572,857**
IV.3	Average emission reduction (tCO_2e/year)				**631,071**

Source: Author compiled

CHAPTER 6. BARRIER ANALYSIS

6.1. Existing barriers for up-scaled use of the technologies

It is pointed out that despite several initiatives for EE from both the government and donor community, significant barriers remain such that many energy-saving opportunities remain unexploited. The constraints to EE investments are usually not due to the financial viability and maturity of EE technologies but to market failures and barriers, including:

- Low or subsidized energy price;
- The small share of energy costs represented in operating cost (leading to consumers' low interest in EE);
- A lack of institutional champions due to the fragmented nature of EE measures;
- Limited financing for the up-front capital expenditure; and
- Lack of energy awareness and capacity to identify and develop EE projects.

This below section provides detailed assessment of existing barriers for the implementation of the alternative technologies identified under this NAMA including: *i)* conversion to EE ACs; *ii)* installation of SWHs; and iii) recovery and destruction of high GWP refrigerants. The barrier analysis covers the economic, technological, political, institutional as well as other barriers within Vietnam context.

6.1.1. Identified barriers for conversion to EE ACs

The identified barriers for conversion to EE ACs are presented in below Table:

Table 26: Identified barriers for conversion to EE ACs

No.	Barriers	Description
1.	Economic barriers	High investment cost compared to traditional one (at least 20 % higher); longer payback period. Higher cost for maintenance and repair due to the complexity of the system and expensive cost of new refrigerants.
2.	Technological barriers	Higher professional skills of service-men required due to the complexity of the system and safety of new refrigerants.

		Much more difficult to recharge refrigerant or repair the equipment than traditional ones.
3.	Political barriers	Low electricity price that demotivate the demand for higher EE.
4.	Institutional and regulation barriers	No encouragement policies for high EE ACs with low (non) ODP and GWP refrigerants The model of Energy Saving Company (ESCO)l is new with almost no support institutions and policies.
5.	Other barriers	Low awareness on GHG mitigation and the link with climate change

Source: Author compiled

6.1.2. Identified barriers for installation of SWHs

The identified barriers for installation of SWHs are presented in below Table:

Table 27: Identified barriers for up-scaled use of SWHs

No.	Barriers	Description
1.	Economic barriers	High investment cost. Longer payback period.
2.	Technological barriers	Difficulties for installation SWHs at existing buildings due to lack of early consideration on design such as: the nature of the roof and the stability of the system. SWHs require a stable water supply source that is still not good in Viet Nam The efficiency of SWH systems depend strongly on time that a SWH is being exposed under the sunshine of the rooftop areas while the time exposure is problem for a high density houses and buildings in Viet Nam
3.	Political barriers	Low electricity price that demotivate the demand for SWHs
4.	Institutional barriers	ESCO model is new with almost no support institutions and policies
5.	Other barriers	Low awareness on GHG mitigation and the link with climate change

Source: Author compiled

6.1.3. Identified barriers for recovery and destruction of high GWP refrigerants

The identified barriers for recovery and destruction of high GWP refrigerants presented in below Table:

Table 28: Identified barriers for recovery and destruction of high GWP refrigerants

No.	Barriers	Description
1.	Economic barriers	No payment to refrigerants thus there is no incentive for collection and recovery. Difficult to find funding source for recovery and destruction of refrigerants
2.	Technological barriers	Specialized technical skills and equipment required for recovery and destruction of refrigerants No technical system.
3.	Political barriers	No regulations on recovery and destruction of refrigerants
4.	Institutional and policy barriers	No institutions and policies to support the recovery and destruction system
5.	Other barriers	Low awareness on GHG emission mitigation and refrigerants in particular

Source: Author compiled

6.2. Recommendations to overcome the barriers

In order to overcome the barriers identified in the above section, the NAMA has proposed some recommendations, which has also be integrated in the NAMA design in order to ensure its effectiveness at national scale.

6.2.1. Recommendations to overcome the barriers for conversion to EE ACs

- Close the gaps of price differences between low EE and high EE ACs through supporting programs to manufacturers/suppliers;
- More financial channels for production and consumption of high EE ACs through grants or concessional loans;
- Impose the fees on low EE ACs that use high ODP and GWP refrigerants based on the low ODP and carbon free labelling system
- Develop the recovery and destruction of refrigerants system at a national scale
- Develop a Fund for recovery and destruction of refrigerants based on the revenues from the above mentioned fee system
- Provide high quality technical trainings to service providers
- Develop and extend the ESCO models to a national scale
- Conduct demonstrations and public awareness programs

6.2.2. Recommendations for up-scaled installation of SWHs

- Reduce the price of SWHs through supporting programs to manufacturers/suppliers and customers;
- More financial channels for production and consumption of SWHs through grants or concessional loans;
- Provide high quality technical trainings to service providers;
- Develop and extend the ESCO models to a national scale;
- Conduct demonstrations and public awareness programs;
- Conduct studies on technical requirement to install SWHs at existing buildings.

6.2.3. Recommendations for recovery and destruction of high GWP refrigerants

- Conduct studies on technical and institutional requirement to set up the system;
- Conduct demonstrations and public awareness programs;
- Develop the recovery and destruction of refrigerants system at a national scale;
- Develop a Fund for recovery and destruction of refrigerants based on the revenues from the above mentioned fee system;
- Provide high quality technical trainings to service providers.

CHAPTER 7. CO-BENEFITS & TRANSFOMRATIONAL CHANGES

7.1. Why co-benefits and transformational change matter to a NAMA?

NAMAs are intended to not only achieve reductions in GHG emissions, but also promote sustainable development. Thus, both the emission reductions and co-benefit are subject to measurement, reporting and verification (MRV).

In prioritizing NAMAs for financing and implementing, co-benefits and transformation change are decisive factors for investors and political partners. The support of donors and financial institutions is strongly influenced by additional sustainable development benefits.

As concluded in UN ESCAP 2015, co-benefits serve to strengthen the political case for NAMAs and to obtain international support to design and finance them, since they could contribute significantly to the transformational aspects of NAMAs. It is hard in many developing countries to achieve political alignment with mitigation measures based solely on the GHG emission reduction potential of the mitigation action(s).

Transformational change and paradigm shifts are becoming important terms within the vocabulary of the climate change and development community. They reflect a shared belief that a fundamental change is needed to prevent dangerous levels of climate change and to ensure a globally sustainable development. Such a change cannot simply arise from changing technologies or simple structures. It must entail a systemic change involving changes in "worldviews, institutions and technologies together, as an integrated system". The question "Does the NAMA steer transformational innovations, right?" is considered vital in designing this NAMA.

7.2. Assessing the NAMA's co-benefits and transformational changes

Co-benefits, though are widely used and discussed in the climate change policy context, do not have a unified definition. The UN defines a set of indicators for sustainable development which can be used as a point of departure[7].

The CDM has developed a detailed set of principles and indicators for co-benefits[8] .The UNFCCC guidebook for NAMA design labels many of the NAMA co-benefits as *sustainable development* benefits and presents a table of criteria and measureable indicators for *economic, social and environment* co-benefits of NAMA (UNFCCC, UNDP, UNEP, 2013). The Institute of Global Environmental Strategies (IGES) takes a more general concept that defines co-

[7] http://www.un.org/esa/sustdev/natlinfo/indicators/guidelines.pdf

[8] http://cdmcobenefits.unfccc.int

benefits as potential benefits of climate change mitigation actions in *other field and areas not covered by climate change or UNFCCC* (US EPA, MO, CAI-Asia, 2007).

Given these background documents, through careful study of the different measures proposed under the NAMA, the following co-benefits and transformational changes have been identified for the NAMA.

a) Economic co-benefits

- Conversion to EE AC helps reduce electricity cost for consumers;
- Installation of SWH helps utilize renewable energy (RE) sources, contributing to decrease electricity demand as well as demand for import of fossil fuel, this in turn reduce foreign exchange outflow to import fossil fuels;
- The use of RE and EE technologies help reduce the demand for construction of new power plants to meet the need of increasing energy use in the country;
- Financial mechanism for NAMA helps leverage private investment and public- private partnership to achieve GHG mitigation targets.

b) Social co-benefits

- Creating business opportunities for investors in EE ACs and SWHs;
- Creating jobs and competitiveness in ACs and SWHs sectors;
- EE (Inverter) ACs have more stable temperature range compared to normal ACs, help stabilize room temperature and increase the health of the consumers;
- Raising social awareness on EE and RE.

c) Environmental co-benefits

- Recovery and thermal destruction of high ODP refrigerants helps protect the Ozone Layer;
- EE and RE measures, recovery and thermal destruction of high GWP help reduce GHG emission and mitigate climate change;
- EE and RE measures help improved indoor air quality.

d) Technological co-benefits

- Enhance technological transfer, investment, production and use of EE AC technologies;
- Enhance technological transfer, investment, production and use of SWH technologies;
- Enhance technological transfer, investment, production and use of technologies for recovery and destruction of high GWP and high ODP refrigerants.

e) Transformational changes

- NAMA design includes establishment and operation of a system for recovery and thermal destruction of high GWP and high ODP for the first time in Viet Nam. This is a fundamental change compared to the normal practice of free discharge to the environment;
- Financial mechanism for NAMA includes fee and tax system based on the labelling system and payment for recovery and thermal destruction services for the first time in Viet Nam. This will induce vital transformational change to raise the awareness of the consumers and technical workers on GHG emission reduction and carbon pricing for equipment for the first time in Viet Nam.

The above identified co-benefits and transformational changes of the NAMA have been discussed and received wide consensus from relevant stakeholders in the Final Workshop organized on 27 December 2017 to consult on details of the NAMA design and NAMA proposal.

7.3. How to MRV co-benefits and transformational change

The approach to develop the MRV of co-benefits and transformational change should follow the following principles:

- **Be based on the country's context:** the existing national/sectoral or programmatic sustainable development policies and strategies, as well as the principles for approving CDM projects provide general guidance on the categories of metrics that reflect a nation's sustainable development priorities.
- **Be based on a small number of indicators specific to the project that align with the established criteria and are measured over time:** there is also flexibility to select indicators that are appropriate to the specific circumstances, including the financial resources, capacity and data that are available or can realistically be made available domestically or with international support.
- **Build on existing institutions and processes**: reporting requirements for projects should piggyback on existing reporting requirements and institutional tasks. This will help to implement MRV in a cost -and time-effective manner.
- **Develop stakeholder consultation as cornerstone of co-benefit/transformational change MRV**: Consultation with affected communities and relevant authorities are important for identifying sustainable development priorities. Robust, in-person consultations with a broad range of stakeholders helps build support for projects, and bring

mitigation project design more closely in line with the sustainable development needs.

Further details about the MRV system for co-benefits and transformational changes of the NAMA are provided in CHAPTER 8 SETTING UP AN MRV SYSTEM.

CHAPTER 8. SETTING UP AN MRV SYSTEM

8.1. Defining the MRV system of the NAMA

8.1.1. MRV of NAMA

MRV is considered a central component in frameworks for emissions mitigation actions through NAMAs in developing countries. The key objective of MRV is to increase the "transparency of mitigation efforts made by the developing countries as well as build mutual confidence among all countries" (UNFCCC, 2011). In simple terms with regards to the implementation of NAMAs, it is defined as:

Measurement	collect relevant information on progress and impacts
Reporting	present the measured information in a transparent and standardized manner
Verification	assess the completeness, consistency and reliability of the reported information through an independent process

Source: UNFCCC, 2013

8.1.2. Role of the MRV system

The guidance for NAMA design published by international organisations (UNFCCC, 2013) provides a good explanation on the role of an MRV system that is "Measurement enables assessment of the implementation of plans, the achievement of objectives/goals and the taking any necessary corrective steps that may be required. Reporting and verification ensure communication of consistent and reliable information to appropriate authorities in order to facilitate assessment. MRV is thus a management tool for monitoring achievement of goals and objectives, whether they be of an organisation, and institution or part of the governance of a country."

For a NAMA, the design of an MRV system is highly important for the following reasons:

- MRV is the basic factor to ensure the transparency, accuracy, and comparability of NAMA;
- MRV let us know if we are on the right track to obtain the goals of NAMA;
- MRV also:
  + Promote national decision-making and planning;
  + Support the implementation of NAMA activities and give feedback on the effectiveness;

+ Promote the coordination and communication between different emission sectors;
+ Provide comparable and transparent information;
+ Provide lessons and successful cases;
+ Increase opportunity for receiving international support.

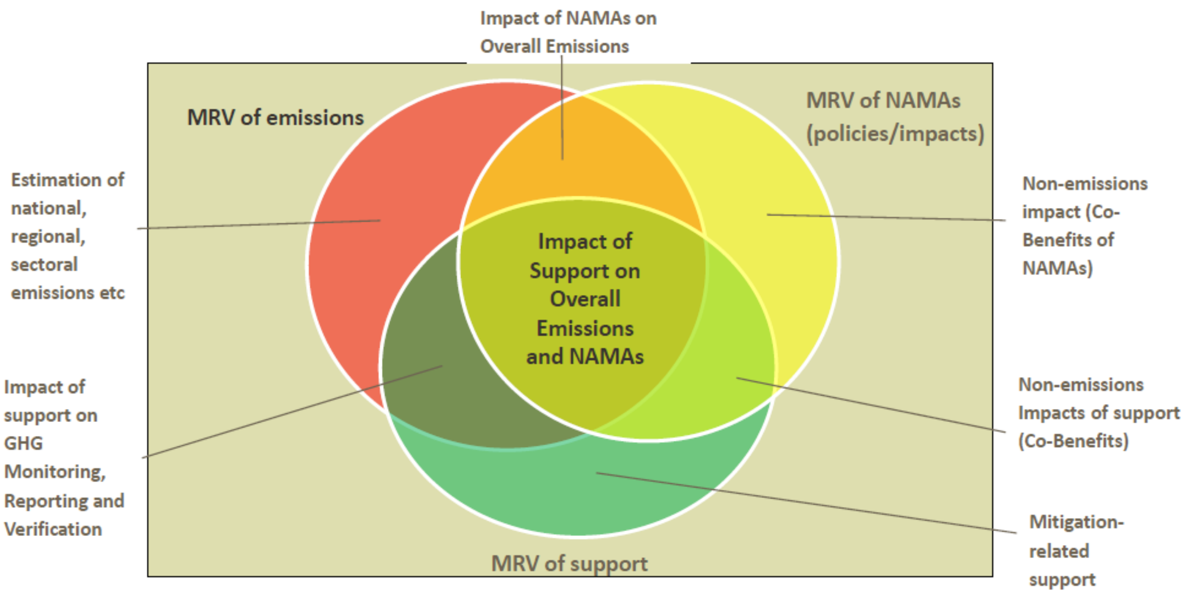
8.1.3. Scoping MRV of the NAMA

The design of the MRV system for the building NAMA covers the followings:

- **MRV of GHG emission** (MRV of GHG emission and GHG emission reduction from mitigation activities of NAMA)
- **MRV of non-GHG emission**
  + MRV of co-benefit (impacts of policy; economic, social, environmental benefits…)
  + MRV of supports (MRV of financial lines/ technologies transferred/capacity building and impacts of all these factors)

The interaction of three sectors is summarized in the Figure below.

Figure 18: MRV background

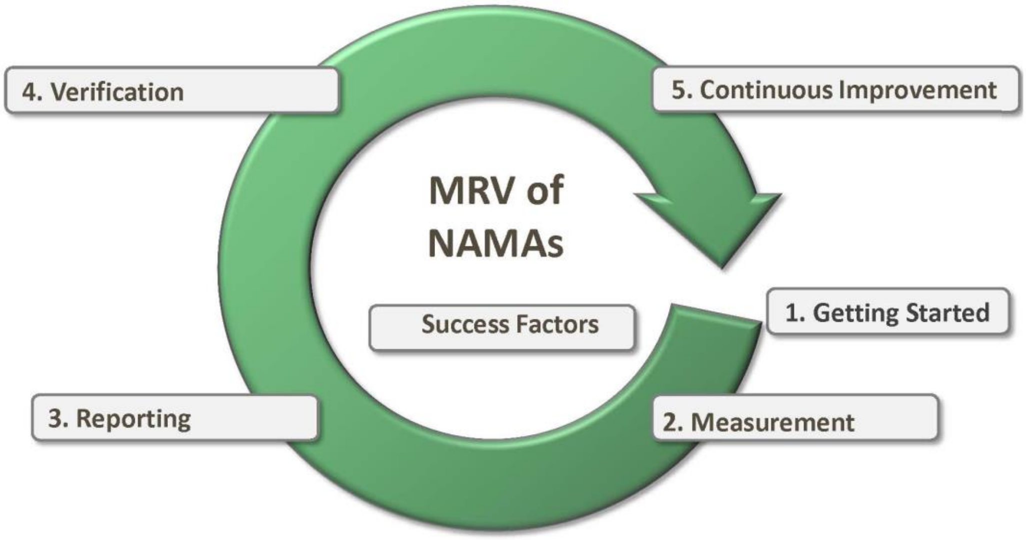


Source: GIZ, 2014

8.1.4. Implementation sequence

For a NAMA project, the "continuous improvement" as indicated in the figure below shall be a natural and inseparable part of any MRV system during its implementation.

Figure 19: The implementation sequence of MRV of NAMAs



Source: GIZ, 2014

8.2. Ex-post calculation of emission reductions and monitoring parameters for the NAMA

As earlier provided, the emission reductions from the NAMA come from:

i) Indirect emission reduction from energy saving from use of EE ACs;
ii) Indirect emission reduction from energy saving from use of SWHs;
iii) Direct emission reduction from recovery and destruction of high GWP refrigerant.

The following section describes the formulas and monitoring parameters for ex-post calculation of emission reductions from these sources, which is based on the following CDM methodologies:

- AM0091: Energy efficiency technologies and fuel switching in new and existing buildings
- AMS-II.C: Demand-side energy efficiency activities for specific technologies
- AMS-I.J: Solar water heating systems

8.2.1. Emission reductions from EE ACs

Emission reduction from energy saving of EE ACs will be calculated ex-post as following:

$$ER_{AC} = ES_y \times EF_{grid,y}$$

Where:

Input data	Description	Unit
ER_{AC}	Emission reduction from AC in year y	[tCO_2/yr]
ES_y	Electricity saving of new AC systems in year y	[tCO_2/yr]
$EF_{grid,y}$	Emission factor of Vietnam national electricity grid in year y	[tCO_2/MWh]

The energy saving from EE ACs is calculated as follows:

$$ES_y = \sum_j (N_{j,y} \times (SEC_{BL,j} - SEC_{new,j}) \times h_{ave,y}$$

Where:

Input data	Description	Unit
ES_y	Electricity saving of new AC systems in year y	[MWh/yr]
j	Type of AC (e.g. 9,000, 12,000, 18,000 BTU...)	[tCO_2/yr]
$N_{j,y}$	Number of new AC with type j in year y	-
$SEC_{BL,j}$	Specific electricity consumption of baseline AC with type j	[MWh/hour]
$SEC_{new,j}$	Specific electricity consumption of new AC with type j	[MWh/hour]
$h_{ave,y}$	Average operation hours of new AC in year y	[hour]

The monitoring parameters for calculation of emission reductions from energy saving from the use of EE ACs as well as monitoring frequency are summarized in below table:

Table 29: Monitoring parameters for EE ACs

Monitored parameter	Unit	Description	Source	Frequency
$N_{j,y}$	-	Number of new AC with type *j* in year *y*	Actual data from the NAMA project activity and/or integrating data of domestic AC manufacturers and import data from	Yearly

			General Department of Vietnam Customs	
$SEC_{new,j}$	[MWh/hour]	Specific electricity consumption of new AC with type *j*	Collecting the name plate/ technical specification of equipment from manufacturers	Yearly
$EC_{new,j,k,y}$	[MWh/yr]	Sample electricity consumption of new AC with type *j* in region *k* in year *y*	Collecting separate meters for new ACs of samples building in 3 regions	Yearly
$h_{ave,y}$	[hour]	Average operation hours of new AC in year *y*	Conducting for new ACs of samples building in 3 regions	Yearly

Source: Author compiled from UNFCCC methodologies

8.2.2. Emission reductions from SWHs

Emission reduction from replacing electricity that is resulted from the use of SWHs will be calculated ex-post as following:

$$ER_{SWH,ele} = ES_{SWH} \times EF_{grid,y}$$

Where:

Input data	Description	Unit
$ER_{SWH,ele}$	Emission reduction from SWH in year y	$[tCO_2/yr]$
$ES_{SWH,ele}$	Electricity saving from SWH in year y	[MWh/yr]
$EF_{gird,y}$	Emission factor of Vietnam national electricity grid in year y	$[tCO_2/MWh]$

The energy saving from SWHs is calculated as follows:

$$ES_{SWH} = Cap_{SWH,y} \times RO_{SWH} \times FU_{SWH,y} \times O_{SWH,y}$$

Where:

Input data	Description	Unit
ES_{SWH}	Electricity saving from SWH in year y	[MWh/yr]
$Cap_{SWH,y}$	Total installed capacity of solar water heater year y	$[m^2]$

RO_{SWH}	Rated output of SWH	$[MWh/m^2/yr]$
$FU_{SWH,y}$	Fraction of utilization per year [% = average operation hours/ 8760]	%
$O_{SWH,y}$	Fraction of SWHs installed that are operational in year y	%

The monitoring parameters for calculation of emission reductions from energy saving from the use of SWHs as well as monitoring frequency are summarized in below table:

Table 30: Monitoring parameters for SWHs

Monitored parameter	Unit	Description	Source	Frequency
$Cap_{SWH,y}$	$[m^2]$	Total installed capacity of solar water heater year *y*	Domestic SWH manufactures, SWH suppliers and General Department of Vietnam Customs	Yearly
RO_{SWH}	$[TJ/m^2/yr]$ or $[kWh/m^2/yr]$	Rated output of SWH	SWHs technical specification from manufactures or default value	Yearly
$FU_{SWH,y}$	%	Fraction of utilization per year [% = average operation hours/ 8760]	Sample records or default value	Yearly
$O_{SWH,y}$	%	Fraction of SWHs installed that are operational in year *y*	Sample records of default value	Yearly

Source: Author compiled from UNFCCC methodologies

8.2.3. Emission reductions from recovery and destruction of high GWP refrigerants

The emission reduction from recovery and destruction of high GWP refrigerants is calculated ex-post as follows:

$$ER_y = \sum_i (RR_{i,y} * GWP_i)$$

Where:

Input data	Description	Unit
ER_y	Emission reduction from recovery and destruction of refrigerants in year *y*	[tCO_2/yr]
$RR_{i,y}$	Volume of refrigerant *i* recovered and destructed in year *y*	[tonne]
GWP_i	Global Warming Potential of refrigerant *i*	[tCO_2/tonne]

The monitoring parameters for calculation of emission reductions from recovery and destruction of high GWP refrigerants as well as monitoring frequency are summarized in below table:

Table 31: Monitoring parameters for recovered and destructed refrigerants

Monitored parameter	Unit	Description	Source	Frequency
$RR_{i,y}$	[tonne]	Volume of refrigerant *i* recovered and destructed in year *y*	Service-men; Recovery and destruction service providers	Yearly

8.3. Current MRV practices

8.3.1. Building stock data

Decree 11/2015/ND-CP dated 12 November 2015 on establishment management use of housing and real estate market information system is the latest regulation on collecting and updating housing and real estate including residential buildings and hotels. The MOC is in charge of coordinating and collaborating database and other related information on housing and real estate market.

Circular No. 03/2016/TT-BXD dated March 10, 2016, regulations on classification of construction works and instructions on application to construction management issued by the MOC provides definitions and instructions for grading the buildings and constructions works with different using purposes.

However, the interview with a specialist from MOC reveals that there is currently no national database yet on residential and commercial buildings in Vietnam for all grades.

Some projects financed by IFC and USAID up to now have attempted to conduct the surveys at the national scale to develop the database on buildings and energy consumption. The database is not yet covered nationally but some major cities and targeted certain building types. No surveyed database under these project is published so far.

For hotel management, the Hotel Department under VNAT belongs to Ministry of Culture, Sports and Tourism is in charge of managing tourist accommodations and the relevant activities. This Agency is responsible for preparing and submitting to VNAT to decide on, among the others, the followings:

- Guidelines, policies, strategies, planning, long-term plans, programs, projects, draft legal documents and draft guiding documents on management of tourist accommodations and other tourism services;
- Setting standards and economic-technical norms related to tourist accommodations and other tourist services; To set criteria for classification and classification of tourist accommodations; dossiers and procedures for rating and signboard of tourist accommodation establishments;

Currently, the classification and rating of tourist accommodations are conducted against the National Standard TCVN 4391:2015 issued by Ministry of Science and Technology in December 2015. The VNAT is responsible for rating and validating the hotels from 3 stars while local Department of Culture, Sports and Tourism in each province is in charge of up to 2 star hotels.

VNAT via the website http://www.vietnamhotels.gov.vn publishes hotels from 3 stars In Viet Nam that have been rated. In 2016, VNAT has announced a list of 829 standard hotels from 3 to 5 stars, of which the highest proportion is a three-star hotel (about 500 hotels), the remaining four stars (more than 200) and the few are 5 star hotels[9] with the total rooms in service are around 100,000 rooms.

8.3.2. Electricity consumption data

At national level

According to the law and regulations, the key energy consumption for buildings is defined as those consume annually a total energy of at least 500 TOE. These buildings shall report energy consumption to Ministry of Industry and Trade (MOIT) annually by 01 February at the latest[10].

Responsibilities of key energy consumption facilities:

[9] http://kinhtedothi.vn/loan-sao-khach-san-126842.html

[10] In accordance with Decision No.1294/QD-TT dated 01 August 2011 of the Prime Minister providing the list of key energy consumption cement plants.

- Develop and implement annual and five-year plan on energy efficiency and conservation in comfort with production and business plan to contribute to the national energy efficiency and conservation target; to report local competent authorities on the achievements regarding energy efficiency and conservation.
- Develop responsibility regime of organization, individual involved in the implementation of the plan for energy efficiency and conservation.
- Appoint energy manager
- Every three (03) years, perform obligatory energy audit. Within 30 days of audit completion, send the audit report to the Department of Industry and Trade where the facilities are located.
- Apply the energy management model as directed by the competent state administration body.
- Implement regulations on energy efficiency and conservation in new construction, improvement and expansion of plant.

The latest list of 2413 key energy consumption facilities issued by the Prime Minister on 03 September 2017 contains about 123 buildings including residential and/or complex buildings of office and residential; and 63 hotels.

At apartment level

In general, each apartment building is equipped with an electric metering system that includes separate meters for each consumer (household).

The household meters records automatically but are verified and sealed by electric supplying companies. Data recorded and read monthly is available to the owners and at the electric companies. Therefore, the total electric consumption of a whole building is available at the electric companies only.

It is the same for hotel buildings and each hotel is considered as one consumer. The only slightly different is in the tariff applied for hotels is higher than those for households.

As a normal practice, the electricity metering system in households/hotels records all electricity consumed without distinguishing the electricity quantity used by different appliances. The data on electricity for specific purposes or appliances is able to obtain via estimation only.

In hotels if they consumes fossil fuels for boiling water, the record of energy consumption can be obtained via purchasing invoices.

The best approach to obtain the data on electricity consumption is via electricity bills for hotels and via data recorded by electricity companies for buildings.

8.3.3. Environment performance data

Annex II, Decree No. 18/2015/ND-CP, dated 14 February 2015 on environmental protection planning, strategic environmental assessment, environmental impact assessment and environmental protection plans regulates that construction projects for tourist accommodations with capacity from 50 rooms and residential buildings with capacity from 100 households have to conduct the Environment Assessment and submit periodically environmental report during construction and then in operation.

However, the assessment of the environmental quality here is an overview of the various sources of waste such as waste water, waste gases, and solid waste (including: domestic, industrial and hazardous waste).

<u>Therefore, the current requirement on reporting environment impacts is not relevant to the subject of this NAMA.</u>

8.3.2. Data on number of installed equipment

There is currently no national data on the number of installed equipment under the NAMA, i.e. EE ACs and SWHs. For data collection on the number of installed EE ACs and SWHs that are covered under the NAMA, it is expected that the management board of apartment buildings and hotels' owners can provide the data. The sale data from importers and manufacturers of the equipment can also be collected for cross-check.

8.4. Proposing the institutional arrangements for MRV

There are principally four major units in MRV processes:

- ***Legislative or law making body***: This body develops the legislations or amends the existing law to mandate the reporting and relevant quality criteria. Lawmakers may draft the detailed rules to govern an MRV system, or may outline the broad principles and objectives of the system and then direct the NAMA Operating Unit to develop the detailed rules.

  In regard to the building NAMA, the legislative/law making body at national level is proposed to be a joint committee consisting of relevant representatives from MONRE, MOIT and MOC.

  At provincial or city level, the Provincial/City People's Committee will play the role of the legislative/law making body.

- ***Administrative and executive body***: This body is in charge of implementing the NAMA as per the rules established by the legislation and regulations. The administrative agency may also be responsible for developing the detailed rules for an MRV and enforcing the implementation of the MRV system. This administrative body collects, analyzes, synthesizes, and presents the reported data; provides verification and accreditation guidelines to ensure the quality of data and may also verifies the data; provides trainings to reporting entities; conducts outreaches; and, undertakes and supervises compliance measures.

At national level, it is proposed that the NAMA Operating Unit formed under MOC with close collaboration with VNTA will play this administration role.

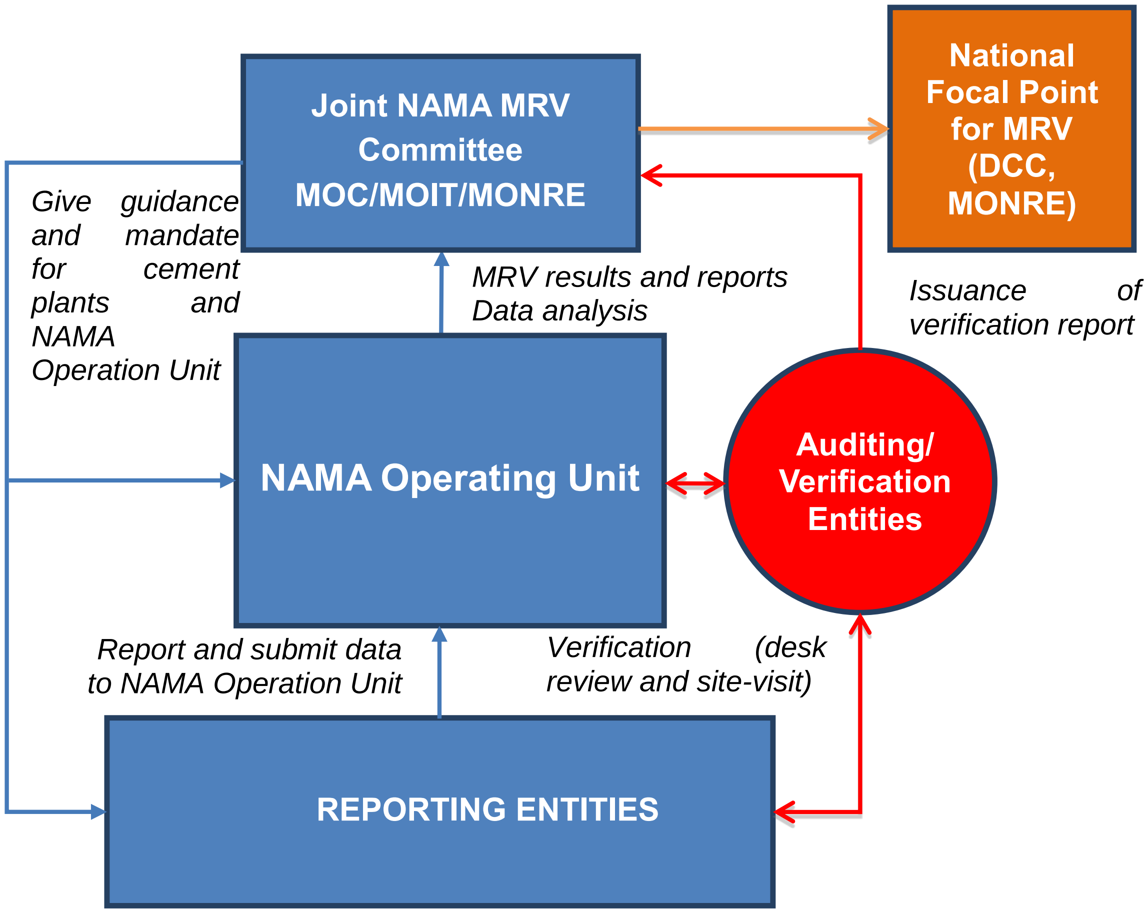
At provincial or city level, the Department of Construction in cooperation with Department of Tourism will be the administrative and executive body for the NAMA.

- ***Reporting entities*****:** They are responsible for providing accurate, reliable data at a frequency required in an MRV.
- ***Auditing and verification entities*****:** These entities will ensure that the data monitored and reported in an MRV system are qualified. These entities conduct audits in accordance with the verification and accreditation guidelines. Depending on the decisions made by NAMA Operating Unit,

the auditors and verifiers can be set up internally or an independent third party verifier is used.

The following figures summarize the preliminary MRV process required for the NAMA cement:

Figure 20: Proposed institutional arrangements for MRV for the building NAMA



Source: Author compiled

Regarding reporting entities, the Joint NAMA MRV Committee and NAMA Operating Unit may consider the following two options:

Option 1:

Option 1 provides for a more generic approach to MRV, in which the reporting entities are importers and manufacturers of EE ACs and SWHs.

The pros and cons of this Option is provide below:

Option 1: **Reporting entities are importers and manufacturers of EE ACs and SWHs**	
Pros	***Cons***
- In line with current practice, *i.e.*, importers and manufacturers of equipment usually have annual report on sale data of their products. - Easier to implement.	- Low accuracy since estimation and sampling approach will be utilized; - Not much effective in terms of awareness rising to consumers on use of EE equipment and GHG emission reduction.

Option 2:

Option 2 provides for a more specific approach to MRV, in which the reporting entities are residents or management board of apartment buildings and owners or managers of hotels.

The pros and cons of this Option is provide below:

Option 2: **Reporting entities are residents or management board of apartment buildings and owners or managers of hotels**	
Pros	***Cons***
- High accuracy since data on the equipment that are actually installed and in operation will be collected; - Customers are aware of the NAMA activities	- New legislation is required to be developed. - Awareness rising and capacity building on MRV is required to performed on residents/management boards of apartment buildings and owners/managers of hotels.

CHAPTER 9. FINANCIAL MECHANISM

9.1. Definition of NAMA mitigation actions and enabling activities

The real reduction of GHG emissions under this building NAMA in Vietnam will require a combination of concrete measures to be taken by several stakeholders. The Consultant suggests to classify these measures as 1) mitigation actions and 2) enabling activities.

(1) Mitigation actions are all physical interventions, usually requiring capital or operating expenditures, with direct impact on GHG emissions. In the case of this NAMA, the mitigation actions could be divided in two categories:

- **Residential and hotel mitigation actions** – investment and operational actions taken at the residential buildings and hotels that directly affect CO_2 emissions and/or energy consumption at these buildings that include: conversion of low EE to high EE ACs and new installation of SWHs.
- **Recover and thermal destruction of refrigerants** – investment and operational of the system to collect, recover ODS refrigerants from old and low EE ACs and then the recovered refrigerants being transferred to and thermally destructed by the cements' kilns.

(2) Enabling activities are interventions that create necessary, favourable or conducive conditions for the uptake of the mitigation actions and, therefore, have an indirect impact on GHG emission reductions. The effectiveness and efficiency of most mitigation actions will depend on the implementation of such enabling activities that typically include:

- **Policy, regulatory measures and technical support:** taken by a public authority (national, regional or local). In this building sector context, this could include the strengthening of policies on EE improvement and mitigation of ODSs & GHGs by introducing new carbon neutral labelling system; the fee system for recovery and thermal destruction of refrigerants.
- **Demonstration activities:** conducting the demonstration activities to catalyse and promote EE practices and application of the recovery and thermal destruction system of refrigerants at a large scale.
- **Financial incentives and market-based approaches** introduced by the government, international donors or financial institutions to incentivise the private sector to invest into mitigation technologies and practices;
- **MRV and NAMA institutional framework:** setting up and operating the NAMA MRV and MRV institution; setting-up NAMA institutional framework including the establishment of NAMA Operating Unit that is

supposed to locate at the MOC and other management body, cooperation mechanisms between stakeholders

- **Capacity building, awareness raising and technical assistance** provided by local or international experts for governmental authorities, the sector and sub-sectors, users and other stakeholders in the country, typically in the form of sharing information, expertise, knowledge, consulting services, technologies and data transfer.

The main stakeholders to carry out and manage the implementation of the enabling activities are governmental authorities, who may be supported by local or international expert organizations, industry associations, and international donors.

The ultimate success of the NAMA will depend on the smooth and effective coordination of all individual actions and activities, as some mitigation approaches might be only feasible or more cost-efficient after certain enabling activities have been implemented.

Therefore for evaluating the overall financing needs for the building NAMA, it's necessary to take into account the costs of both mitigation actions and enabling activities, and to assess how these enabling activities could bring down the incremental costs of GHG reduction interventions.

9.2 Methodology for estimating financial needs

The first objective of this report is to determine the overall financial needs for implementation of the future building NAMA. The NAMA includes a set of mitigation actions that is required to bring GHG emissions from using ACs, producing hot water and discharging refrigerants from the current BAU GHG emissions onto lower-carbon future GHG emissions pathways and a set of enabling (readiness) activities to support introduction and deployment of these mitigation actions. In order to estimate the overall NAMA financial requirements, one has to take into account the potential costs of both. The sections below will briefly explain the applied methodology for estimating such costs and the results of the NAMA financial needs analysis.

The actual calculations have been carried out in the **Building NAMA_ Database and Finance Assessment** (see the separate excel file).

9.2.1 Methodology for estimating financial needs for mitigation actions

To estimate the financial needs for mitigation actions per scenario, the following steps have been taken:

Step 1. Estimation of costs

(1) Identification of incremental cost of equipment includes additional capital investments and the additional operational & maintenance (O&M) costs compared to the baseline scenario.

For ACs: the average of incremental cost per AC unit is calculated as the mean value of the price differences of low energy efficiency and high energy efficiency ACs in the same capacity range that are dominant in the domestic market.

The identified costs of AC conversion have been multiplied by the total number of installations in residential buildings and hotels to which this mitigation action has to be applied to, taking into account the scenario-specific technical potential for implementing this mitigation action.

For SWHs: the average of investment cost per SWH unit is calculated as the mean value of the price of different types and capacities of most dominant and available SWHs in the domestic market.

The identified costs of SWH installation have been multiplied by the total number of installations in residential buildings and hotels to which this mitigation action has to be applied to, taking into account the scenario-specific technical potential for implementing this mitigation action.

All the retail prices are collected from the survey as presented in CHAPTER 4. The retail prices of key ACs brands in the market have been accounted that included Daikin, Panasonic, Toshiba, Sharp, LG, Reetech, Midea. Similarly the retail prices of most available SWHs in the market (Tan A Dai Thanh, Son Ha, Solar Bach Khoa, Toan My, Viet Uc) have been taken into the calculation.

The incremental operational cost in this case is the saving costs (revenue) from conversion to high energy efficiency AC and/or installation of SWH due to saving electricity consumption. The maintenance costs are almost the same in the baseline and in mitigation actions, therefore it is not considered in the analysis.

(2) Identification of cost of recovery and thermal destruction of refrigerant. The cost of recovery and destruction of refrigerant is defined according to the international rate since this kind of activities is limited to a small pilot in Viet Nam only and not comprehensive enough (not covering the collection, transportation and other administrative expenses).

The identified cost has been multiplied by the total estimated refrigerant that is recovered from mitigation actions.

Step 2. Estimation of revenues (saving)

The only revenue source generated under this NAMA is from the saving of electricity consumption compared to the baseline scenario.

Step 3. Consolidation of results

Comparison of the overall required costs vs. savings of each mitigation action in 2030.

Calculation of the cumulative impact of deploying a set of mitigation actions and the annual cost/revenue balance to identify the break-even point for each mitigation option.

9.2.2 Methodology for estimating financing needs for enabling activities

In the 'Introduction' section of this report, the Consultant has defined NAMA enabling activities as interventions that create favourable conditions for the uptake of mitigation actions in the sector where NAMA is to be implemented, and that are aimed at establishing the NAMA operational framework.

While some enabling activities are no-cost interventions (such as adoption of certain policy and regulatory decisions by the Government), others have associated costs, either in the form of 1) capital investments (e.g. into establishing an energy efficiency service centre, or into purchasing and installing MRV equipment) and demonstration activities; 2) O&M costs associated with the functioning of the NAMA Operating Unit and other management bodies; 3) organization of various events (workshops, trainings, meetings, etc.); or 4) fees and travel expenses for experts providing technical assistance.

The costs of enabling activities have been estimated based on the NAMA needs to support the mitigation activities.

For the purposes of the finance assessment, all cost-associated enabling activities have been grouped as follows:

1. Policies, incentives and technical assistance
2. Demonstration activities
3. Financial mechanisms and market based approaches
4. Setting up NAMA MRV system and NAMA managing
5. Capacity building and awareness raising.

9.3. Existing financial mechanisms and institutions to support energy efficiency measures

There are existing financial mechanisms to support the measures in Viet Nam. Apart from the subsidies, preferential taxes and financial incentives by laws and regulations that have been presented in Section 2.3 Incentives for energy efficiency in the building sector, there are also a number of financial mechanisms and financial institutions available to support energy efficiency measures, including the ones for building sector.

9.3.1. Existing financial mechanisms through projects/programs and financial institutions

A number of commercial banks and national/international supported projects/programs are providing financial support to application of EE measures through different projects/programs in the following forms:

- **Subsidies**

Under the program to promote the use of solar water heaters under VNEEP (2011-2015), a subsidy of one million VND per one unit of solar water heater for each household is applied. Total budget spent on the project is 77 billion VND.

- **Grants**

Grants are usually provided to capacity building, technical assistance projects or projects for demonstration at pilot scale.

There are a number of grants from international donors to support to the Viet Nam Government and other stakeholders in their efforts to improve national energy efficiency.

The World Bank's Global Environment Facility funded the US$2.37 million three-part project namely Vietnam Clean Production and Energy Efficiency Project (CPEE) with the aim to reduce GHG emissions across Viet Nam's industrial sectors.

- **Concessional loans**

Under the Energy Efficiency for Industrial Enterprises (VEEIE) project, an EE financial intermediary lending program of US$156.3 million is expected to be provided to EE projects in industries.

- **Commercial loans**

Commercial loans are provided to EE projects through normal lending channel.

So far, Techcombank is one of few active commercial banks to provide optimal financial solutions to enterprises involved in energy audit. In period 2011-2015, Techcombank has been endorsed by IFC to manage a project that supports lending of US$50 million to energy efficiency and cleaner production activities.

- **Equity investment**

Some private financial institutions have been investing in equity in Viet Nam. For instance, the Asia Energy Transition Fund (AETF) provides equity investment in renewable energy projects and EE upgrades at existing infrastructure in Asia's emerging markets including Viet Nam.

- **Guarantees**

Green Investment Facility was established under the Low Carbon Transition in Energy Efficiency Sector (LCEE) programme, in which the Government of Denmark has committed grant support of US$6.5 million to help small and medium enterprises in Viet Nam get access to funding for energy efficient projects through 3 banks in Viet Nam: Techcombank, Bank for Investment and Development of Viet Nam (BIDV), and Saigon Commercial Bank (SCB).

The means of support include bank guarantee and energy saving award in 3 target sectors: bricks, ceramics and food processing.

- **Result based finance**

ESCO model

In the framework of the CPEE project sponsored by the World Bank and Global Environment Fund (GEF), the MOIT deploys the pilot Voluntary agreement (VA) program and disseminates the ESCO model in Viet Nam. The VA program and ESCO model aim at promoting energy-saving activities in the industry in Vietnam; helping enterprises improve their EE, reduce production costs, improve their competitiveness and abide by legal provisions.

Since 2014, the Vietnam Electricity Cooperation (EVN) has implemented a pilot ESCO programme in the South. In March 2017, this programme has signed the ESCO contracts with 7 clients to provide solar water to industrial facilities, including a hotel.

ESCO contracts have been signed with customers under the forms of Energy Saving Contract and Energy Saving Agreement.

According to the plan of EVN, from 2016 to 2020, each year EVN will implement at least 50 ESCO projects in Viet Nam. It will open to all customers using electricity and EVN will prioritize SMEs with total investment from 500 million to 2 billion VND[11].

[11] http://www.evn.com.vn/d6/news/EVN-day-manh-mo-hinh-cong-ty-dich-vu-nang-luong-6-12-17936.aspx

Carbon crediting

Financial support can be provided through carbon crediting mechanisms such as CDM, Joint Crediting Mechanism (JCM), Verified Carbon Standard (VCS), etc.

9.3.2 Existing financing institutions to support NAMA implementation

- **National public and private institutions**

The above mentioned financial mechanisms to support EE measures in Viet Nam are operated by a number of key existing financing institutions as well as through donor- supported projects/programs.

Vietnam Environment Protection Fund

Vietnam Environment Protection Fund (VEPF) receives capital sources from the state budget, sponsors, contribution, commissions from domestic and international organizations, and individuals to support financing for environment protection activities throughout the country.

VEPF activities include:

- Loans with preferential interest;
- Support loan interest, guarantee loans for environmental projects;
- Support finance for developing, implementing projects to prevent and reduce environmental pollution, environmental risks and accidents, etc.

VEPF charter capital is 500 billion dongs (US$24 millions). Its operation capital is supplemented from other sources such as the environmental protection tax, Certified Emission Reduction (CER) selling fee and budget allocation.

National Technology Innovation Fund

The National Technology Innovation Fund (NATIF) was established by the Decision No. 1342/QD-TTg dated August 5, 2011 of Prime Minister.

Affiliated with the Ministry of Science and Technology (MOST), the Fund operates for non-profit purposes, functions in granting and lending capital to implement scientific and technology projects proposed by organizations or individuals.

The charter capital of the Fund is VND 1,000 billion which is mainly to support enterprises, organizations and individuals whose conduct activities to innovate technology applications, commercialize the results of scientific research and technological development to bring to the market new products and services that have high technological content and high added value.

Vietnam Development Bank

The Vietnam Development Bank (VDB) was established under Decision No.108/2006/QD-TTg of the Prime Minister on 19 May 2006 on the basis of restructuring the Development Assistance Fund (01 January 2000 - 30 June 2006).

Total assets and charter capital of VDB are nearly VND 247,000 billion (US$12 billion) and VND 10,000 billion (US$47 billion) respectively. VDB focuses on financing development projects and exporting enterprises in the sector of infrastructure and key industries, rural agriculture and disadvantaged areas in line with the socio-economic development strategy of the country.

The main financial instruments of VDB include: investment lending, investment credit guarantee, medium and small-enterprise credit guarantee, post-investment support, export credit, bid security and export contract performance security. During the period of 2006 – 2010, VDB supplied the economy with investment capital of over VND 170,000 billion VND, accounting for 9.5% of the total investment capital in the period[12].

Commercial banks

Apart from the above mentioned key financial institutions, there are also existing/ ongoing projects/programs to support EE.

- **International public and public-private finance**

This group includes multilateral and bilateral development financial institutions (DFIs), international organizations including UN agencies, climate and green energy funds, financial support by individual governments of developed countries and other public or public-private sources of finance that could be used for the NAMA.

It should be noted, however, that some of the institutions and initiatives listed below will provide financial support and related technical assistance only for NAMA design, some will focus on NAMA implementation actions and activities (i.e. required investment for full-scale operation), while others could be used for both. Each of them has its specific requirements and procedures.

Official development assistance

Financial support channeled annually through multilateral, bilateral development agencies, UN organizations and specialized climate-related funds, is mostly developed country government commitments to finance activities in developing countries, as well as official development assistance

---

[12] http://www.vidifi.vn/english/index.php?option=com_content&view=article&id=59:the-vietnam-development-bank&catid=35&Itemid=68

(ODA) marked as having 'climate change mitigation' or 'adaptation' as its principal objective.

ODA consists of disbursements of loans made on concessional terms and grants by official agencies of the members of the Development Assistance Committee (DAC), by multilateral institutions, and by non-DAC countries to developing countries and territories that are on the DAC list of ODA recipients. ODA flows comprise contributions of donor government agencies, at all levels, to developing countries ("bilateral ODA").

USD 64 billion has been pledged since 1998 in ODA to Vietnam (GIZ 2013). USD 4 billion was contributed as mitigation-targeted aid since 2004. 50.4% of the total mitigation aid was earmarked for the energy sector and 44.8% for environment protection.

So far, the main climate source of climate finance in Vietnam has been the Support Program to Respond to Climate Change (SP-RCC). The total budget of the programme, accumulated mostly from the international donors' support, reached USD 872.65 million by the end of 2014.

Multilateral sources and intermediaries

There are various multilateral sources and intermediaries that provide support for climate change mitigation activities and NAMA design or implementation in Southeast Asia, including Vietnam:

(i) Global and regional DFIs, primarily the World Bank Group (WB) that includes IFC, the Asian Development Bank (ADB), the European Bank for Reconstruction and Development (EBRD) and others. These DFIs use their own capital raised using capital initially provided by multiple government donors or on behalf of these donors. They provide financial support to climate change mitigation projects and activities through a wide range of instruments, including funds, special programs and initiatives, direct investments, concessional loans, grant based mechanisms, technical assistance, etc. DFIs also act as administrators of the finance from multilateral and bilateral climate or green energy funds.

(ii) United Nations agencies and other international organizations, among which the most important in terms of NAMA support are UN Environment and United Nations Development Programme (UNDP). UNDP assists countries (including Vietnam) in developing NAMA proposals through its Low Emission Capacity Building Programme (LECBP) and its Millennium Development Goal (MDG) Carbon initiatives, and in preparing funding proposals mainly to be funded by the Global Environmental Facility (GEF).

UN Environment is the operator for the End-User Finance for Access to Clean Energy Technologies in South and South-East Asia (FACET) initiative supported by the German Government under International Climate Initiative (ICI).

(iii) International public-private initiatives aimed at supporting climate change mitigation activities, for example Climate and Development Knowledge Network (CDKN).

The key multilateral sources of finance for mitigation activities available in Vietnam:

ADB **-** Asian Development Bank including:

- ADB Climate Change Fund (CCF)
- ADB Future Carbon Fund (FCF)
- ADB Clean Energy Financing Partnership Facility (CEFPF) that incorporates Asian Clean Energy Fund (ACEF), Clean Energy Fund (CEF) and Canadian Climate Fund for the Private Sector in Asia (CFPS)
- ADB Asian Development Fund (ADF)

WB - World Bank including:

- WB Partnership for Market Readiness (PMR) programme
- WB Carbon Partnership Facility (CPF)
- WB Pilot Auction Facility for Methane and Climate Mitigation

IFC – International Finance Corporation including IFC Catalyst Fund

UNDP **–** United Nations Development Programme including:

- UNDP MDG Achievement Fund (MDG-F)
- UNDP MDG Carbon
- UNDP Low-Emission Capacity Building Programme (LECBP)

UN Environment **–** UN Environment Programme and its FACET initiative

Bilateral sources and governments of developed countries

This group includes national institutions ranging from government aid agencies, to bilateral development banks, export credit agencies or dedicated funds, which provide finance bilaterally, typically from a developed country to multiple developing countries.

Two DAC countries that provided the lion's share of climate change mitigation aid to Vietnam in 2013 were Japan (USD 229 million) and Germany (USD 209 million). Jointly, they contributed 81.4% of the total mitigation aid flow[13].

Climate and clean energy funds

There is a number of special purpose funds that have been created by multiple government donors and intermediate public funds from developed countries to support climate-relevant projects in developing countries, often in tandem with DFIs.

Some of the key climate and clean energy funds for which Vietnam is eligible:

- GEF - Global Environment Facility
- GCF - Green Climate Fund
- MLF – Multilateral Fund for the implementation of the Montreal Protocol
- CTF - Clean Technology Fund
- NAMA Facility (Germany/UK)
- NDF/NCF - Nordic Development Fund and its Nordic Climate Facility (NCF)
- PMR - Partnership for Market Readiness by World Bank

Below is the brief description of the key climate and clean energy funds active in Vietnam.

<u>Global Environment Facility</u>

GEF was established in 1991 and provides funding to developing countries for projects related to various environmental issues including climate change. GEF is an entity entrusted with the financial mechanism of the UNFCCC. The COP provides regular guidance to GEF on policies, programme priorities and eligibility criteria for funding. Since 1991, the GEF has provided USD13.5 billion in grants and leveraged USD 65 billion in co-financing for 3,900 projects in more than 165 developing countries.

Under the Trust Fund the GEF finances projects for mitigation and adaptation and other relevant activities. Replenishment of the Trust Fund takes place every four years, based on donor pledges. The GEF supports climate change mitigation projects that reduces or avoids GHG emissions in the areas of renewable energy, energy efficiency, sustainable transport, LULUCF. In addition, the GEF finances multi-focal projects that benefit several focal areas.

[13] http://stats.oecd.org/Index.aspx?DataSetCode=RIOMARKERS

Some of these projects have a climate change component and are listed separately from the projects of the climate change focal area.

The Green Climate Fund

GCF was formally established in 2010 as a financial mechanism of the UNFCCC with the aim to catalyse and channel financial resources from the developed to the developing countries in order to assist the developing countries in implementing climate change adaptation and mitigation measures.

GCF will support projects, programmes, policies and other activities in developing countries using thematic funding windows for mitigation and adaptation (with equal allocation of financial resources to mitigation and adaptation). In addition, 14 initial result areas for funding within these thematic windows were adopted. As a results-based approach is required to be an important criterion for allocating the resources, the first criterion – impact/result potential – will be used to assess a particular programme or project.

Multilateral Fund for the implementation of the Montreal Protocol (MLF)

The Fund is dedicated to reversing the deterioration of the Earth's ozone layer. It was established in 1991 to assist developing countries meet their Montreal Protocol commitments. It is managed by an Executive Committee with equal membership from developed and developing countries. The Fund Secretariat in Montreal assists the Committee in this task. Since 1991, the Fund has approved activities including industrial conversion, technical assistance, training and capacity building worth over US$3.6 billion.

So far, the MLF has provided a total of almost US$15 million to cover the technical assistance and incremental costs to convert to non (low)-ODS technologies.

The support includes grants to help local businesses (including AC manufacturers) boost technology transfer, focusing on producing and repairing in refrigeration sector.

Clean Technology Fund

One of the activities supporting the implementation of climate change mitigation action in Vietnam through the sustainability programme is the CTF. The CTF invests USD 250 million in various projects in Vietnam, ranging from energy efficiency in industry to transport initiatives in Ho Chi Minh and Ha Noi . The portion of the CTF channeled through the World Bank focuses on distribution efficiency in Vietnamese power networks, offering loans for energy efficiency equipment and renewable energy projects, as well as for small and medium-sized enterprises. The portion of the CTF channeled through the Asian Development Bank focuses on mass rapid transit in urban transport enhancement and improvement of industrial energy efficiency, offering loans for small and medium-sized enterprises for their investment in energy efficient equipment.

The Special Climate Change Fund

The Special Climate Change Fund (SCCF) was established under UNFCCC in 2001 to finance projects relating to adaptation; technology transfer and capacity building; energy, transport, industry, agriculture, forestry and waste management; and economic diversification. This fund complements other funding mechanisms for the implementation of the UNFCCC.

NAMA Facility

The UK-German NAMA Facility is one of the most advanced sources of NAMA support. In 2015 the Danish Ministry of Climate, Energy and Building and the European Commission joined the NAMA Facility as new Donors. The focus of this Facility is on financing the implementation of the most promising and ambitious NAMAs already at an advanced design stage. The selection of NAMA Support Projects is based on three sets of criteria: general eligibility, ambition, and feasibility/readiness.

The Facility is currently undergoing its third call for NAMA Project proposals with the total budget of EUR 85 million. It provided a first tranche of EUR 70 million worth of grant support to five selected NAMAs in Chile, Colombia, Costa Rica, Indonesia and Mexico in 2013 and additional EUR 50 million to four more projects in Peru, Tajikistan, Thailand and Burkina Faso in 2014.

Nordic Development Fund

The NDF is the joint development finance institution established by five Nordic countries: Denmark, Finland, Iceland, Norway and Sweden in 1989. The objective of NDF's operations is to facilitate climate change investments in low-income countries including Vietnam.

9.4. Roll-out plans for the NAMA

In order to estimate how in fact the finance flows should be prioritised and spread out over NAMA preparation, pilot and implementation stages by 2030, the Consultant has prepared the roll-out plans outlining actions to be taken to realise the full GHG reduction potential.

These roll-out plans will serve as a basis for the NAMA financial assessment and for developing the Implementation Roadmap for this NAMA in Vietnam.

9.4.1. Conversion from low EE to high EE ACs in apartment buildings and hotels

<table>
<tr><td>Action</td><td>Conversion from low EE to high EE air-conditionings in residential buildings and hotels. The conversion will be incentivised by:
The savings from electricity consumption
The savings and favorable investment cost via the programs provided by manufacturers/suppliers like: direct reduction of retail prices for high EE AC, exchanging low EE to high EE AC with (low) no cost, subsidizing for installation and maintenance fees, reducing the prices for carbon neutral ACs via the Fund for Recovery & Destruction of ODS, concessional loans from commercial banks, revenues from carbon trading
Financial supports from ODS phase out activities funded under the MLF
Risk reduction and savings via ESCO models for hotels
An ODS neutral and low carbon labeling system (OLS) will be set up for ACs with 5 grades and operation similar to energy efficiency labeling system. This OLS will be operated either by NAMA Operating Unit or integrated in the management of EE labeling system.</td></tr>
<tr><td>Required enabling activities</td><td>Establishing NAMA Operating Unit and setting up management for labelling system
Setting up NAMA MRV system
Conducting demonstration cases
Designing and applying carbon neutral labelling system and applying incentives (tax exemption/reduction) for carbon neutral products
Designing and applying carbon credit and trading system for carbon mitigation obtained under this activity
Establishing Fund for Recovery & Destruction of ODSs refrigerants (FRD) based on the fees including in retail prices of ACs and regulated by the OLS
Applying ESCO model for hotels
Conducting capacity building, training activities and public awareness activities</td></tr>
<tr><td>Key stake-holders</td><td>Apartments and hotels owners
Residential building project developers
AC Manufacturers and suppliers
AC service and maintaining providers
MOC, MOIT, MONRE, Ministry of Finance (MOF), Ministry of Planning and Investment (MPI)</td></tr>
<tr><td>Source of finance</td><td>A domestic private sources (equity and concessional loan)
Domestic public and/or international support (capacity building, technical assistance and demonstration cases).
Fund for recovery & destruction of ODSs from 2025</td></tr>
</table>

9.4.2. Installation of SWH in residential buildings and hotels

Action	New installation of SWH in residential buildings and hotels. The installation is incentivised by: • The savings from electricity consumption • The savings and favorable investment cost via the programs provided by manufacturers like: direct reduction of retail prices, subsidizing for installation and maintenance fees... • The revenue from carbon trading • Risk reduction and savings via ESCO models for hotels
Required enabling activities	• Establishing NAMA Operating Unit • Setting up NAMA MRV system • Conducting demonstration cases • Designing and applying carbon credit and trading system for carbon mitigation obtained under this activity • Conducting capacity building, training activities and public awareness activities • Applying ESCO model for hotels
Key stake-holders	• Apartment and hotels owners • Project developers, operators and owners of buildings • SWH Manufacturers and suppliers • ESCO service providers (EVN and private ones) • MOC, MOIT, MONRE, MOF, MPI
Source of finance	• A domestic private sources (equity and concessional loans) • Domestic public and/or international support (capacity building, technical assistance and demonstration cases).

9.4.3. Recovery and thermal destruction of refrigerants

Action	A national program for recovery, reclaim and thermal destruction of ODS refrigerants from ACs, especially the ones with low efficiency ACs that are dominated by ODSs with high GWP (like R22 and later R410a and HFC). A common practice is to discharge directly into the environment. This is a new initiative in order to eliminate the refrigerants being leaked freely into atmosphere. By setting up this program, refrigerants firstly will be recovered from low EE ACs by technicians during maintenance or replacement. It then will be delivered to collecting centers to transfer to thermal destruction sites, for instance to be destructed at cement kilns. The rules and institutions as well as technical system for recovery, reclaim and destruction will be set up and operated by the government or authorised entity. Ideally, it should be integrated with the existing management bodies of EE labelling system. The system will create incentives for recovery activities such as direct payment to recovered refrigerant that is delivered to collecting centers.

	Until 2025, the program will be financed by grant from international donors and domestic public financial sources (like MLF and VEPF). A FRD will be set up that will charge a certain fee rates on low efficiency ACs but high ODP and/or GWP. The fund will be based on the revenue from fee collections that will fund partly for non ODS and low carbon ACs products to reduce the retail prices.
Required enabling activities	• Establishing NAMA Operating Unit • Setting up NAMA MRV system • Conducting demonstration cases • Establishing the reclaim, recovery and thermal destruction system (rules and infrastructures) • Establishing FRD refrigerants via the fees including in retail prices of ACs • Conducting capacity building and training activities
Key stake-holders	• Cement factories (thermal destruction at cement kilns) • AC manufacturers • AC service and maintaining providers • MOC, MOIT, MONRE, MOF and MPI
Source of finance	• A domestic public sources (VEPF) • International support like MLF source and other donors (capacity building, technical assistance and demonstration cases, public awareness and grant for setting up and operating recovery & destruction program until 2025).

9.5. Estimating financial needs and financial analysis for the NAMA

9.5.1 Investment costs for the NAMA mitigation options

The detailed analysis of costs accrued, revenues generated and payback period for each mitigation action as well as for the whole NAMA is summarised in the following table. Summarises the financial aspects of the NAMA are detailed for three milestone years: Pilot phase (2021-2022), mid-term period (2023-2027) and long-term period (up to 2032).

Table 32: Summary of estimated investment costs for the NAMA mitigation options

No.	Item	Unit	Pilot period	Implementation period	
			2022	2027	2032
I	**Total investment cost per each phase**	USD	**83,077,657**	**495,310,392**	**606,267,697**
I.1	Investment cost of ACs	USD	42,764,832	356,939,221	394,074,802
	Investment cost of ACs in residential buildings	USD	28,783,743	263,460,411	345,499,874
	Investment cost of ACs in hotels	USD	13,981,088	93,478,810	48,574,927
I.2	Investment cost of SWH	USD	40,015,578	135,890,177	209,453,781
	Investment cost of SWH in residential buildings	USD	20,942,476	78,722,092	138,735,224
	Investment cost of SWH in hotels	USD	19,073,102	57,168,085	70,718,557
I.3	Recovery and destruction costs	USD	297,248	2,480,994	2,739,114
II	**Saving cost (Revenue) per each phase**	USD	**7,738,827**	**144,349,669**	**418,298,477**
II.1	Saving cost from ACs	USD	5,744,057	115,374,769	306,101,008
	Saving cost of ACs in residential buildings	USD	3,232,272	70,532,640	210,979,917
	Saving cost of ACs in hotels	USD	2,511,785	44,842,130	95,121,091
II.2	Saving cost from SWHs	USD	1,994,770	28,974,900	112,197,468
	Saving cost of SWH in residential buildings	USD	1,048,588	17,043,107	74,772,457
	Saving cost of SWH in hotels	USD	946,182	11,931,793	37,425,012
III	**Total investment cost/revenue for whole NAMA lifetime (2018-2030)**	USD	**83,077,657**	**495,310,392**	**606,267,697**
III.1	Total investment cost	USD			**1,184,655,746**

	Total investment cost for ACs	USD	793,778,855
	Total investment cost for SWHs	USD	385,359,535
	Total investment cost for Recovery and destruction program	USD	5,517,356
III.2	Total saving cost	USD	**570,386,973**
IV	**Payback period**	**year**	**5.69**
IV. 1	Payback period of ACs	year	4.86
IV. 2	Payback period of SWHs	year	7.45

9.5.2. Estimation of costs of enabling activities

Below is a more detailed explanation how the costs for each category of enabling activities have been estimated.

a. Policies, incentives and technical assistance

- A study on setting up and application of carbon neutral labelling system for ACs and tax reduction for low (no) carbon AC products (US$70,000)
- A study on costs and technical requirements to install SWHs at existing buildings (US$50,000).
- A feasibility study on establishing capacity of ESCOs and gaps to meet the demand under this NAMA (US$50,000).
- A feasibility study for establishing the recovery and destruction of ODS refrigerants system and fee collection (US$70,000).

b. Demonstration activities

- A demonstration for recovery and destruction of ODS refrigerants program (US$200,000).
- Demonstration for high EE ACs and SWHs at existing buildings and to-be cconstructed buildings (US$200,000).

c. Financial mechanisms and market based approaches

- Design of financial instruments for carbon crediting and trading program (US$100,000).
- Facilitation of access to existing EE investment support funds (technical assistance – US$30,000).

d. Setting up NAMA MRV system and NAMA management and annual operation & management (O&M)

- Development of MRV Operational Support System (US$20,000), purchasing and installation of MRV management hardware/software at MOC (US$30,000) and annual support.
- Annual technical support for MRV system of US$ 2000 per year
- Overhead costs related to setting up and operation of NAMA Operating Unit and salaries of the Unit's staff (US$30,000/year for operation and US$100,000/year for 12 years period from 2018 - 2030).
- Annual O&M cost related to operation of carbon neutral labelling system (US$30,000/year for operation and US$100,000/year for 12 years period from 2018 - 2030).

e. Capacity building and awareness raising

The costs associated with the capacity development and awareness raising include:

- Expenses related to organization of workshops/trainings.
- Fees of consultants for preparing and leading trainings/workshops and their travel expenses. The suggested approach is that during the first two years (2018-2020) all workshops and trainings are led by an international expert (US$6,000 per event); and starting from 2020, the events will be organised by national experts (US$3,000 per event).

9.6. Proposing appropriate mechanisms to channel support for the implementation of the mitigation actions.

9.6.1 Mechanisms to channel support for the enabling activities

The associated enabling activities are expected to a) create operational readiness for the NAMA Operating Unit and be sufficient to catalyse the implementation of mitigation actions

Table 33: Funding needs for enabling activities related to policies, incentives, and technical assistance

Type of activity	Financial need	Origin of financing	Activities and nature of financial need
Policy incentives	US$120K	International support	• A study on setting up and application of carbon neutral labelling system for ACs, fee collection and tax reduction for low (no) carbon AC products (US$70,000) • A study on costs and technical requirements to install SWHs at existing buildings (US$50,000)
	US$120K	International support	• A feasibility study on establishing capacity of ESCOs and gaps to meet the demand under this NAMA (US$50,000). • A feasibility study for establishing a recovery and destruction of ODS refrigerants system (US$70,000).
Financial incentives	US$50K	International support	Design of financial instruments for carbon crediting and trading program
	US$30K	International support	Facilitation of access to existing EE investment support funds

Table 34: Funding needs for pilot and demonstration activities

Type of activity	Financial need	Origin of financing	Activities and nature of financial need
Demonstration activities	US$200K	Domestic and international support	Demonstration of the recycle and thermal destruction program for refrigerants.
	US$200K	International support	Demonstration for high EE ACs and SWHs at existing buildings and to-be cconstructed buildings

Table 35: Funding needs for enabling activities related to MRV

Type of activity	Financial need	Origin of financing	Activities and nature of financial need
MRV system	US$2k/y (USD 24k for 2019-2030)	International support	Development of MRV Operational Support System and annual support
	US$50K	International and domestic public support	MRV management hardware/ software installation at MOC

Table 36 : Funding needs for enabling activities related to NAMA managing entity and carbon neutral labelling office

Type of activity	Financial need	Origin of financing	Activities and nature of financial need
NAMA Operating Unit			
Setting up, operation (US$30K/y)	US$ 100k (2018) US$ 360k	International and domestic public support	Preparation cost for2018 Overhead costs related to NAMA managing (2019 – 2030)
Staff salaries (US$50K/y)	US$ 600k		Salaries of the NAMA Operating Unit's staff (2019 – 2030)
Carbon neutral labelling office			
Setting up, operation (US$30K/y)	US$ 360k		Overhead costs related to managing carbon neutral

Type of activity	Financial need	Origin of financing	Activities and nature of financial need
		International and domestic public support	labelling system (2019 – 2030)
Staff salaries (US$50K/y)	US$ 600k		Salaries of the Carbon neutral labelling office's staff (2019 – 2030)

Table 37: Funding needs for enabling activities related to capacity building & awareness

Type of activity	Financial need	Origin of financing	Activities and nature of financial need
Capacity building and awareness raising	2019-2030: av. US$30K/y (360k)	International and domestic public support	Workshops and trainings and NAMA managing entities related to specific mitigation actions, MRV, policies and financial incentives, etc.

The implementation of these enabling activities – including the provision of financial incentives will unlock investment in mitigation actions with the budgets and outcomes as shown in the previous sections.

9.6.2 Financial channels to implement the mitigation activities

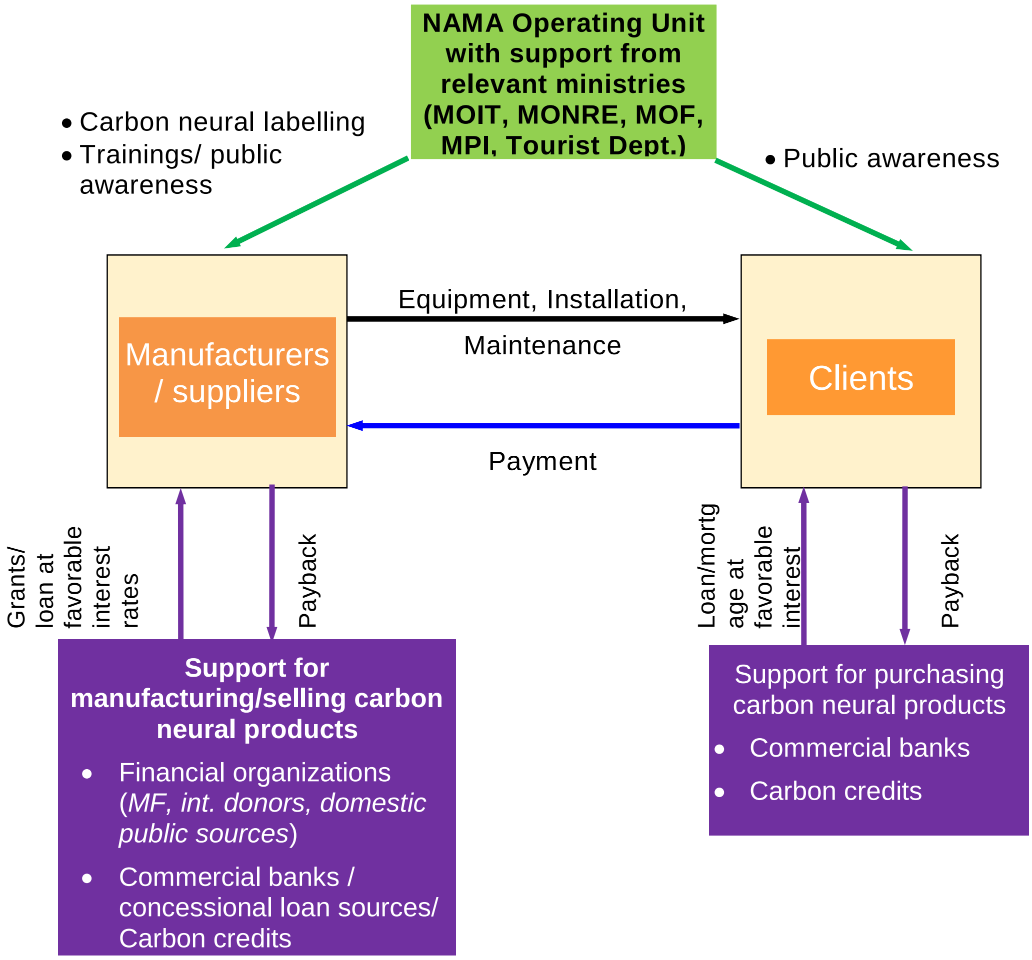
The main financial sources for investment in purchasing high EE ACs to replace for low EE, and SWHs for new installation in residential buildings and hotels will be from the users and/or owners of buildings/apartments/hotels as those in a conventional investment and trading.

The grants to cover the investment costs are only provided in demonstration cases in the beginning of pilot phase. Another grant source is from MLF to cover partly/mainly the incremental investment cost to covert the domestic AC manufacturing to non-ODS ACs with (low) non GWP.

The commercial loans/mortgage with favorable conditions can be provided to clients who purchase non-ODS ACs with (low) non GWP.

The financial sources and channels for conversion the ACs and new installation of SWHs in residential buildings and hotels under this NAMA are summarized in the following figure:

Figure 21: Financial sources and channels for conversion the ACs and new installation of SWHs



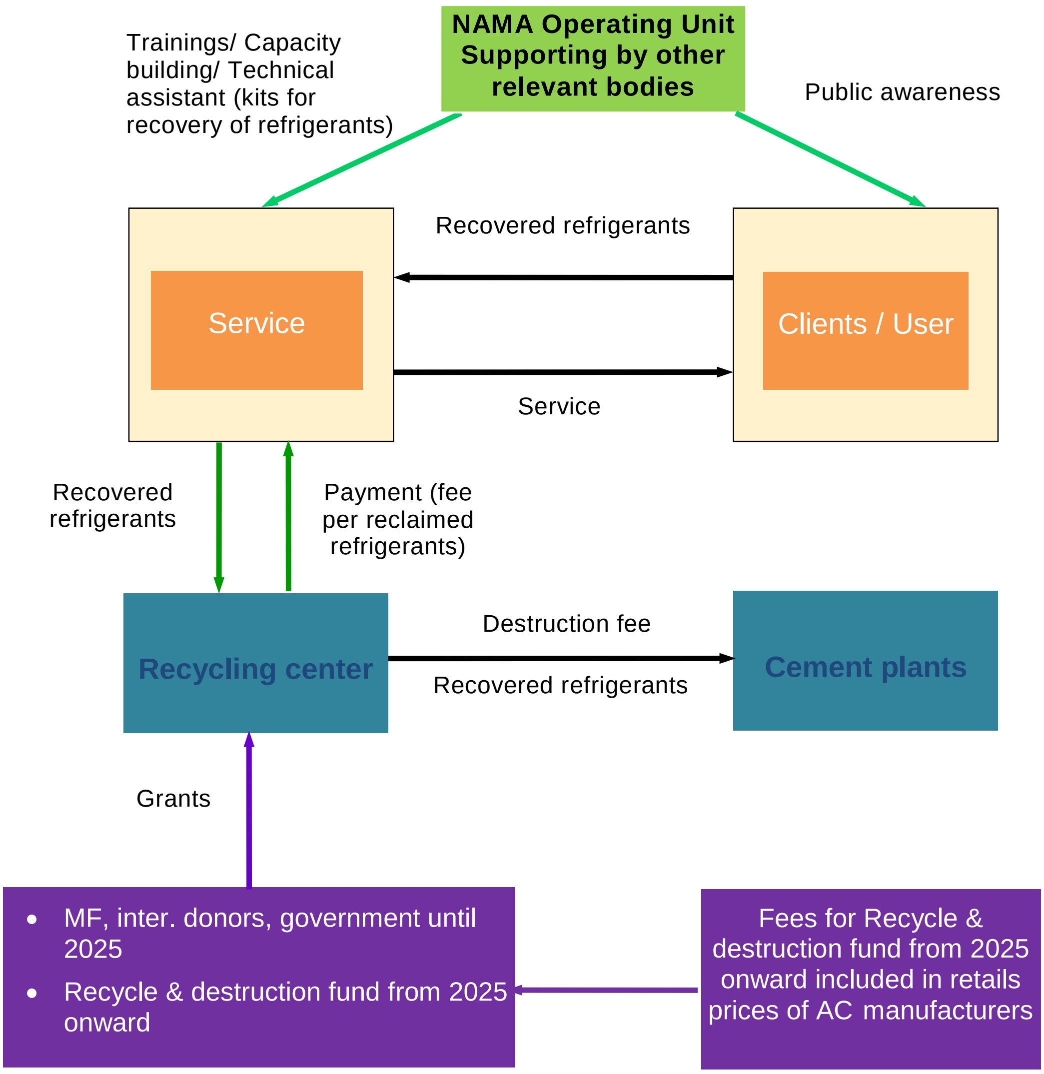
a) Program for recovery and thermal destruction of refrigerants

This system does not exist yet in Viet Nam and will be considered as an environment protection service provided by public service entity. It is proposed that the finance for investment and operating this system will be covered wholly by granted at least until 2025. The sources can be from the VEPF (domestic) and/or MLF, bilateral ODAs (international). Then it can be operated based on specific environment fees on high ODP and GWP refrigerants as discharging fee that is designed under the OLS and FRD. Such fees will be imposed on each unit of ACs according to the quantity and type of refrigerants charged per equipment. The rate will be set inverse to the label grade applied to the ACs. These fees will be included in the retail prices and the manufacturers/suppliers are in charge of paying these fees on behalf of their clients to FRD that will be set up to manage the fees under this NAMA.

It will take time to set up such a system as the process involves the collaboration from different authorities and issuing regulations. Therefore, it is proposed that the system will be operated based on grant until 2025 and will shift to use fees revenues after that.

The major principle and financial channel for the recovery and destruction program is presented in the following figure.

Figure 22: Principle and financial channel for the recovery and destruction program

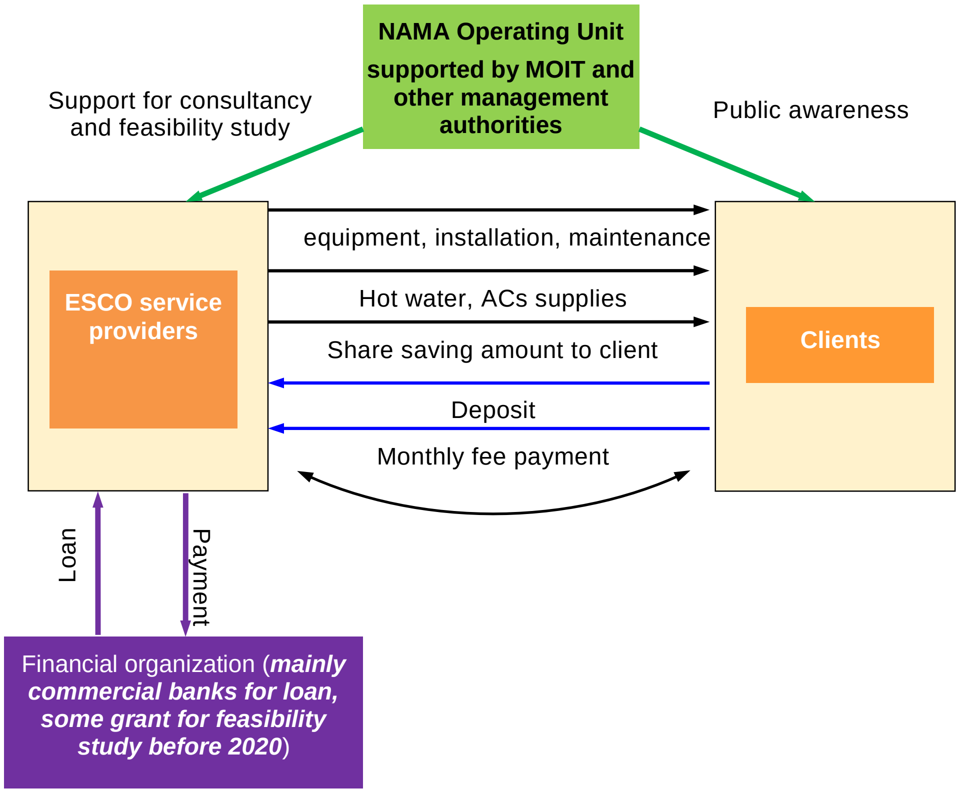


The Consultant team proposes two models for a cost recovery mechanism for this NAMA implementation:

b) ESCO Model:

The principle of ESCO model applied for the ACs and SWHs in hotels are summarized in the following figure:

Figure 23: Proposed ESCO model for the building NAMA



Entities (hotels) that participate in actions facilitated under the NAMA agree to pay a small share of the resulting energy cost savings (which are monitored and verified as per NAMA rules) to fund the operation of the NAMA Operating Unit. This approach is similar to a standard ESCO agreement. The Consultant estimates that the share of energy cost savings that would need to be shared is less than 1% (annual operating costs of the NAMA Operating Unit of USD 0.3 million vs. average annual savings of around USD 47 million), if fully implemented.

c) Polluter pays fee:

The Consultant also proposes (as supplementary or substitute option) to put in place a fee (or tax) on the use of high ODP and GWP refrigerants in ACs. This will *i)* create an additional incentive to switch to high EE ACs with low (non) ODP and GWP refrigerants; and *ii)* create revenues for the cost recovery mechanism and operation of the recovery and destruction program.

A Carbon labelling initiative applies to all ACs in the market is the key structure of this model. As mentioned before, the design of this carbon labelling program is quite similar to EE labelling run by MOIT.

The design of this cost-recovery mechanism must be discussed and agreed with the key NAMA stakeholders and beneficiaries.

d) Overhead fee paid by co-beneficiaries:

The Consultant team proposes that in addition, the NAMA Operating Unit is also co-financed by the beneficiaries of this NAMA via a fee per carbon credit if any is traded as a result under this NAMA. Assuming that carbon credits from this NAMA are purchased by its beneficiaries (international supporters, MOIT, MONRE, international buyers etc.), the cost of operating the NAMA Operating Unit will thus be shared with them. According to the first estimate, this fee would amount to USD 0.1 per carbon credit, if fully funded by NAMA beneficiaries.

9.7. Key findings

The table below summarises the mix of financing sources and instruments to catalyse implementation of different groups of mitigation actions that were identified and enabling activities for the building NAMA in Vietnam. All sources and instruments are phased-out over short-term (2021-2022) including preparation (2020), pilot (2021-2022), mid-term (2023-2027) and long-term (2027-2032) time periods.

The key conclusion is that this building NAMA will need international support over the mid-term (by 2027), with the major injections needed during the first years of pilot (2021-2022). International finance will be crucial for the initial enabling activities that will incentivise the investments into low-carbon technologies and practices. After 2027, the NAMA management costs can be covered through one of the cost recovery options as described above.

Table 38: Required financing and financial channels for mitigation actions and enabling activities

Item	Financial need (US$)	Origin of financing				Actions and nature of financial need
		Private	Public (Govt.)	Banks	International sources	
Investment in equipment (ACs& SWH)	793,778,855	Equity from clients ESCO model for hotels	State budget/ concessional loan/ Guarantee/ Discharge fee	Commercial loan with favorable interest rate and/or conditions	Grant/ Concessional loans for manufacturing	Cost of high EE ACs substituting for low EE ACs
	385,359,535					Cost of new SWHs installing
Recovery and destruction program	5,517,356	--	State budget/ Guarantee	--	Grant	Cost for recovery and thermal destruction of high ODP refrigerants
Enabling activities	3,174,000	Saving from clients under ESCO model Fees paid under carbon neutral labeling program	State budget	--	Grant	Cost for enabling mitigation activities and annual operation of management units

CHAPTER 10. IMPLEMENTATION ROADMAP AND INSTITUTIONAL ARRANGEMENTS FOR NAMA

10.1. The NAMA implementation roadmap

The implementation of the NAMA is envisioned in 4 main periods:

- Preparation period: 2020
- Mid-term implementation period: 2022-2027
- Long-term implementation period: 2028-2032

Detailed objectives and activities of each period is described below:

10.1.1. NAMA preparation period (2022)

The NAMA design and NAMA proposal is finalized by end of 2017. It is expected that NAMA preparation period begins from 2020 and it aims to achieve the objectives and implement the activities as follows.

a) Targets:

- Registration of the NAMA to NAMA registry;
- Finance received for pilot and implementation periods.

b) Activities:

- Submit NAMA proposal to relevant authorities for endorsement letters;
- Submit NAMA proposal to UNFCCC NAMA registry;
- Outreach for potential donors for financial support of NAMA enabling activities.
- Establishing NAMA Operating Unit;
- Setting up NAMA MRV system;
- Organizing stakeholders' meeting for preparation for NAMA pilot and implementation periods;
- Conducting studies on feasibility and design of the labelling system, ESCO model and the fund for recovery and destruction of high GWP refrigerants;
- Conducting awareness rising, capacity building and training activities.

10.1.2. NAMA pilot period (2021-2022)

The NAMA pilot period is expected to perform in 2 years from 2021-2022 in three cities: Ha Noi , Ho Chi Minh City and Da Nang. It aims to achieve the objectives and implement the activities as follows.

a) Targets:

- Conversion of 10% of the targeted ACs to EE ACs;
- Installation of 10% of the targeted SWHs;
- Recovery and thermal destruction of 50% of the refrigerants from the converted ACs.

b) Activities:

- Operating NAMA Operating Unit;
- Pilot operation of NAMA MRV system;
- Pilot implementation of the labelling system, ESCO model and the fund for recovery and destruction of high GWP refrigerants;
- Conducting awareness rising, capacity building and training activities;
- Organizing stakeholders' meeting for dissemination of the results of the pilot period and lessons learnt for full-scaled implementation of the NAMA.

10.1.3. NAMA mid-term implementation period (2023-2027)

The NAMA mid-term implementation period is expected to perform in 5 years from 2023-2027 at national level. It aims to achieve the objectives and implement the activities as follows.

a) Targets:

- Conversion of 50% of the targeted ACs to EE ACs;
- Installation of 50% of the targeted SWHs;
- Recovery and thermal destruction of 50% of the refrigerants from the converted ACs.

b) Activities:

- Extending the scale of operation of NAMA MRV system;
- Extending the scale of implementation of the labelling system, ESCO model and the fund for recovery and destruction of high GWP refrigerants;
- Conducting awareness rising, capacity building and training activities.

10.1.4. NAMA long-term implementation period (2028-2032)

The NAMA long-term implementation period is expected to perform in 5 years from 2028-2032 at national level. It aims to achieve the objectives and implement the activities as follows.

a) Targets:

- Conversion of 100% of the targeted ACs to EE ACs;
- Installation of 100% of the targeted SWHs;

- Recovery and thermal destruction of 50% of the refrigerants from the converted ACs.

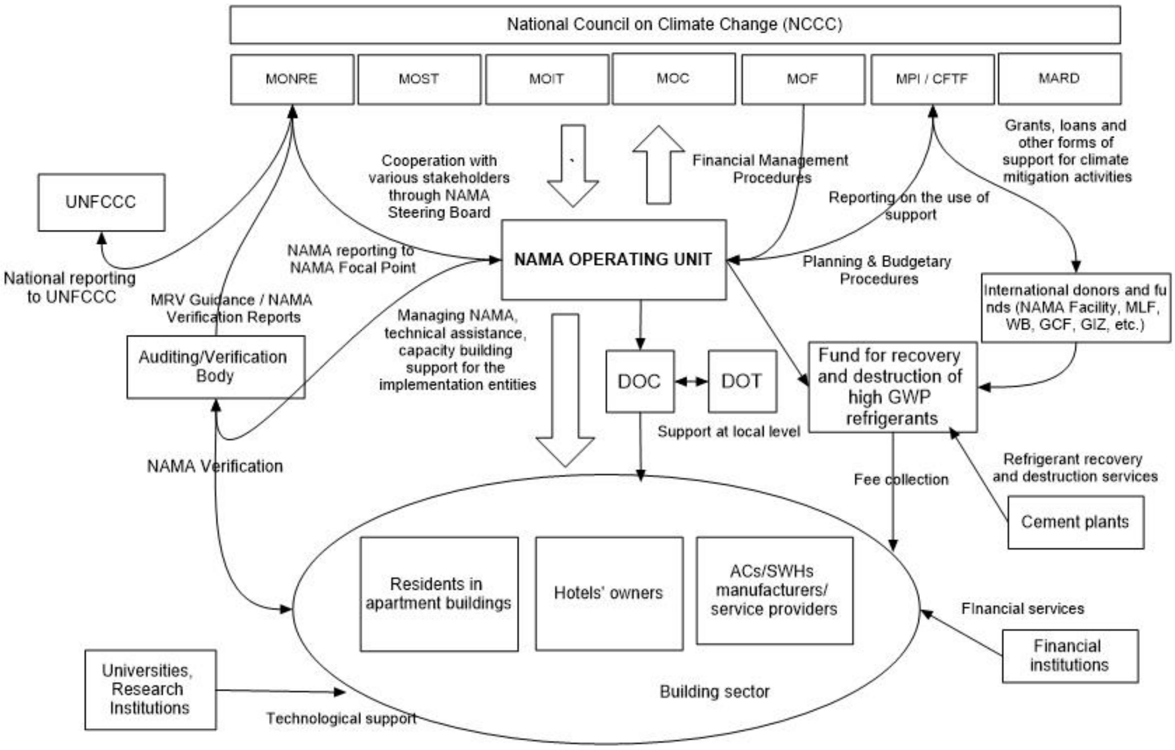
b) Activities:

- Full-scaled operation of NAMA MRV system;
- Full-scaled implementation of the labelling system, ESCO model and the fund for recovery and destruction of high GWP refrigerants;
- Organizing stakeholders' meeting for dissemination of the results and lessons learnt from the NAMA implementation period.

10.2. Institutional Arrangements for NAMA

The institutional arrangements for NAMA is illustrated below based on the generalization of the proposed institutional arrangements for MRV and the proposed financial mechanisms for the NAMA.

Figure 24: Institutional Arrangements for the building NAMA



Source: Author compiled

REFERENCES

1. GIZ (2013) International Partnership on Mitigation and MRV, Institutional Arrangements for MRV, Knowledge Product, Oct 2013.
2. GIZ (2014a) MRV of NAMAs The question of Measuring, Reporting and Verification, UNFCCC Regional Workshop on NAMAs for Africa, October 2014.
3. GIZ (2014b) MRV Measurement, Reporting, Verification: How to set up national MRV systems, 2014
4. Government (2011) Decree No. 21/2011/ND-CP providing details and measures for implementation of the Law on Energy Efficiency and Conservation, 2011.
5. Government (2015) Decree No. 18/2015/ND-CP on environmental protection planning, strategic environmental assessment, 2015.
6. Government (2015b), Decree 11/2015/ND-CP on establishment management use of housing and real estate market information system, Ha Noi .
7. Ha Noi 's People's Committee (2012), Decision No. 4597/QD-UBND on approval of the Tourism Development Plan for Ha Noi up to 2020 with vision to 2030, 2012.
8. Ha Noi 's People's Committee (2014), Decision 6336/QD-UBND of on approval of House Development Plan for Ha Noi in 2015 and the following years (2016-2020), 2014.
9. International Finance Corporation (2016), EDGE's User Guide for Homes (ver. 2.0), 2016.
10. International Finance Corporation (2017) EDGE's User Guide for Hotels (ver. 2.0), 2017
11. Ministry of Construction (2013), National Technical Regulation on Energy Efficiency Buildings QCVN 09:2013/BXD, 2013.
12. Ministry of Construction (2016a), Circular 31/2016/TT-BXD providing for grading and grade recognition for apartment buildings, 2016.
13. Ministry of Construction (2016b), Circular No. 04/2016/TT-BXD providing for Awards on quality of construction works, 2016.
14. Ministry of Construction (2016c): Circular 03/2016/TT-BXD providing for categorization of construction works and guidance for application to construction investment management, 2016.
15. Ministry of Science and Technology (2009a) TCVN 7898:2009 Storage water heaters- Energy efficiency, 2009.

16. Ministry of Science and Technology (2009b) TCVN 8251:2009 Solar water heaters- Technical requirements and testing methods, 2009.
17. Ministry of Science and Technology (2012) TCVN 7831:2012 Non-ducted Air conditioners- Methods for determining energy efficiency, 2012.
18. Ministry of Science and Technology (2013) TCVN 6576:2013 Testing and rating for non-ducted air-conditioners, 2013.
19. Ministry of Science and Technology (2015a) TCVN 4391:2015 Hotels-Classification, 2015.
20. Ministry of Science and Technology (2015b) TCVN 7830:2015 Non-ducted Air conditioners- Energy Efficiency, 2015.
21. Ministry of Science and Technology (2015c) TCVN 7831:2012 Non-ducted Air conditioners- Energy Efficiency, 2015.
22. National Assembly (2010), Law on Energy Efficiency and Conservation, Ha Noi .
23. National Assembly (2014a), Law on Construction, 2014, Ha Noi .
24. National Assembly (2014b), Law on Residential Buildings, 2014, Ha Noi .
25. Prime Minister (2011a) Decision 2473/QD-TTg on approval of the Strategy for Tourism Development in Viet Nam up to 2020 with vision to 2030, 2011.
26. Prime Minister (2011b) Decision No. 2127/QD-TTg on approval of the National Strategy for House Development up to 2020 with vision to 2030, 2011.
27. Prime Minister (2015a), Decision No.134/QD-TTg approving the project on re-structuring of construction sector in association with conversion of growth model toward enhancement of quality, efficiency and competitiveness in 2014 - 2020 period, 2015.
28. Prime Minister (2017a) Decision No. 1305/QD-TTg on list of major energy users for year 2016, 2017.
29. Prime Minister (2017b), Decision No. 04/2017/QD-TTg on promulgating the list of devices and equipment subject to energy labeling and application of the minimum energy efficiency, and the road map for implementation, 2017.
30. UNEP project (2015), Data Survey for buildings in Ha Noi and Ho Chi Minh City, 2015.
31. UNFCCC (2011) FCC/CP/2011/Decision -/CP.17 Outcome of the work of the Ad Hoc Working Group on Long-term Cooperative Action under the

Convention. United Nations Framework Convention on Climate Change, 2011.
32. UNFCCC/UNEP/UNDP (2013) Guidance for NAMA Design Building on Country Experience, 2013.
33. UNFCCC/UNEP/UNDP (2013) Guidance for NAMA Design Building on Country Experience, 2013.
34. US EPA/MO/CAI-Asia (2007) The Co-Benefits of Responding to Climate Change: Status in Asia, 2007.
35. WBCSD & WRI (2004) The Greenhouse Gas Protocol. A corporate Accounting and Reporting Standard, 2004.
36. World Bank (2017) National Survey of ODS Alternatives, 2017.

ANNEX 1: COMPLETED UNFCCC FORM FOR "NAMA SEEKING SUPPORT FOR IMPLEMENTATION"

NAMA Seeking Support for Implementation

A Overview	
A.1 Party Viet Nam	
A.2 Title of Mitigation Action	Promoting Up-scaled Use of Energy efficient Air-Conditioning (ACs) and Solar Water Heating Systems (SWHs) in Residential and Commercial Buildings in Viet Nam
A.3 Description of mitigation action	The Building sector is one of the fast growing sectors and the largest energy consumers in Viet Nam, accounting for approximately 30% of the total energy consumption, in which residential and commercial buildings are the most prominent energy users. According to the Ministry of Construction, the annual expansion rate of residential and commercial buildings is 6-7% and they are recognized as a significant GHG emitter in Viet Nam. In addition, approximately 95% of the commercial and high buildings in Viet Nam are not yet considered efficient use of energy. There is thus huge potential for GHG emission reduction from the building sector by applying different measures such as improved energy efficiency of housing cooling and heating systems through technical solutions and comprehensive institutional support from government authorities in environment, buildings and energy sectors with collaboration from private sectors. The NAMA aims to focus on three mitigation actions: i) conversion to high efficient ACs; ii) installation of SWHs; and iii) recovery and destruction of refrigerants of high Global Warming Potential (GWP) in ACs. The actions proposed will achieve 22-25% energy savings compared to Business- As- Usual scenario. Together with emission reduction from recovery and destruction of high GWP refrigerants, total emission reduction from the NAMA is expected at 7,572,857 tCO2e over 2019-2030 period, i.e. an annual reduction of 631,071 tCO2e/year. The NAMA is scheduled to be implemented in three phases: i) preparation (2020); pilot implementation (2021-2022) and iii) full-scale implementation (2023-2032) in which mid-term implementation (2023-2027) and long-term implementation (2028-2032). Co-benefits of the NAMA will cover economic, social, environmental and technological benefits which include lower demand for electricity and fossil fuel, enhanced technology transfer, and job creation and improved air quality. The NAMA includes establishment and operation of a system for recovery and thermal destruction of high GWP refrigerants for the first time in Viet Nam. This is a fundamental change compared to the normal practice of

free discharge to the environment. The financial mechanism for NAMA includes fee and tax system based on the labelling system and payment for recovery and thermal destruction services for the first time in Viet Nam. This will induce vital transformational change to raise the awareness of the consumers and technical workers on GHG emission reduction and carbon pricing for equipment for the first time in Viet Nam.

A.4 Sector
☐ Energy supply
☒ Residential and Commercial buildings
☐ Agriculture
☐ Waste management
☐ Transport and its Infrastructure
☐ Industry
☐ Forestry
☐ Other

A.5 Technology
☐ Bioenergy
☒ Energy Efficiency
☐ Hydropower
☐ Wind energy
☐ Carbon Capture and Storage
☐ Land fill gas collection
☐ Cleaner Fuels
☐ Geothermal energy
☐ Solar energy
☐ Ocean energy
☐ Low till / No till
☐ Other <Pls enter Other text here>

A.6 Type of action
☒ National/ Sectoral goal
☐ Strategy
☒ National/Sectoral policy or program
☐ Project: Investment in machinery
☐ Project: Investment in infrastructure
☐ Project: Other
☐ Other:

A.7 Greenhouse gases covered by the action
☒ CO_2
☐ CH_4
☐ N_2O
☒ HFCs
☐ PFCs
☐ SF_6
☐ Other <Pls add in text here>

B National Implementing Entity

B.1.0 Name Ministry of Natural Resources and Environment
B.1.1 Address No. 10, Tonne That Thuyet str., Cau Giay, Ha Noi, Viet Nam

B.1.2 Contact Person Tang The Cuong

Alternative Contact Person Luong Quang Huy

B.1.3 Phone +84 244 37759384
Alternative Phone
B.1.4 Email huylq98@gmail.com
Alternative Email
C. Expected timeframe for the implementation of the mitigation action
C.1 Number of years for completion 12
C.2 Expected start year of implementation 2021

D.1 Used Currency USD
Conversion to USD <to be filled automatically>

E Cost

E.1.1 Estimated full cost of implementation 1,187,829,746

Conversion to USD <to be filled automatically>

E.1.2 Comments on full cost of implementation

Full cost of implementation include investment in equipment (ACs & SWHs), recovery and destruction program and enabling activities

E.2.1 Estimated incremental cost of implementation 1,184,655,746

Conversion to USD <to be filled automatically>

E.2.2 Comments on estimated incremental cost of implementation

Total saving cost is 570,386,973 USD. Payback period is 5.69 years

F Support required for the implementation of the mitigation action

F.1.1 Amount of financial support 3,174,000

Conversion to USD <to be filled automatically>

F.1.2 Type of required financial support

☒ Grant
☐ Loan (sovereign)
☐ Loan (Private)
☒ Concessional loan
☐ Guarantee
☐ Equity
☒ Carbon finance
☐ Other <Pls enter Other text here>

F.1.3 Comments on Financial Support Financial support mainly to cover cost for enabling activities

F.2.1 Amount of Technological Support 474,000

Conversion to USD <to be filled automatically>

F.2.2 Comments on Technological Support <Pls enter Comments here>

F.3.1 Amount of capacity building support 2,280,000 $ (Dollars)

Conversion to USD <to be filled automatically>

F.3.2Type of required capacity building support

☐ Individual level
☒ Institutional level
☐ Systemic level
☐ Other <Pls enter Other text here>

F.3.3 Comments on Capacity Building Support Capacity Building Support covers the establishment and operation of NAMA Operating Unit and the Carbon Neutral Labelling Office as well as relevant trainings for these entities.

F.4 Financial support for implementation required ☐
F.5 Technological support for implementation required ☐
F.6 Capacity building support for implementation required ☒

G Estimated emission reductions

G.1 Amount 7.572 857

G.2 Unit MtCO2e

G.3 Additional information (e.g. if available, information on the methodological approach followed): Estimation of emission reductions is based on CDM methodologies: AM0091 (Energy efficiency technologies and fuel switching in new and existing buildings), AMS-II.C (Demand-side energy efficiency activities for specific technologies) and AMS-I.J (Solar water heating systems)

H.1 Other indicators of implementation: Policy incentives and financial incentives that require the technical assistance of 320,000 USD

I.1 Other relevant information including co-benefits for local sustainable development Co-benefits of the NAMA will cover economic, social, environmental and technological benefits which obviously include lower demand for electricity and fossil fuel, enhanced technology transfer, and job creation and improved air quality. The first-ever establishment of the system for recovery and thermal destruction of high GWP refrigerants and the financial mechanism includes fee and tax system based on the labelling system and payment for recovery and thermal destruction services will induce transformational changes for Viet Nam

J Relevant National Policies strategies, plans and programmes and/or other mitigation action

J.1 Relevant National Policies Nationally Determined Contribution to UNFCCC, Law on Energy Efficiency, Building Code, National Strategy for Response to Climate Change, National Green Growth Strategy

J.2 Links to other mitigation actions <Pls enter/select NAMA ID>

K Attachments

K.1 Attachment description NAMA Design Document

K.2 File Browse

L Support received

L.1 From outside the Registry <Please enter text here>

L.2 From within the Registry

Source	Amount	Date