Public Housing Development and Low-Carbon Society Transitions: National Housing Authority's Experiences and Applications

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Abstract

Presently, the growing interest of a low-carbon society is widely concern on various sectors of development. Housing sector is directly associated with of climate change and it needs to be studied and explored how low-carbon society principle integrates into housing policy and practice. Particularly, affordable public housing in Thailand to low and middle-income people in the country is one prioritized solving issues. Therefore, extensive knowledge of low-carbon society concerning environs and quality of living can be incorporated into providing public housing patterns. This article presents a public housing development under National Housing Authority (NHA) of Thailand, what is initiative program of National Housing Authority has been implemented to advance low-carbon innovation in the country context. The analysis is an investigation on existing NHA's researches and pilot projects how it contributes to achieve a low- carbon transition along with sustainable development policy.

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1. Introduction

A trend of green house gas (GHG) is continually rising due to direct and indirect products of human activities such as fossil energy consumption, industrial operations, massive land use changes, and deforestation. In 2100, the consequence of emitting CO_2 and other pollutants the world temperature will raise 1.1 – 6.4°C approximately (Inter-governmental Panel on Climate Change [IPCC], 2013). As showing the temperature change map by using RCP4.5 scenario (Figure 1) in 2016–2035, 2046–2065 and 2081–2100 with respect to 1986–2005 founds the Southeast Asia Countries have been encountering a raised temperature with extreme weather events (IPCC, 2013). Global emissions increased by 1.4% over 2011, reaching a total of 34.5 billion tones in 2012 (Oliver, Janssens-Maenhout, Muntean & Peters, 2013). This huge emission volume is majority generated by energy consumption, transport and industry, while residential and commercial buildings, forestry (including deforestation) and the agricultural sector have been growing at a lower rate (Iamtrakul, Satichob & Hokao, 2013, pp. 21-33).

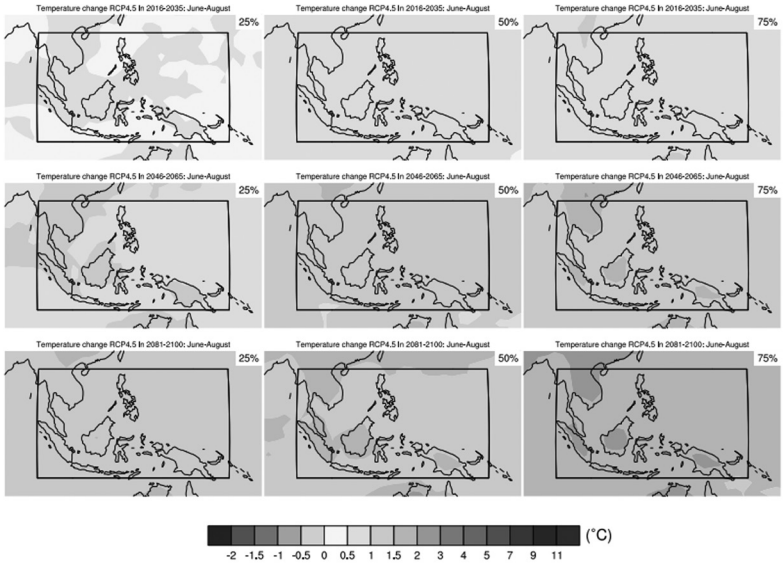

Figure 1. Temperature changes map in South-East Asia of RCP4.5 scenario. (Source: IPCC, 2013)

This impact of climate changes has seriously affected to ecosystems-humans inclusive. Particularly the developing countries such as Thailand, the climate change issues has been taking place from gradual changes in temperature and sea level, from increased climate variability and extremes including more intense floods and droughts. Thailand is ranked 22nd of the largest emitter with total emission is 29,888 million tons (Intaraprasong, 2013). According to ASEAN Community Progress Monitoring System report, Thailand produces per capita 4.1 metric tons of CO_2 emission that is ranked 4th whereas Brunei, Malaysia, and Singapore produce the highest CO_2 emission in the ASEAN region of 15.5, 7.1 and 6.39 metric tons respectively. Four sectors of CO_2 emission in the Thailand include power generation, transport, industry, and other by causing a boosting economic and rapid urbanization with highly fossil consumption rate (Figure 2).

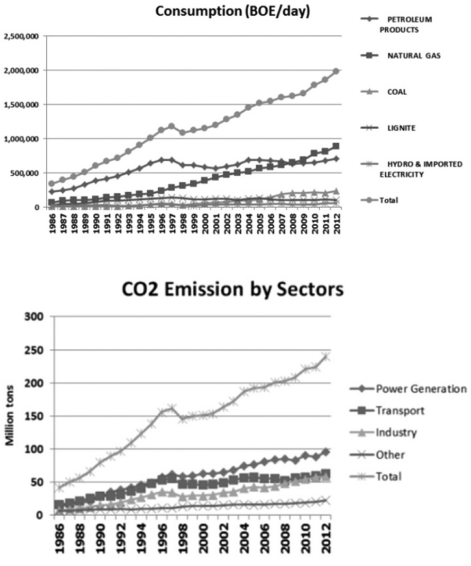

Figure 2. Fossil consumption and CO_2 emission by sector. (Source: Ministry of Energy, 2013)

Addressing this challenge of climate change, low-carbon society has been addressed in the 11st National Economic and Social Development Plan (2012-2016) by having national policy and technology approach application to minimize CO_2 Thailand. In order to mitigate the emission to a lower level, several comprehensive measures such as diffusion of low-carbon technologies in the residential sector, energy efficient buildings, energy efficient industry and fuel switching, and fuel substitution in the transport sector and electricity generation sector are needed (Sirindhorn International Institute of Technology [SIIT], 2010). However, the residential sector in term of public housing, especially low-income people, is slightly less concerned when it comes to strategies that seek to lessen the impact of climate change on households. In 2010, there are approximately total numbers of public housing completed in the whole country by NHA 730,000 units. Especially, most of housing units about 524,267 were highly constructed in Bangkok Metropolitan Region (BMR) as shown in Table 1 (National Housing Authority, [NHA], 2013) due to rapid urbanized area with demand of housing increases.

These public housing were build by poorly adapted to climate change, develops the housing is rather over represented in low cost construction throughout the country under low-income circumstances. This article sought to investigate what does exist of the government and relevant agency in Thailand adapts and supports the public housing in moving towards on low-carbon society. Experiences from learning as well as residential sector implementation in developing countries such Thailand including the policy and practice would be a pathway to deal with climate change adaptation.

2. Literature Review

2.1 Low-carbon society concept and principle

There has been a growing concern about low-carbon society which has recently attracted attention in discipline researches and it different stages of approaching climate change. Low-carbon society is a part of three phases of low-carbon development including low-carbon economy (primary stage), low-carbon society (development stage) and low-carbon world (maturity stage) as shown in Figure 3 (Yuan, Zhou & Zhou, 2011). By the low-carbon economy phases is completed, low-carbon society, which includes low-carbon life, low-carbon culture, low-carbon politics, etc enters in this stage. Government and related agencies should promote low-carbon life styles and consumption patterns such as encouraging people to choose low-carbon transport mode. Achieved city in all aspects including economy, daily life, politics and culture can be defined as a low-carbon city and just not a city by itself a society will become a low-carbon society.

Area	Total	Public housing sector by government			
		NHA	CODI	Total	%
BMR	4,451,540	524,267	11,104	535,371	12.0
Central	4,244,683	71,300	9,098	80,398	1.9
Northern	4,134,288	49,460	2,711	52,171	1.3
Northeastern	5,939,879	50,733	4,609	55,342	0.9
Southern	2,911,245	33,288	3,747	37,035	1.3
Whole country	21,681,635	729,048	31,269	760,317	3.5

Table 1. Number of housing unit in Thailand, 2010. (Source: National Housing Authority of Thailand [NHA], 2013)

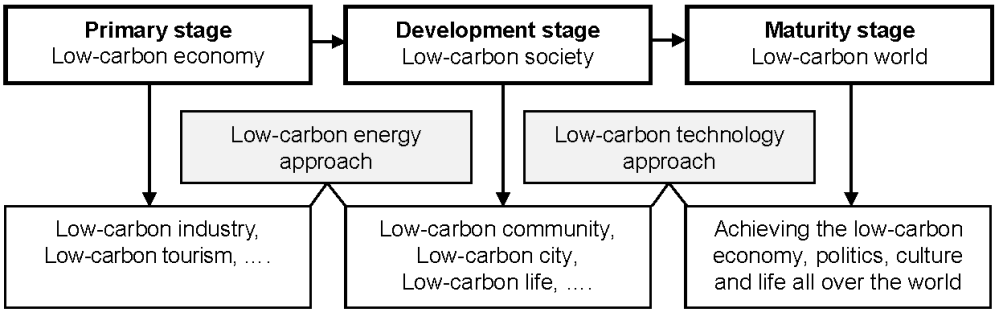

Figure 3. Three phases of low-carbon development. (Source: Adapted from Yuan, Zhou & Zhou, 2011)

The definition of low-carbon society (LCS) can be described that a society has a minimum of GHG emission; bringing the high quality of life. The basic concept of LCS is to reduce or limit the activity that emits GHG emission (Center of Excellence on Energy and Environment [CEEE], 2013). Developing idea and concept on LCS has often been cited by countries such as Japan that in 2007 Japan Government identified "Building a Low-Carbon Society" to reduce a half of global emission in 2050 (SIIT, 2010). There are three principles that all countries, organizations, and entities have to take action based on the following philosophies:

1) Reducing carbon discharge in all sectors such as industries, governments, and citizens, will naturally or automatically give special consideration to their selection and decisions in order to minimize carbondioxide emissions.
2) Achieving high-quality life through simpler ways of life, and shifting from a high consumption society to a high-quality society by consumer choice would lead to a revolution in the social system, moving toward a low-carbon and rich society.
3) Harmonic coexistence with the nature and maintaining and safeguarding natural environment that local communities should place importance on harmony and coexistence with nature, and promote "nature-friendly technologies" such as utilization of renewable energy.

2.2 Low-carbon society policy in Thailand and its contribution in public housing

Thailand has signed to the UN Framework Convention on Climate Change (UNFCC) in 1994 and is in the group which polluted a low rate of CO_2. However, the impacts of overall climate change on Thailand will not relatively as its low emission rates. The impacts of climate change on Thailand can be seriously issues throughout whole country such as sea level, temperature rise, drought and flooding. After Kyoto Protocol in 2002, Thailand has addressed a climate change by implementing Clean Development Mechanisms (CDM) to encourage clean and environmental friendly technologies for GHG reduction. The Office of Natural Resources & Environmental Policy and Planning (ONEP), under the Ministry of Natural Resources & Environment (MONRE), is the responsible and main organization to outline mechanisms and measures that would need to be undertaken by various agencies (SIIT, 2010). In 2006, the Thai cabinet approved the setting up of National Board on Climate Change Policy, Climate Change Coordinating Office and Thailand Greenhouse gas management Organization (TGO) to overlook Clean Development Mechanism (CDM) in Thailand. TGO is the autonomous governmental organization to undertake CDM and promote low carbon activities, investment and marketing on GHG emission reductions, establishment of GHG information centers, review of CDM projects for approval, and provides capacity development and outreach for CDM stakeholders. Presently, National Strategic Plan on Climate Change (NPCC) 2013 – 2017 and Thailand Climate Change

Master Plan (TCCM) 2012 – 2050 have been drawn up to be used by relevant agencies as guidelines to develop their own plan to address climate change. Especially, TCCM of 2012 – 2050 is a long term framework and guideline on climate change preparedness, adaptation in efficient competitiveness and development sufficient economy and low-carbon society. Three key management strategies are:

- Strategy 1: Adaptation for coping with the negative effects of climate change;
- Strategy 2: Mitigation of greenhouse gas emissions and increase of greenhouse gas sinks;
- Strategy 3: Strengthening the capacity of human resources and institutions and to manage the risks from the effects of climate change and cross cutting issues.

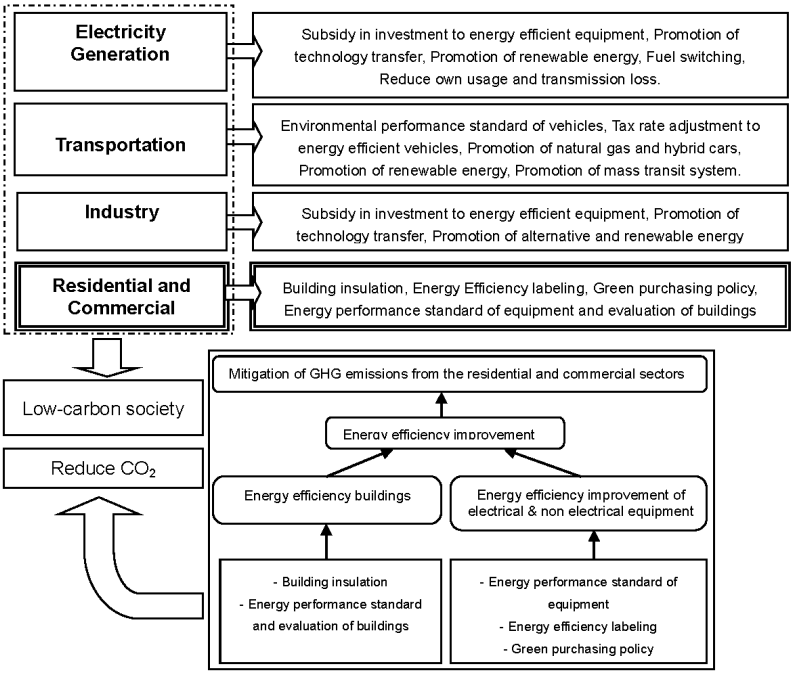

Figure 4. GHG comprehensive measures guideline. (Source: Adapted from SIIT, 2010)

In Strategy 2, LSC is added of TCCM to promote and support development cities and communities toward efficient and sustainably low carbon society. Recently to achieve LCS on national strategy, Thailand has joint collaboration with among Asian countries and Japan under the Low-Carbon Society Scenarios towards 2050 project and funded by Environment Research and Development Fund of the Ministry of the Environment, Japan (MOEJ). Up to this point, Thailand's LCS Vision 2030 envisages the possibility of reducing about 42.5% of the 563,730 kt-CO_2 as total CO_2 emission of business-as-usual (BAU) case to 324,170 kt-CO_2 of countermeasure (CM) scenario (SIIT, 2010). In order to mitigate GHG; there are mainly comprehensive measures in the residential, commercial, industrial, transport, and power sectors as shown in Figure 4.

As shown in Figure 4, to promote GHG mitigation measures in the residential and commercial sectors, it would require policies related to building design, building codes, energy efficient equipment and use of renewable energy. Key policies are energy performance standard of buildings, building insulation, building codes, energy efficiency labeling of electric devices, and green purchasing policy of the government. These parameters of energy performance in residential sector would be influence revision in improving housing development both local and national perspectives especially for National Housing Authority of Thailand that need to cope GHG emissions with play an important role in social housing. The National Housing Authority (NHA) is a state enterprise attached to the Ministry of Social Development and Human Security. It currently operates under the National Housing Authority Act (1994), with the objectives to provide housing for low and middle income earners, to provide financial assistance to those who need to have their own housing, to deal with the business of building construction and land acquisition, and to upgrade, demolish or

relocate slums in order to assist people in achieving better living, social and economic conditions. The NHA is not only responsible for development of housing for low-income people, but also for improvement of the quality of life of community members to receive physical, social and economic development that would help engender good-living communities. Public housing for low income people has been provided in Thailand more than 40 years especially in urbanized area such Bangkok that more than thirty public housing projects are built. To achieve the organization's vision, and to enhance the organization's operational efficiency, the following missions as shown in Figure 5 were established for implementation:

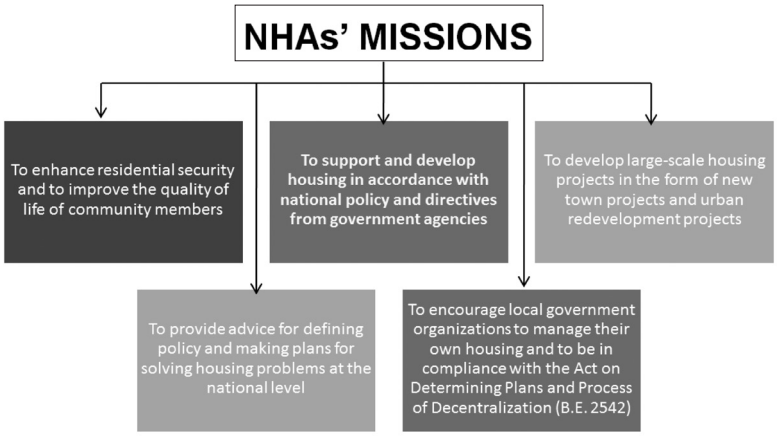

Figure 5. Five main missions of NHA organization.

In 2013, the New Paradigm of Housing and Urban Development in Thailand by in conjunction between NHA and the Pacific Rim Council on Urban Development (PRCUD) under the expert's knowledge and experience found there are five main topics should be promoted including 1) Urban development and housing development along the transportation network, 2) Public-private partnership or PPP, 3) Resilience form flooding climate change, 4) Housing finance and affordability and 5) Urban development planning and development of infrastructure of the city. Especially, a resilient form flooding climate change theme indicates that NHA is concerned on climate change in preparing for flooding, water management, open space and green city, infrastructure and building design as well as environmentally friendly approach. Also, participating with community, policymakers and development financial institutions are associated in development. A pilot project to demonstrate and promote the campaign for housing and urban development in the future has been establishing.

From above literature review on concept and principle, it can be summarized that a low-carbon society is a tool for taking action of sustainable development underlying three pillar aspects; economy, social and environment as not only focusing one side of development. Furthermore, low-carbon society is an advanced stage of low-carbon economy that contributes to reducing GHG emissions. To approaching low-carbon society, using high energy efficiency, low-carbon energy, low-carbon manufacturing technologies, and adopt low-carbon living and consumption styles have been integrated substitution to cope with climate change in different of country, contexts. Government policy as from national organization has presented LCS vision in the country however it seems the least influential to archive in all sectors practice on global warming with sustainable development basis. Based on the 11st National Development Plan which has been using since 2012 to 2016 focusing on economic development in environmental friendly provision. Therefore, the state agencies such NHA which has the mission in housing and urban development, is on going to study and develop their policy and knowledge. As seen in the above missions of NHA, those are not confronted to a climate change policy in directly. However, the extensive increase in climate change study as well as low cost housing and energy efficiency transformation in research and community development is ongoing to be a pathway of NHA implementation projects.

3. Method of Analysis

A housing development framework coping climate change and to generate social benefits in line with environment vulnerability has been studying by NHA since 2009. "Eco-Village Project" is established as a green conceptual research to assess livable and sustainable community development under NHA's operation. Approaching the Eco-Village provision of NHA, it consists four sub-topics namely (i) livable and sustainable community assessment, (ii) renewable energy for electricity of wastewater system, (iii) livable and sustainable community by using renewable energy and eco-cycle with interconnection economic feasibility, and (iv) livable and sustainable community management as self-management and cooperative relevant stakeholders. Presently, the pilot project Eco-Village of NHA, is conducting by private enterprises and NHA under the MOU. 50,000 units are proposed to built between 2012 – 2018. On the other hand, an idea to develop residential energy efficiency and environmentally friendly would be also applied into Baan Eua Arthorn Project (this project would serve government policy and one of the NHA's quality housing development in providing standard residential quarters for the target groups; low-income earners, junior civil servants and government employees) using renewable energy in highly efficient natural resource usage. To understand and investigate of Eco-Village policy provision that what has been done and ongoing project, the qualitative approach by contents analysis was applied. First section, relevant housing development policies and researches based on Eco-Village concept were examined and discussed through state of planning (building and community design); production (green material and environment friendly construction technology); and operation (technology adaptation and changing behavior life styles). Second section, the benefits and barriers of housing development policy in corresponding climate change as well as adaptive efficiency energy and green solution was analyzed and discussed.

4. Result and Discussion

4.1 Public housing development towards climate change initiative policy and practice.

From Eco-Village Project framework of NHA, it can be drawn into a new scheme application for public housing development in Thailand as shown in Figure 6. All four sub-projects represented a commitment comprehensive framework to archive energy efficiency public housing. Not only dwelling unit is addressed to play the role of Eco-Village guideline specification, but the aimed specifically to improve the living condition as social parameter within public housing community is also provided in the provision. However, retrofitting existing public housing program (old public housing condition projects) in deriving energy from design improvement and energy performance to reduce GHG emission does not account rather than focusing a new building development criteria and its benefits in affordability for low-middle income. Presently, there are mass public housing projects in form of walk-up flat throughout the country especially in urban area as Bangkok and its vicinity. For example, Ding Dang Flat, Aor-Ngen Community, and Klongchan Flat are built more than 30 years, thus they are encountering a poor condition as shown in Figure 7. Up to this point, Eco-Village provision is not emphasied in term of old public housing development retrofitting to contribute an energy saving and carbon reduction. Therefore, Eco-Village vision of old public housing project should be determined and promoted in proper assessment including effects on comforts, building appearances, security and occupation behaviors to deal with green building performances and retrofitting design approaches.

To understand Eco-Village policy on livable and sustainable community provision of NHA in details, three sub-projects of livable and sustainable community assessment, renewable energy for electricity of wastewater system, and livable and sustainable community by using renewable energy and eco-cycle with interconnection economic feasibility have rearranged into three states. These states clearly provide a comprehensive step from the physical process consideration throughout operation step (using technology application).

- *Planning: building and community design*

Currently, a green building design principle has been used to tackle energy and environment issues. LEED (Leadership in Energy and Environmental Design) is used for building standard design, which has been developed and widely used in many countries. In Thailand, conceptual and building performance assessment of LEED in U.S.A and TEEAM were developed by PCD (Pollution Control Department, Thailand). It is a platform of TREES (Thai's Rating of Energy and Environmental Sustainability). TREES is an assessment criteria of building and environment that merely played attention to shopping complex and commercial buildings. Nevertheless, for residential sector, there is no specific assessment to support.

Recently, NHA has developed a public housing program in Eco-Village model for initiative housing industry. To archive Eco-Village, self community support in long term development is a core of this concept. And creating social enterprise and green community are associated toward the goal. Five criteria assessment of residential performance of NHA is

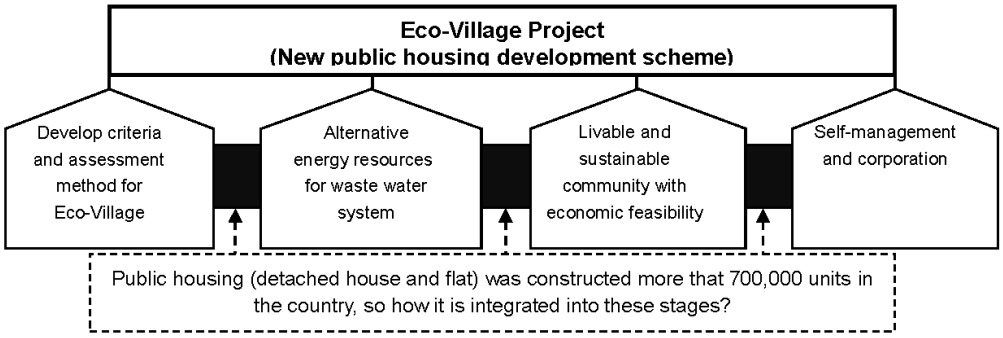

Figure 6. Eco-Village Project towards climate change and energy savings.

a) Ding Dang Flat	b) Aor-Ngen Community	c) Klongchan Flat
Location: Ding Dang District, Bangkok	Location: Saimai District, Bangkok	Location: Bangkapi District, Bangkok
Size of project: 6,502 units	Size of project: 2,344 units	Size of project: 5,7142 units
Year of built:1965	Year of built:1978	Year of built:1976

Figure 7. Old public housing condition in Bangkok.

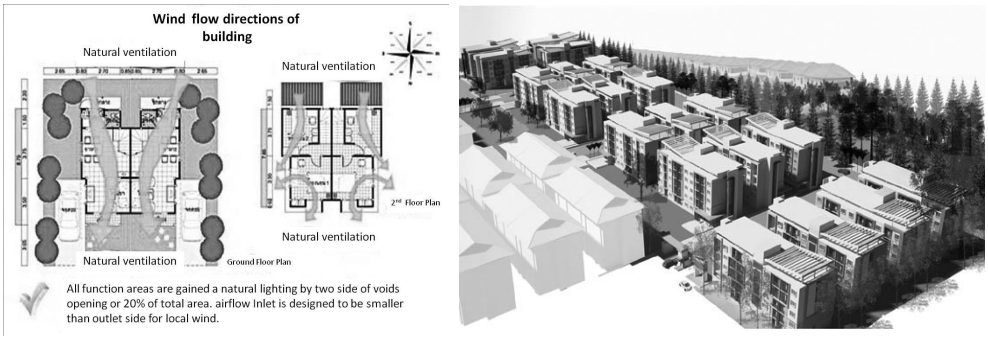

Figure 8. Eco-Village criteria assessment of National Housing Authority.
(Source: NHA, 2014)

provided to meet Eco-Village are site planning and landscape, building design, building system, management and building innovation (Atch, 2012). By 2014, the dwelling unit of 17, 634 of 29 projects is purposed to be constructed in Bangkok and region areas in approaching environmentally friendly design. Public-Private Partnership is a type of investment in case of high potentially land site and 20 - 30 year of long-term benefits setting (NHA, 2014). In this process of planning with environment based on living and construction in public housing, a passive design is rather discussed and studied on comfortable condition in tropical climate. Shading, airflow & natural ventilation, daylight, and energy simulation are drawn in of Eco-Village as applied methodology in significance assessment. Furthermore, assessing in social and culture contexts also definitely indicates the Eco-Village in line with sustainable living such as providing space for sharing activities.

• *Production: green material and environment friendly construction technology*

Normally, the basic materials for low-middle public housing in Eco-Village concept are heat absorbing glass, saving light bulb, 5w electronic ballast, ceiling insulation and all of these materials should be locally product which Green-Label or Carbon Footprint-Label. To operate such as a pilot project, NHA and private company have launched a prototype house and community based on renewable energy concept (NHA, 2014). Research done by Thammasart University has shown a low cost saving energy housing (Two-story detached house) guideline to cope with climate change. This type of house uses an environmental friendly material and natural ventilation flow throughout space there is no air-conditioning (AC) system installation for saving energy. House's area is 120 sqm. and functions consisting two bedrooms, living room, kitchen, and toilet for second floor whereas the first floor is designed for open space with 2.8m high by preventing flood. The house represented a well passive design approach as experimental testing of air temperature was found that lower than outside about 0.10-2.86°C. Additional, installation of photovoltaic systems with capacities 1.35 kW of each 6 solar cell Panel on the roof produced electric power 4.03 kW/hours a day or 120.90 kW hours per month. This pilot housing project will be applied for NHA's development project in the first phase of 56 units at Romkaol Housing Community which integrated in Eco-Village criteria assessment including site planning and landscape, building design, building system, management and building innovation. Middle and high income is target group of the project dwellers.

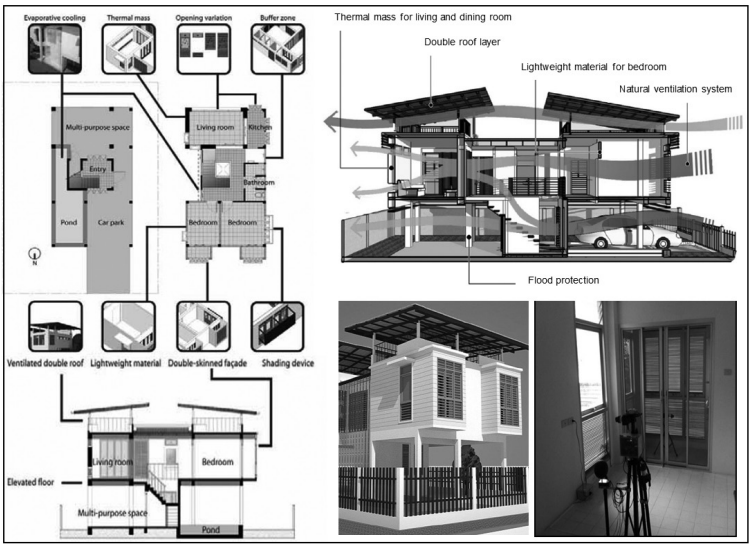

Figure 9. Saving energy housing prototype concept. (Source: Tantasvasdi, Chenvidyakarn & Pichaisak, 2011, p. 13)

• *Operation: technology adaptation and changing behavior life styles*

In case of using technology adaption such innovative approach to reduce energy and to alter energy solution in public housing for water treatment systems, the research (Wankanapon, Suwanchaiskul, Srisuwan & Tantasavasdi, 2012, pp. 49-61) indicated that using roof-mounted solar cells is alternative energy with capability of electricity production, heat transfer reduction from the building envelope, carbon emission reduction, and backup electricity for use during disaster and economical feasibility study. The benefits on a building envelope's heat transfer is that by using solar arrays to cover about 81% of the roof area, the indoor temperature of the room adjacent to the roof can be reduced by up to 4°C. For carbon emission reduction, by using solar cells for the energy in water treatment systems, it is possible to achieve a reduction of 44.91-

Figure 10. Roof-mounted solar cells for water treatment systems. (Source: NHA, 2014)

718.61 Ton CO_2 Putting this technology application in public housing could be adapted through project of NHA. However, large scale solar installations to afford low and middle income of public housing project as energy cost and extra financial support from government and relevant energy industry should be pointed out.

4.2 Benefits and barriers of housing development policy in corresponding climate change to approach low carbon society

As we seen in the background towards low carbon society that government sector of Thailand keeps forwarding to combat climate change which stated in the Thailand Climate Change Master Plan (TCCM) and Low-Carbon Society Scenarios towards 2050 are launched. These master plan and LCS scenarios are in a beginning process to be addressed achieving climate change management throughout the country perspectives; electricity alternative sources, transportation, industry, and residential and commercial sector. NHA (public organization), who delivers public housing and community facilities, aware to be a part of climate change program. Established Eco-Village Project has shown that NHA's vision and commitment to approach affordable housing environmental friendly to all residents. Regarding the Eco-Village, it can be mentioned that this concept and principle made benefits for the society and also the NHA organization such as a tool for steering and control a quality of public housing in the most effective assessment, benchmarking and co-operation with public and private sector to handle Eco-Village Project as a practical implementation, economic and financial benefits to investors and residents in term of low cost house where high efficiency energy saving, and improved image of NHA as green business concept development.

However, this is a big effort that will require many partners over an operation period of time where co-funding as well as subsidy from government to support low income people could not ignore. Subsidy and taxation can be an incentive mechanism in driving sustainable public housing with minimizing carbon emission and saving energy.

In addition, for building performance assessment process underlying Eco-Village indicators, the cost would come up with building lifecycle from construction based on environmental impacts. Land which is provided to supply to construct a residential area should be created more open space contributes a high cost of investment. And location of lands is probably difficult to find out at nearby completed public infrastructure and facilities services in low cost price. This problem issue would be a big challenge to handle public housing under Eco-Village principle (Atch, 2012). For elements of building, it could be an influent indicator to deal with Eco-Village assessment through passive design. However, a comprehensive knowledge of NHA designers and architects in responsible on environments with low cost of social housing will be required to work closely with a number of professionals including planners, energy assessors and advisors. Designing dwelling unit in compatible with environments on oriented features and materials should be promoted. In additional, building should be representing a local cultural perspective enough. Moreover, government, professional institution, and relevant agencies should be promoted to use Eco-Village widely.

Normally, there are barriers for improved energy efficiency towards LCS (United Nations Environment Programme, Sustainable Building and Climate Initiative [UNEP-SBCI], 2009; The World Business Council for Sustainable Development [WBCSD], 2009) including incentives, information, initiative, innovation, and investment as summarized in Table 2. These barriers directly seem an obstacle in providing an affordable housing for low income people in Thailand without a long-term housing strategy. Spatial concentration with basic services is still being a prioritized policy. Therefore, following LCS provision and Eco-Village framework in order to transformative existing housing policy in responding environmental sustainability and energy efficiency for the development of low-income housing, the role of government and housing policy instruments should rely on good central-local coordination. It also attract private developers use wide range of incentives such as tax deductions, direct subsidies, land grants. Additionally, social and cultural changes as trends in Thai's context for an integrated approach housing program would be useful such their specific needs. Moreover, towards energy-efficient buildings and housing requires a strong institutional environment stimulating deployment of technological solutions, informing consumer choice with regard to these solutions and motivating behavioral change, while also balancing different priorities should be addressed (Oleg, 2012).

Table 2. Key Five-ins conditions and barriers to improved energy efficiency in public housing. (Source: UNEP SBCI, 2009; WBCSD, 2009)

Conditions	Barriers
Incentives	Low priority for energy efficiency, Energy price subsidies Split incentives or principle-agent problem (owner vs tenants) Poor enforcement of standard, corruption
Information	Inaccuracy information, Lack of awareness and knowledge
Initiative	Lack of management or leadership, Fragmentation of the stakeholder, Poor coordination and communications, Political, Organization and structure barriers
Innovation	Path development in decision making, Technical, Market barriers for efficient technology, Lack of affordable technologies
Investment	Short-term investment, Uncertainties, Risk, Lack of financial capacities, High transaction cost, High upfront costs

5. Conclusions

Global climate change has profound implications for human societies. This situation implies that we should try to reduce and where possible to prevent, the adverse effects of climate changes by planned adaptation. This paper contributes to understand a public housing perspective on climate vulnerability, in particular, explaining the dynamics of energy changes in public housing development of National Housing Authority (NHA) to deliver a low carbon society. Integrating environmental friendly design in Eco-Village policy by passive design principle and adopt technology appliances throughout a comprehensive planning process and operation presented a crucial saving energy and low carbon emission of public housing sector. However, co-operation among relevant stakeholders (public and private) and rising awareness to people play important role for long term sustainable Eco-Village development. In addition, the existing public housing in old conditions also suggests that should be addressed making low carbon study and experiments on energy vulnerabilities.

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