



Acknowledgements

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August, 2014



Preface

The concept of sustainable transport development was conveyed in the global arena, the United Nations Conference on Environment and Development (UNCED) or also known as the “Earth Summit,” held in Rio de Janeiro, Brazil, during June 20-22, 2012. Attended by state leaders, the Earth Summit aimed to outline strategies for environment and development in all fields for world community to further abide by in the future, highlighting promotion of a policy on sustainable development that supports habitation and social services. Also addressed at the summit was the promotion of inexpensive and sustainable transportation with an awareness of the importance of mixed use planning and the promotion of non-motorized mobility by promoting development of infrastructure for sidewalks and bike lanes and promoting sustainable transport or green transport, which develops and utilizes a transport system with little environmental impact, whether in areas surrounding the transport systems such as pollution around roadways and railways or in the overall urban areas. Apart from alleviation of environmental impact from commuting, these measures also help to enhance traveling flexibility, reduce economic losses and mitigate other problems, notably road accidents.

With the support of the Ministry of Energy’s Energy Conservation Promotion Fund, OTP launched a project study on promotion of non-motorized transport (NMT) and improvement of public transport connectivity for sustainable and environmentally friendly transportation by engaging a consortium of consultants, consisting of (1) Green Infrastructure and Transport Technology Research Center, Faculty of Engineering, Chiang Mai University, (2) Thammasat University Research and Consultancy Institute, and (3) Naresuan University, to conduct the project study.

The project aims to push for urgent measures to promote NMT in the immediate term, hoping to directly reduce volume of unnecessary commuting or minimize motorized transport distance, thereby leading to a shift to energy-efficient and eco-friendly modes of transportation.



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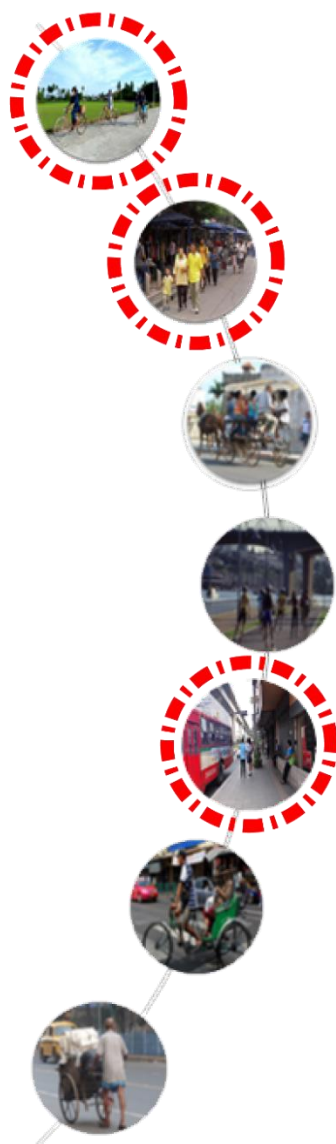
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Executive Summary Report

With the support of the Ministry of Energy's Energy Conservation Promotion Fund, OTP launched a project study on promotion of non-motorized transport (NMT) and improvement of public transport connectivity for sustainable and environmentally friendly transportation by engaging a consortium of consultants, consisting of (1) Green Infrastructure and Transport Technology Research Center, Faculty of Engineering, Chiang Mai University, (2) Thammasat University Research and Consultancy Institute, and (3) Naresuan University, to conduct the project study.

The project aims to push for urgent measures to promote NMT in the immediate term, hoping to directly reduce volume of unnecessary commuting or minimize motorized transport distance, thereby leading to a shift to energy-efficient and eco-friendly modes of transportation.



Non-motorized transport (NMT) refers to the kind of transport powered by humans or other living things, including walking, running, use of roller shoes, bicycling, tricycling, horse carriage and handcart. These modes of transportation help to eradicate pollution created by combustion of fuels in vehicle engines, and are accordingly deemed as the most environmentally friendly means of transport. Apart from helping to reduce pollutant emissions from fuel combustion and solve traffic congestion problems, NMT can be of benefit to commuters themselves since most kinds of NMT also provide recreation, leading to a travel with fun and health benefits. Some commuters apparently opt for cycling or walking rather than driving a car, recognizing this mode of travel as a fun activity and a form of physical exercise

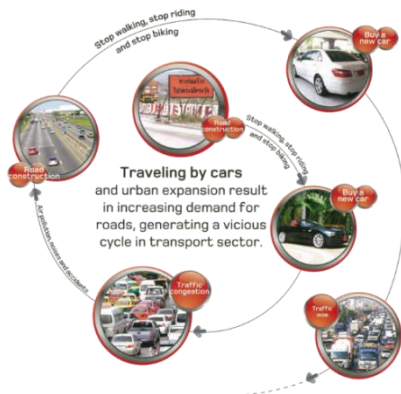
Modes of NMT under study This project study focuses on public transport connectivity and cycling.

- **Public transport connectivity** concentrates on facilitation of transport network connection for commuters and provision of an easy access to mass transit systems without reliance on motorized transport.
- **Cycling** is a study on designing and development of bike lanes and other cycling facilities and also on planning for promotion of bicycle culture development.
- **Walking** accentuates designing and development of sidewalks to promote walking, notably in the mass transit network connection areas and the target areas for bikeway development.



“Problems and Obstacles”

Today, Bangkok's population already exceeds 15 million persons and tends to grow annually. Such population growth relates directly to traveling demand. It is estimated that more than half of the total 17 million trips in Bangkok and its vicinities are travels by private vehicles. With ever-increasing percentage of private cars, over the past 20 years number of automobiles in Bangkok has grown by an average rate of 4% a year, while road space has not increased in line with such growing number of vehicles, leading to deficiency of road space to accommodate the ongoing increase in traffic volume. The gap between traffic volume and road space is increasingly widened, considering that number of car registrations in Bangkok and its vicinities rises by more than 700 units per day.

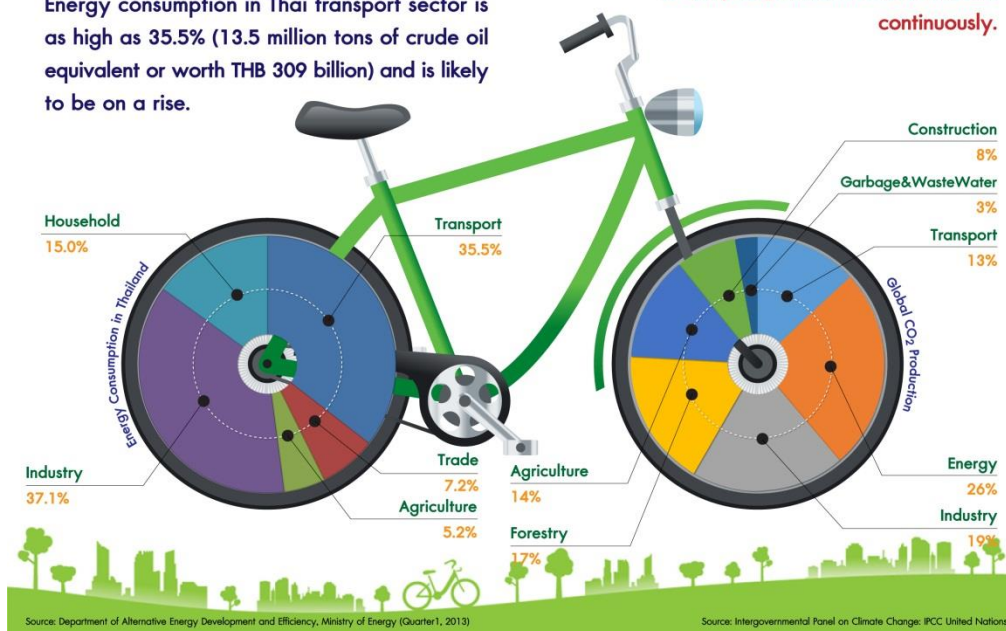


The key factor is a lack of sustainable transport that emphasizes safety, environment friendliness, accessibility, efficiency and less reliance on limited resources such as fuel oils. Previous transportation system development concentrated primarily on road network expansion. Moreover, the government-initiated projects were conducive to greater preference for commuting by cars, while such other modes as public transport, walking and bicycling were not adequately developed.

Environment and Energy Situation

Energy consumption in Thai transport sector is as high as 35.5% (13.5 million tons of crude oil equivalent or worth THB 309 billion) and is likely to be on a rise.

By global average, CO₂ production in transport sector amounts to 13.1%. Thai transport sector's CO₂ emission is 50.2 million tons or 25.6%, surpassing the industrial sector's (45.1 million tons or 23%). CO₂ emission tends to increase continuously.





Road accident in Thailand has become a threat to its people's quality of life and tarnished the country's image, thus requiring a prompt remedial action. Based on the Global Status Report on Road Safety 2013 revealed by representatives of World Health Organization (WHO) attached to Thailand, **the rate of fatality from road accident in Thailand climbed to the third place in the world.**

Thailand's road traffic death rate reached 38.1 persons per 100,000 population, trailing after Niue Island and Dominican Republic. The country registered a total number of 13,766 reported deaths from road accident, of which 79% were males and 21% females, with economic losses equal to 3% of GDP.



Statistical summary

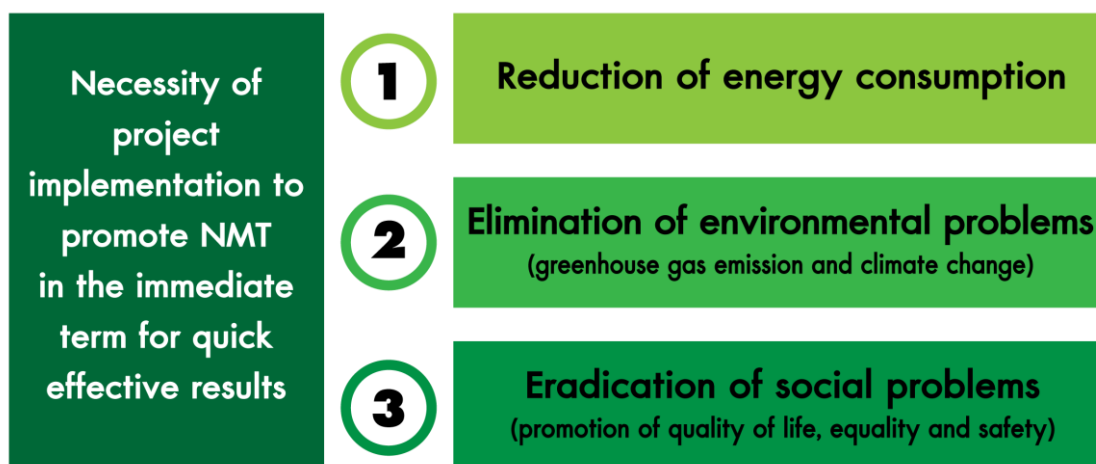
- Number of automobiles in Bangkok grew by an average rate of 4% a year, while road space has not increased in line with such growing number of vehicles (2013 records).
- Number of car registrations in Bangkok and its vicinities rose by more than 700 units per day (2013 records).
- Energy consumption in Thai transport sector was as high as 35.5% (13.5 million tons of crude oil equivalent or worth THB 309 billion) and is likely to be on a rise (2013 records).
- Twenty-seven percent of accident-related deaths across the world were “pedestrians” and “cyclists.” Especially in middle-income and low-income countries, the number of such deaths was almost three quarters of the total fatalities, while in some countries the proportion reached 75%. The government of each country must take into account the enhancement of safety for those vulnerable groups (Global Status Report on Road Safety 2013).
- The global statistics 2013 suggested that there were 1.24 million people dying each year from road accident and number of vehicle registrations all over the world increased by 15%. Despite that, the total world population of 1.6 billion people in 88 countries have proven that during 2007-2010 (B.E. 2550-2553) each country could save a considerable number of their citizens from road traffic death (Global Status Report on Road Safety 2013).
- In 2013, vehicle registrations in Thailand (data before the first car buyer incentive scheme) consisted of 9,887,706 four-wheeled cars, 17,322,538 two-wheeled and three-wheeled vehicles, 816,844 heavy trucks, 137,943 buses, and 319,798 units of other types of vehicles. There were a total number of 13,766 reported deaths from road accident, of which 79% were males and 21% females, with economic losses equal to 3% of GDP.
- Based on the accident-related death report from Bureau of Policy and Strategy, Office of Permanent Secretary, Ministry of Public Health, B.E. 2554 (2011), the number of deaths caused by road traffic, including all kinds of vehicles and pedestrians, was as many as 13,766 persons.
- Thailand's road traffic fatalities, as forecast by WHO in 2010, were as high as 26,312 persons, representing a rate of 38.1 deaths per 100,000 population.
- Based on the 2014 “World Health Rankings,” Thailand ranks sixth for highest road traffic death rate.
- A Thai RSC report shows that the accumulative road accident statistics in 2013 included a total of 410,219 accident cases with 405,282 injuries and 4,937 deaths.



“Current constraints on NMT Promotion”

- **Lack of infrastructure and facilities** to ensure adequate and efficient transport connectivity.
- **Lack of holistic public relations** and two-way communications to disseminate information and keep abreast of users' demand.
- **Lack of definite measures or motivation** and continuous follow-up

“Objectives of the Project”



The project study aims to push for urgent measures to promote NMT in the immediate term, hoping to directly reduce volume of unnecessary commuting or minimize motorized transport distance, thereby leading to a shift to energy-efficient and eco-friendly modes of transportation. The objectives of this NMT study are as follows:

- 1 **To integrate ideas and participation of concerned agencies and the general public** in the NMT promotion and public transport connectivity improvement.
- 2 **To establish a framework for NMT promotion** and public transport connectivity improvement that meets with traveling requirement and demand from people in the target areas in order to ultimately achieve sustainable transportation.
- 3 **To hold campaigns and public relations so as to ensure public's awareness and participation in the use of NMT** and mass transport.

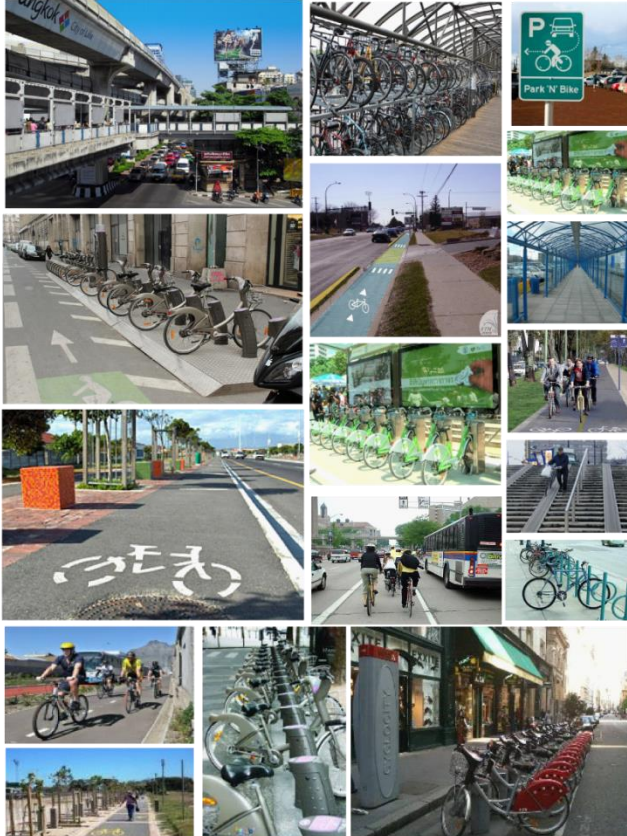
Policies that are aligned with the objectives and goals of the project

- Promotion of non-motorized mobility, which becomes a global dialogue, in line with the guideline on promotion of a policy on sustainable development that supports habitation and social services, as discussed at the United Nations Conference on Environment and development (UNCED) or the “Earth Summit” held in Rio de Janeiro, Brazil, during June 20-22, 2012
- Direction of transport and traffic system development to achieve sustainable transport/green transport
- The Eleventh National Economic and Social Development Plan
- The 20-Year Energy Efficiency Development Plan (2011-2030)



“Goals of the Project”

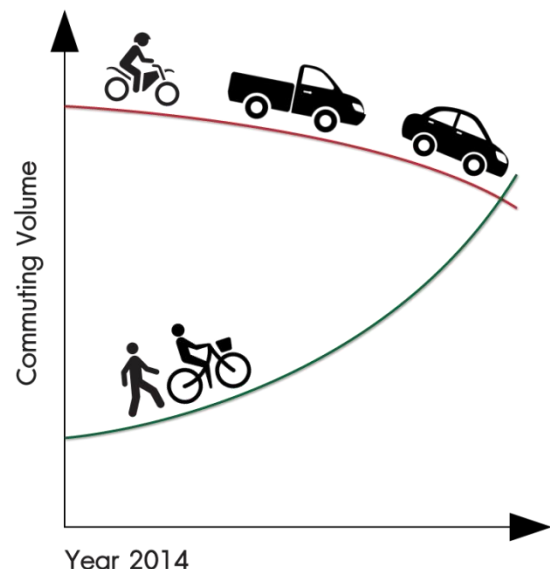
Output



- Suggestions on projects/measures to promote NMT and details of public transport connectivity improvement in Bangkok and its vicinities
- Details of project/demonstration that are suitable and viable in Bangkok and its vicinities or any appropriate areas, involving three projects with differing use of land
- Recommendations on establishment of a Bicycle City in one pilot province
- Results of legal study, review and advice and measures relating to walking and cycling to promote walking and bicycling as part of people's everyday life
- Guidelines and results of an analysis on efficiency in reduction of greenhouse gas emission and energy consumption as a consequence of sidewalk and bikeway development

Outcome

- Promoting a reduction in private vehicle use, leading to a decline in demand for petrol and other kinds of energy
- Promoting an eradication of congestion problems, helping to cut down on energy consumption rate from commuting
- Encouraging and generating a change in traveling modes via public buses, resulting in an optimized and efficient use of energy
- Promoting a decrease in emission of greenhouse gas and air pollutants (HC, Nox, particulates, etc.) from vehicle use
- Promoting social equality by making efficient transport services available for and accessible to people of all classes





“Overview of Procedures for Project Study”



1. Study on systems for NMT promotion and public transport connectivity improvement:

The procedures consist of “*study, review, and preliminary survey and analysis*,” entailing review of the study and operation guideline for NMT promotion, review of laws and measures relating to walking and bicycling, review of land use in Bangkok and its vicinities, and development of NMT-oriented areas.

As regards the “preliminary survey and analysis,” the Consultants conducted a survey and analysis on traveling demand in Bangkok and its vicinities and public transport connectivity and a survey on demand for infrastructure and facilities necessary for public transport users.

2. Study and analysis on traveling demand in Bangkok and its vicinities:

Following the first step, this process features a combined use of results of the survey and analysis on traveling demand in Bangkok and its vicinities and public transport connectivity and results of the study and survey on traffic condition in the designated project areas for forecasting future traveling demand and for predicting traveling demand proportion that may change in the future in Bangkok and its vicinities, given that the public transport connectivity is improved in tandem with the objectives and study results of this project.

3. Preparation of a development master plan for NMT promotion:

This process focuses on two target areas: (1) Bangkok and its vicinities and (2) Bicycle City. For “*Bangkok and its vicinities*,” we selected the areas and provided suggestions on projects/measures to promote NMT, as well as prepared and devised details of the NMT promotion and public transport connectivity improvement project in pilot areas. As for the study and proposal of a *guideline on development of a model “Bicycle City,”* we opted for Phitsanulok Municipality as a pilot city and collaborated with it in devising a bicycle city master plan and details of the pilot city plan. In parallel with this, we arranged seminars to transfer the know-how for NMT promotion both domestically and overseas. In addition, this process includes “*analysis on efficiency in reduction of greenhouse gas and energy consumption*” based on a forecast from the case where the proposed action plans under this project study for Bangkok and its vicinities and the Bicycle City (Phitsanulok Municipality) are implemented.

4. Public relations and participation:

The Consultants publicized the project through various forms of media such as the Internet, fliers, advertising boards, and videos. We also organized seminar programs and encouraged public participation, particularly in the target areas for the bicycle city development



“Results of a review of the study on and approach to NMT promotion”

Based on a review of the lessons learned from bicycle culture building in other countries, it is found that under the approach to bicycle city development or promotion of bicycle culture in urban areas, the **4E principle (Engineering, Education, Enforcement, and Encouragement)** was grouped and then compared with the approach suggested by Dr. Soranarat Kanchanavanich, PhD, in an article pertaining to the concept on bicycle city or bicycle culture development, recommending therein two solutions, Opening the Path and Opening the Mind,¹ which could be described as follows:

1. Opening the Path refers to engineering and enforcement or, in other words, opening of bikeway or reallocation of road space to bicycles through following measures:

- **Development of bikeway network and infrastructure to meet bicycling demand (engineering):** From a review of foreign cities with a success in bicycle culture promotion, it is discovered that the starting crucial step implemented by every city is development of bikeway network and infrastructure. It is further noted that, irrespective of the differences in topography, climate, traffic condition and culture, the cities which could make available a complete city-wide cycling network and facilities are quite likely to push a bicycle culture forward.



- **Enforcement:** Review of legal enforcement is one of the means to reallocate road space to bicycles and enhance road safety for cyclists. In doing so, some of the legal measures successfully led to an increase in number of cyclists, while some other measures have very little impact on bicycle culture development. Among the legal measures currently in force to promote bicycle culture development are commuting speed limits and vehicle entry restrictions or area pricing.



Based on a review of foreign model cities, it is evident that in Beijing, for instance, despite the infrastructure development and enforcement of measures such as downtown car-free zoning during the Olympic Games, number of car users remains unchanged there. From an identical perspective, the USA's New York City, which has developed a quite complete bikeway infrastructure, still has problems associated with safety and balancing in road usage between pedestrians, cyclists and motorists. This points to the need to implement indispensable measures to build an understanding and awareness of bikeway use, or Opening the Mind, after having achieved the Opening the Path measures that allow for safe and convenient bicycling.

¹ Useful Information on Bicycles (gathered from the heart of cyclists) URL: <http://writer.dek-d.com> Soranarat Kanchanavanich



2. Opening the Mind refers to education and encouragement, aiming to develop a positive attitude towards bicycle commuting. The physical (Opening the Path) and mental (Opening the Mind) readiness is crucial to a shift towards the cycling culture. For Thailand, a survey conducted to identify reasons why bicycling is not popular among Thai people² shows that there are five most common causes discouraging the use of bicycles, including (1) inability to reach far destinations, (2) greater convenience provided by motorcycling, (3) heat/sunlight, (4) hindrance from rain, and (5) fear of road danger/accident. Problems no. 1 and 2 can be dealt with through development of cycling infrastructure and facilities (Opening the Path), whereas causes no. 3 (heat/sunlight), no. 4 (rain) and no. 5 (road danger/accident) result from a negative attitude towards bicycling, which are to be coped with by the Opening the Mind solution



- **Education**

Thailand has already adopted this measure through programs such as bicycle ride training organized by Thai Cycling Club, publishing of bicycle-related magazines to provide useful information for cyclists, and web board to allow sharing of knowledge and experience in bicycling. These activities help to increase knowledge and enable an exchange of knowledge and experience among cyclists, thereby leading to improvement of the attitude towards bicycling.



- **Encouragement**

From a review of foreign model cities, they have implemented a broad variety of measures through both advertising campaigns and activities to reiterate their stance on cycling advocacy to the public. We have sorted out the existing measures derived from such model city review into two groups, i.e., direct encouragement measures and indirect encouragement measures. Samples of the bicycle culture encouragement measures from the said review can be summed up as follows:



Principle of 4 E (Engineering, Education, Enforcement, and Encouragement)

Engineering concerns with planning and construction.

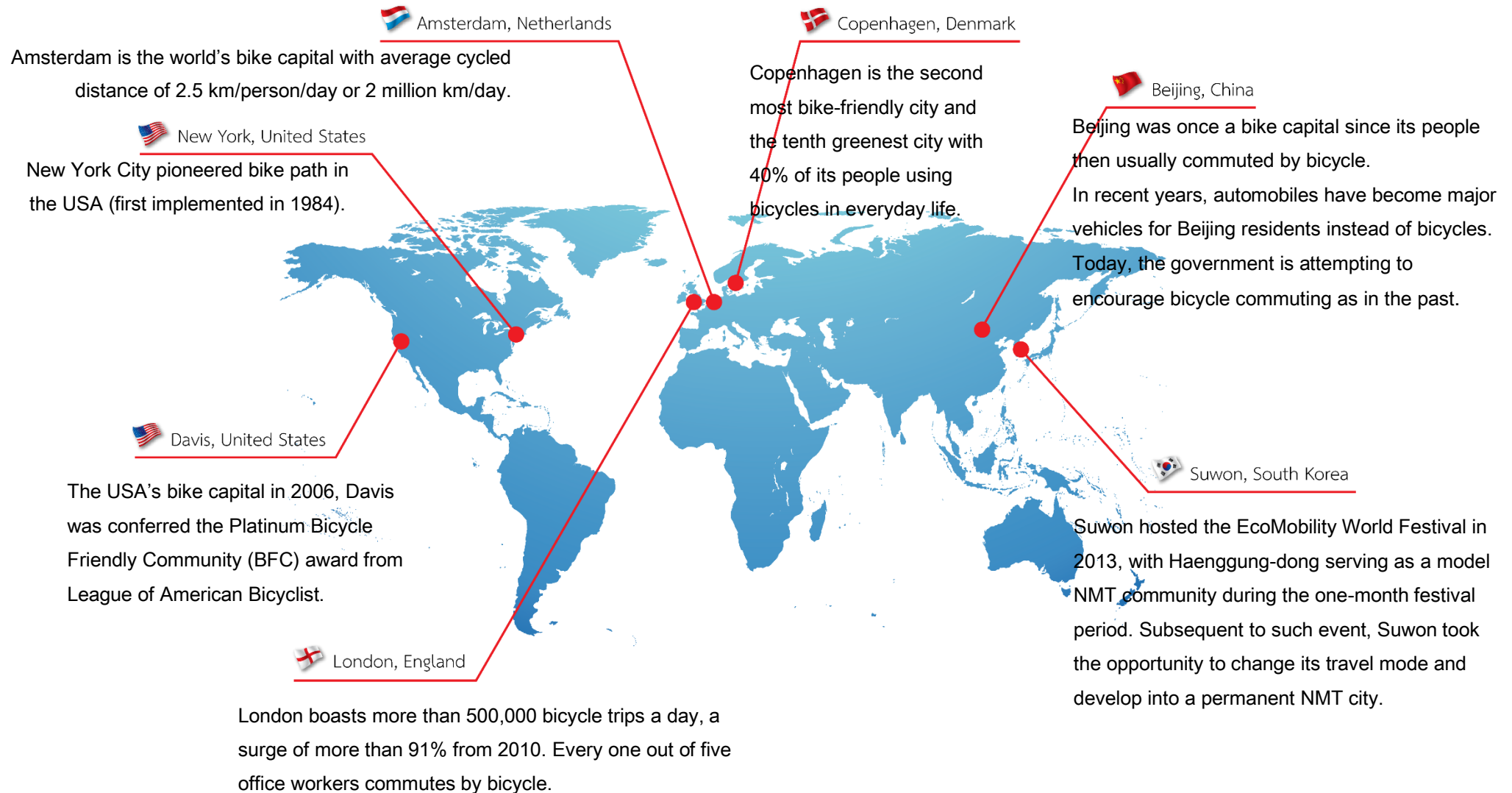
Education focuses on providing knowledge and understanding for road users.

Enforcement includes legal and control measures to ensure road users' compliance with the established rules and regulations.

Encouragement concentrates on campaigning for community people and road users to recognize the importance and join forces in translating the measures into practice.

Currently, a measure, **Evaluation**, has been introduced in order to redefine and determine additional future plans to be put into action.

² Project to study enabling factors and limiting factors for community bicycling in nine provinces in 2012 under the project to incorporate the promotion of bicycling in everyday life into the public policy of Thai Cycling Club, sponsored by Thai Health Promotion Foundation



WORLD BICYCLE CITY MAP

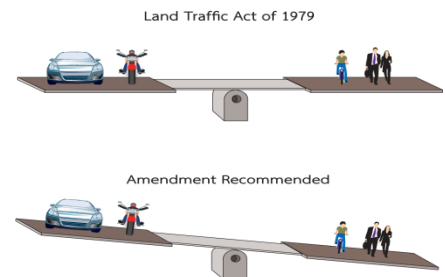


“Recommendations on law enforcement”

It is found from a legal review that the laws governing pedestrians and bikeways have already been in place. The laws of Thailand are similar to those of other countries, but less importance has been given to law enforcement with respect to both walking and bicycling. As such, the laws on pedestrians and bicycling have become insignificant and have not been adequately observed by either the general public or the enforcement officers. After reviewing the laws and measures relating to walking and bicycling, we recommend four solutions as follows:

1. Contents and details of the laws (contents)

General provisions: The Land Traffic Act of 1979 prescribes rules for use of sidewalk and bikeway and rights of pedestrians and cyclists to use roadway. However, it focuses on regulations for road users or regulations for pedestrians and bicycles only. For Thailand’s existing legislation in overall, the Land Traffic Act of 1979 still lacks sufficient contents to support or promote commuting by bicycle. From this limitation, there should be a study and suggestions on effective and practicable laws to support and promote bicycling, especially in Bangkok and other municipalities.



Traffic light and sign standards: From a review of traffic sign standards, it is found that the standards set forth in OTP’s safety handbook are consistent with those specified in the Department of Highways’ standard traffic sign manual in terms of both definition and format. In practice, however, the format of traffic signs on roads that are under the oversight of local authority still differs from those prescribed by both OTP and the Department of Highways. Such difference might be deemed a trivial issue. Nonetheless, in view of familiarity with and respect for the enforcement or warning messages conveyed by the signs, the use of standard signs could better increase road users’ acquaintance with the signs and more effectively communicate the enforcement or warning messages to road users.

Bikeway designing standards: Today, no engineering standards for bike path have yet been clearly imposed. The most common designs are bike lane stretching alongside the roadway, with about 0.5-meter-wide buffer space on which grasses or trees are planted for safety purposes. The popular design of bikeway in Thailand features a bike lane width of 1.50 meters, which could accommodate two-way bicycling, and next to the bike path is sidewalk.

This design is suitable for a community where there is enough commuting space. In some areas, there are shared-use paths for biking and motorcycling, primarily using roadside shoulders. In overall, the clarity of bikeway regulations is one of the issues recommended for improvement as another means to encourage the use of bicycle and development of bike path in everyday life





2. Prevention of non-compliance with the laws (prevention)

There are two preventive measures against violation of the laws, as follows:

Campaign for increased awareness of legal and regulatory compliance:

The pedestrian and bicycle laws have today been violated without serious punishments, demonstrating inefficiency of the applicable laws. The campaign for prevention of a breach of the laws should thus be focused on pedestrians, cyclists and motorists, or all groups of road users, aiming at developing a sense of responsibility and providing knowledge, understanding and awareness of the importance and benefit of the laws. A success in the campaigning will have a direct positive impact on the attitude and respect for the laws, thereby contributing to efficient enforcement.



Promotion and provision of knowledge about relevant laws: In addition to the above awareness-raising campaign, the laws governing bicycling and pedestrians should be promoted in order to increase knowledge and understanding of all groups of road users and enable them to properly act in compliance with the laws. Presently, not only motorists but also cyclists and pedestrians have breached the Land Traffic Act of 1979.

3. Enhancement of punishment efficiency (punishment)

Apart from the campaign for awareness and respect for the laws, the current punishment measures with respect to the use of sidewalk and bicycle are still inadequate and have not been strictly implemented, leading motorists and other road users to pay less attention to the law enforcement. However, the measures to be imposed should be appropriate and acceptable to the overall target groups (pedestrians, bicyclists, car users and motorcyclists), which will likewise have a positive impact on the respect for the laws and success in enforcement.

4. Strengthening of the rigidity of law enforcement (enforcement)

This measure concerns directly with the enforcement officers, including issues such as knowledge, understanding and attitude towards non-motorized mobility.

For example, taking into account the Land Traffic Act of 1979, **Section 7, which reads ‘Motor vehicles without registration plates, registration mark plates or license plates under the law on automobiles, the law on transport, the law on vehicles, the law on rickshaw or the law on serviced vehicles shall be prohibited from using the roadways,’** it is found that there has been no strict



control and inspection of the registration of motorcycles when in use on the road. Such registration data are useful both for regulating and standardizing the use of motorcycles and for compiling relevant statistics that will contribute to future development. Besides, the government sector's readiness in terms of budget, personnel and technology is also crucial to ensuring efficiency in inspection and operation. Despite the authority allowed by laws for the officers to track and inspect vehicles at entrepreneurial premises and to stop and inspect vehicles while in service, the enforcement of such measure is considerably reliant on the readiness of state personnel with respect to number of personnel, management and transparency of public officers in properly performing their duty in accordance with the laws.



“Results of a survey and analysis on traveling demand in Bangkok and its vicinities”

Summary of an analysis on traveling demand by public transport in Bangkok and its vicinities: We conducted an eBUM analysis to identify the future commuting condition in Bangkok and its vicinities (for the years 2017, 2022, 2027 and 2032), by focusing on the analysis and forecast of number of commuters through different modes of public transport. The outcome of future traveling demand analysis and prediction in Bangkok and its vicinities, using the eBUM model, is as follows:

- Ratio of commuting by public transport in 2017-2037 will reach 58.98% on average.
- In 2037, electric train ridership will grow from 2017 (from 2,798,000 person-trips/day to 10,898,000 person-trips/day), while number of public bus commuters will still rank top.
- In 2037, number of public transport commuters will reach 25,173,000 person-transit trips/day, using transportation modes such as electric train, train, van, public bus and boat, which are almost two-folds higher than the ridership in 2017 thanks to the more complete transport network.

Ratio of Main Commuting Including Public Transport Connections, Classified by Vehicle Type
(000's person-trips/day)

Year	Total	Private Vehicles	Private Vehicles (%)	Public Transport	Public Transport (%)
2560	25,900	11,300	43.63%	14,600	56.37%
2565	30,100	12,300	40.86%	17,800	59.14%
2570	33,900	13,600	40.12%	20,300	59.88%
2575	39,200	14,900	38.01%	24,300	61.99%
2580	43,800	18,600	42.47%	25,200	57.53%

Source: An eBUM model analysis in Bangkok and its vicinities conducted by the Consultants

Note: Including transit trips

Forecast of Main Public Transport Ridership (000's person-trips/day)

Mode	2017	2022	2027	2032	2037
Electric train	2,798	5,611	7,065	10,309	10,898
Public bus	10,902	11,167	11,975	12,520	12,857
Passenger boat	300	318	383	487	526
Others	598	750	876	991	892
Total	14,598	17,846	20,299	24,307	25,173

Source: An eBUM model analysis in Bangkok and its vicinities conducted by the Consultants



Summary of analysis on traveling mode preference of public transport commuters at large transport interchanges:



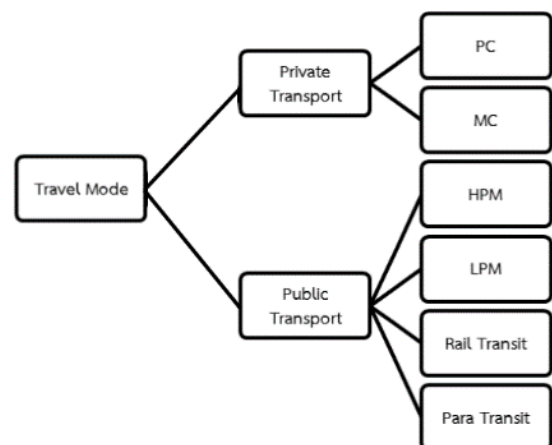
To analyze travel choices, we conducted a survey on data for restructuring of such model. The Stated Preference method was employed, whereby respondents of the questionnaires selected their preferred non-motorized travel mode versus other commuting modes. We made a field survey and had a total of 1,500 questionnaires filled out at various public transport interchanges and service stations.

We used the data derived from the survey for analyzing a shift of travel mode based on a model developed by the Utility Theory and the assumption that the individual commuters will decide whether to travel, how to travel and by which mode to travel by judging from the maximum utility they will obtain from the chosen mode. We took into account the following travel choices:

(1) private car, (2) motorcycle, (3) rail, (4) para transit, (5) high performance mode (HPM), and (6) low performance mode (LPM).

The model separated the travel modes between HPM and LPM to forecast number of travel trips based on commuters' household income. Parameters influencing the travel modes include travel time, access and egress time, waiting time, and cost. The forecast was made in the scenarios where there is, and there is no, improvement of sidewalk and public transport connectivity and commuting ratio of different vehicle types.

Assuming that there is improvement of sidewalk and public transport connectivity, which has an influence on the access and egress time and the waiting time and by adopting an established ratio of commuting via different vehicle types, **in case the development master plan for NMT promotion is implemented, it is found that the chosen travel mode by public transport, both HPM and LPM, will relatively grow.**





From a forecast in the case where the NMT project plan is not implemented,

it is found that most commuters prefer HPM, accounting for 29.85%, followed by motorcycle, 23.56%, and private car, 23.20%. The reason why HPM captures the highest commuting ratio is because most of the sample commuters chose to travel by public transport. The outcome of the analysis on a shift of travel mode is as tabulated below:

Travel Choices in Case NMT Project Plan Is not Implemented (from sample groups)

Private Car	Motorcycle	HPM	LPM	Rail	Para Transit
23.20%	23.56%	29.85%	13.97%	4.02%	5.39%

A forecast in the case where the NMT project plan is implemented

points to growth in travel mode by public transport, with, for example, HPM increasing by 1.56% and LPM by 4.67%

Travel Choices in Case NMT Project Plan Is Implemented (from sample groups)

Private Car	Motorcycle	HPM	LPM	Rail	Para Transit
19.83%	20.14%	31.41%	18.65%	5.36%	4.61%





Summary of a survey and inspection of NMT infrastructure and facilities:

It has been discovered from the survey that there is still a lack in bicycling facilities such as bikeway, park & bike, etc., as well as a lack in facilities for pedestrians such as safe crossing, while there are some obstructions to walking such as advertising signs, makeshift stalls, and so on.

Key Inspection Factors	BTS	MRT	ARL	BRT	Public Bus	Saen Saep Express Boat	Chao Phraya Express Boat	Ordinary Train
Width of surrounding area (meter)	2.6-3.0	2.6-3.0	2.6-3.0	3.1-3.5	1.6-2.0	< 1.6	< 1.6	< 1.6
Sidewalk on both sides of the road	Available	Available	Available	Available	Available	Not fully available	Not fully available	Not fully available
Sidewalk condition	Moderate	Moderate	Excellent	Moderate	Moderate	Incomplete	Incomplete	Incomplete
Pleasant and shady ambience	Moderate	Moderate	Poor	Moderate	Moderate	Poor	Poor	Poor
Sidewalk continuity in 400-m radius	Uninterrupted	Interrupted	Interrupted	Interrupted	Uninterrupted	Interrupted	Interrupted	Interrupted
Sidewalk lighting	Available	Inadequate	Available	Available	Inadequate	None	None	None
Pedestrian bridge, crossing signal light and crosswalk in 500-m radius	Available	Inadequate	Available	Available	Available	Inadequate	Inadequate	Inadequate
Handicap ramp	Not fully available	Not fully available	Complete	None	Inadequate	None	None	None
Pedestrian roofing	Interrupted	Interrupted	Interrupted	Interrupted	Interrupted	Interrupted	Interrupted	Interrupted
Bikeway	None	None	None	None	None	None	None	None
Park & bike	None	None	Available	Available	None	None	None	None



Summary of attitude survey on use of public transport and NMT among Bangkok residents:

We made a survey on volume of public transport commuters with a sample of 1,500 questionnaires at various places, including:

- BTS and MRT interchanges at Asok-Sukhumvit Station and Silom-Saladaeng Station
- Mo Chit-Chatuchak
- BTS and Airport Rail Link interchange at Phayathai Station
- MRT and Airport Rail Link interchange
- Makkasan-Phetchaburi Station
- New Mo Chit Bus Terminal
- Chao Phraya express boat Rama VII Pier and Taksin Bridge Pier (connection with BTS station)
- Khlong Saen Saep Pratunam Pier
- Chiang Rak and Lat Krabang railway stations
- Bus stops at important interchange stations such as Queen Sirikit National Convention Center, Lumpini Park, Taksin Bridge, Wongwian Yai, Memorial Bridge (Saphan Phut), etc.

Importance placed on facilities: It is found from the survey that the sample group attached the highest degree of importance to crossing signals and signs, accounting for 66%, followed by street-wide lighting, low speed limits and ramp availability, amounting to 62%; roads with either asphalt or concrete surface, 61%; bicycle/pedestrian signs and markings and pedestrian/bicycle-only lanes, 59%; and adequate bikeway width which ranked in the lowest place, 54%.

Opinion on bikeway and sidewalk development: The survey results show that the sampling group agreed the most with bikeway and sidewalk development, 62%, followed by cycling and walking promotion campaigning, 54%, and NMT support/promotion, 42%.

Survey on travel behaviors and opinion on infrastructure and facilities needs of commuters at public transport interchanges

- ✓ Among those polled about bicycling in Bangkok, comprising 55% females and 45% males, only 30% of them used a bicycle. Of the total respondents, 16% biked less than four times a month, 9% used the bicycle 1-2 times a week, 2.6% biked 2-4 times a week, 3.4% biked more than 4 times a week, and as high as 69% of the respondents never used the bicycle.
- ✓ Nineteen percent used the bicycle for an end-to-end commuting, 12% used the bicycle to connect to a public transport system, and the rest 69% never used the bicycle.
- ✓ A majority of 29% preferred to travel by electric train. Coming second was travel by bus, 26%, followed by private car, 24%. Only 7% liked to commute by motorcycle and 6% preferred walking. Those commuting by bicycle made up only 4%, while the remaining 4% opted for other modes such as boat.
- ✓ When asked about their infrastructure and facilities requirements, the respondents agreed that there should be signal lights and warning signs. Those agreed with street-wide lighting, low speed limits and ramp availability made up 62%; roads with either asphalt or concrete surface, 61%; pedestrian/bicycle-only lanes and bicycle/pedestrian signs and markings, 59%; bikeway continuity, 58%; and adequate bikeway width, 54%.



“Summary of suggestions on projects/measures to promote NMT and details of public transport connectivity improvement in Bangkok and its vicinities”

We selected the areas ideal for our preparation of suggestions on pilot projects/measures to promote NMT and details of public transport connectivity improvement in Bangkok and its vicinities, and divided them into three groups (comprising a total of 140 locations) as follows:

- 1) Road transport transit area (36 locations);
- 2) Rail transport transit area (53 locations); and
- 3) River boat transport transit area (51 locations).

Of the total of 15 selected areas, **three areas are deemed uncomplicated for development of Bangkok NMT system and have the highest potential for initiating a pilot project**, namely (1) Mo Chit Bus Stop and BTS Station, (2) Phayathai BTS Station, and (3) Pak Kret Pier.



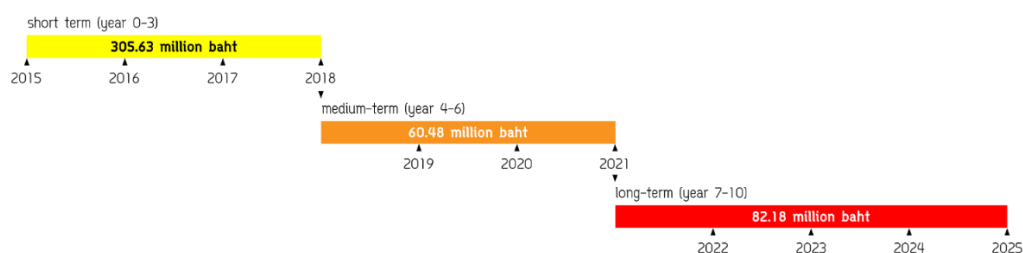
The other 12 selected areas for which we have devised development guidelines and measures are:

- | | |
|--------------------------------------|--|
| (1) Government Housing Bank Bus Stop | (7) Udomsuk BTS Station |
| (2) Hua Lamphong Bus Stop | (8) Ratchaprarop Airport Rail Link Station |
| (3) Lat Phrao MRT Bus Stop | (9) Saphan Phut Pier |
| (4) Rama IX Bridge Bus Stop | (10) Witthaya Bridge Pier |
| (5) Pho Nimit BTS Station | (11) Ratchawong Pier |
| (6) Phra Khanong BTS Station | (12) Wat Tuk Pier |



Based on the study of all above connectivity points, we mapped out a development master plan for NMT promotion and public transport connectivity improvement in Bangkok and its vicinities, with the project life of 10 years and an estimated budget of THB 450 million. The plan is divided into three phases of 3-4 years each, details of which are as follows:

- **Short-term plan/project, 2015-2017 (0-3 years)**: This phase features a plan that is achievable in an immediate term. It involves the areas ready for development with respect to their physical, economic and social conditions, including the three selected pilot areas, namely Mo Chit Bus Stop and BTS Station, Phayathai BTS Station, and Pak Kret Pier, the 12 recommended areas and other 29 areas, making up a total of 44 locations.
- **Medium-term plan/project, 2018-2020 (4th-6th years)**: This phase focuses on projects that will be carried on after completion of the short-term plan or projects that are of a lesser degree of importance than the short-term plan. It entails development of 17 rail transport connectivity locations, 12 road transport connectivity locations, and 15 water transport connectivity locations, making 44 locations in total.
- **Long-term plan/project, 2021-2024 (7th-10th years)**: This phase concerns with projects to be implemented in the long term in developing additional connectivity areas to cover Bangkok and its vicinities to a broader extent, consisting of 19 rail transport connectivity locations, 12 road transport connectivity locations, and 21 water transport connectivity locations, making 52 locations in total.



Initially, the authorities responsible for the development budget are as follows:

- 
Bangkok Metropolitan Administration
 responsible for development of sidewalk and bikeway in Bangkok Metropolitan areas.
- 
Nonthaburi Municipality
 responsible for development of sidewalk and bikeway in Nonthaburi Municipality areas.
- 
Pak Kret Municipality
 responsible for development of sidewalk and bikeway in Pak Kret Municipality areas.
- 
Bang Bua Thong Municipality
 responsible for development of sidewalk and bikeway in Bang Bua Thong Municipality areas.
- 
Rangsit Municipality
 responsible for development of sidewalk and bikeway in Rangsit Municipality areas.
- 
AOT
 responsible for development of sidewalk and bikeway in bus stop areas at Suvarnabhumi International Airport.
- 
State Railway of Thailand
 responsible for development of sidewalk and bikeway in the areas under supervision of SRT.

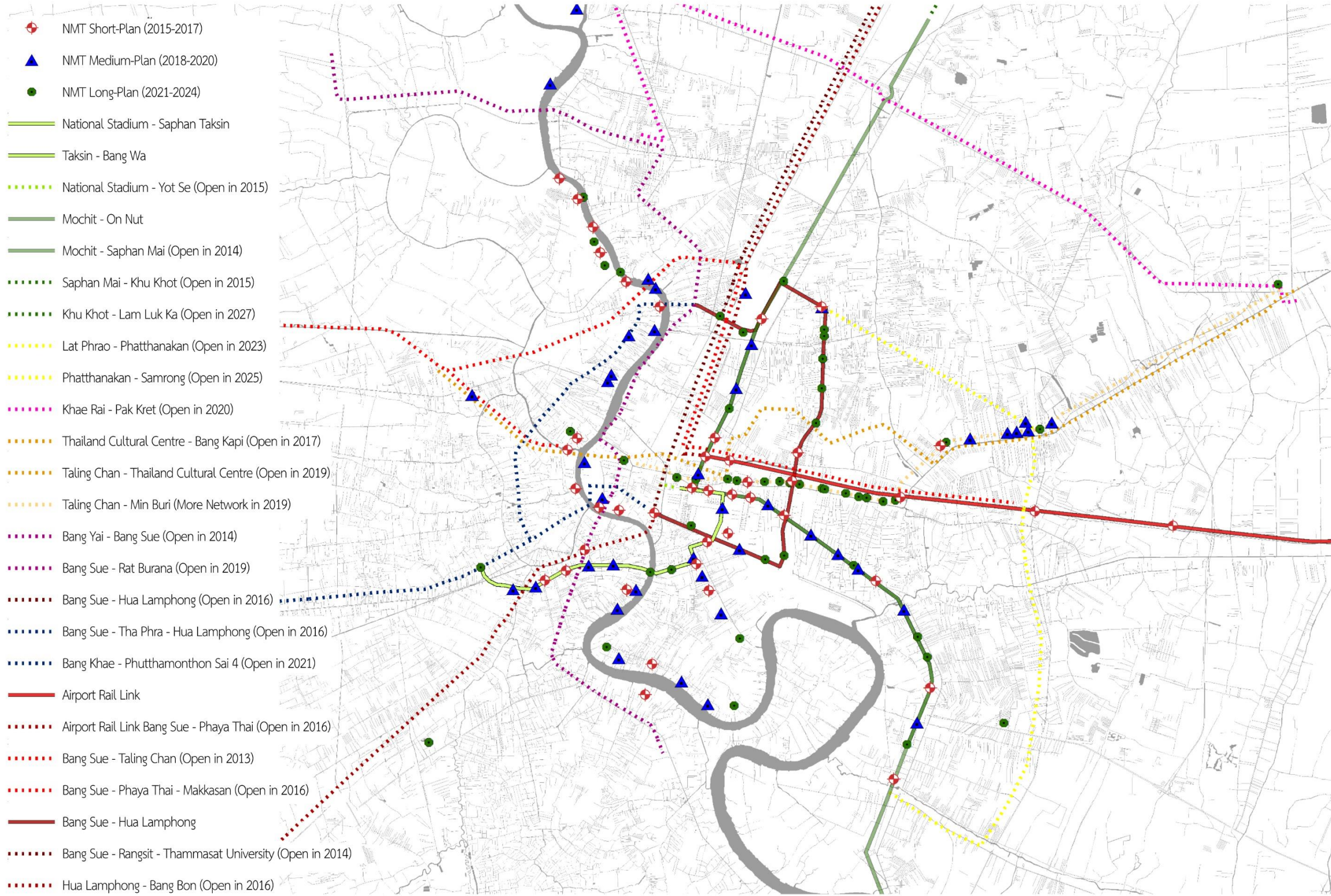


Summary of investment plan on public transport connectivity improvement of each agency

Details of the master plan	Year	หน่วยงาน/ งบประมาณ (บาท)							Budget
		BMA.	Nonthaburi Municipality	Pak kret Municipality	Bang Bua tong Municipality	Rangsit Municipality	AOT.	SRT.	
Short Term plan , including the development of : <ul style="list-style-type: none"> • Bus stop area at BTS Mo Chit • Surrounding area of BTS Phaya Thai • Surrounding area of Pak Kret pier • Recommended area for development : 12 area • Other area : 29 area • Total : 44 area 	B.E. 2559 – 2561 (year 0-3)	292,848,000	5,364,000	7,420,000	-	-	-	-	305,632,000
Medium term plan , including : <ul style="list-style-type: none"> • Rail transit system development : 17 area • Road transit system development : 12 area • River boat transit system development : 15 area • Total : 44 area 	B.E. 2562 – 2564 (year 4-6)	56,496,000	1,008,000	-	1,488,000	-	1,488,000	-	60,480,000
Long term plan , including : <ul style="list-style-type: none"> • Rail transit system development : 19 area • Road transit system development : 12 area • River boat transit system development : 21 area • Total : 52 area 	B.E. 2565 – 2568 (year 7-10)	72,080,000	5,872,000	-	-	1,728,000	-	2,496,000	82,176,000
Total Budget		421,424,000	12,244,000	7,420,000	1,488,000	1,728,000	1,488,000	2,496,000	448,288,000

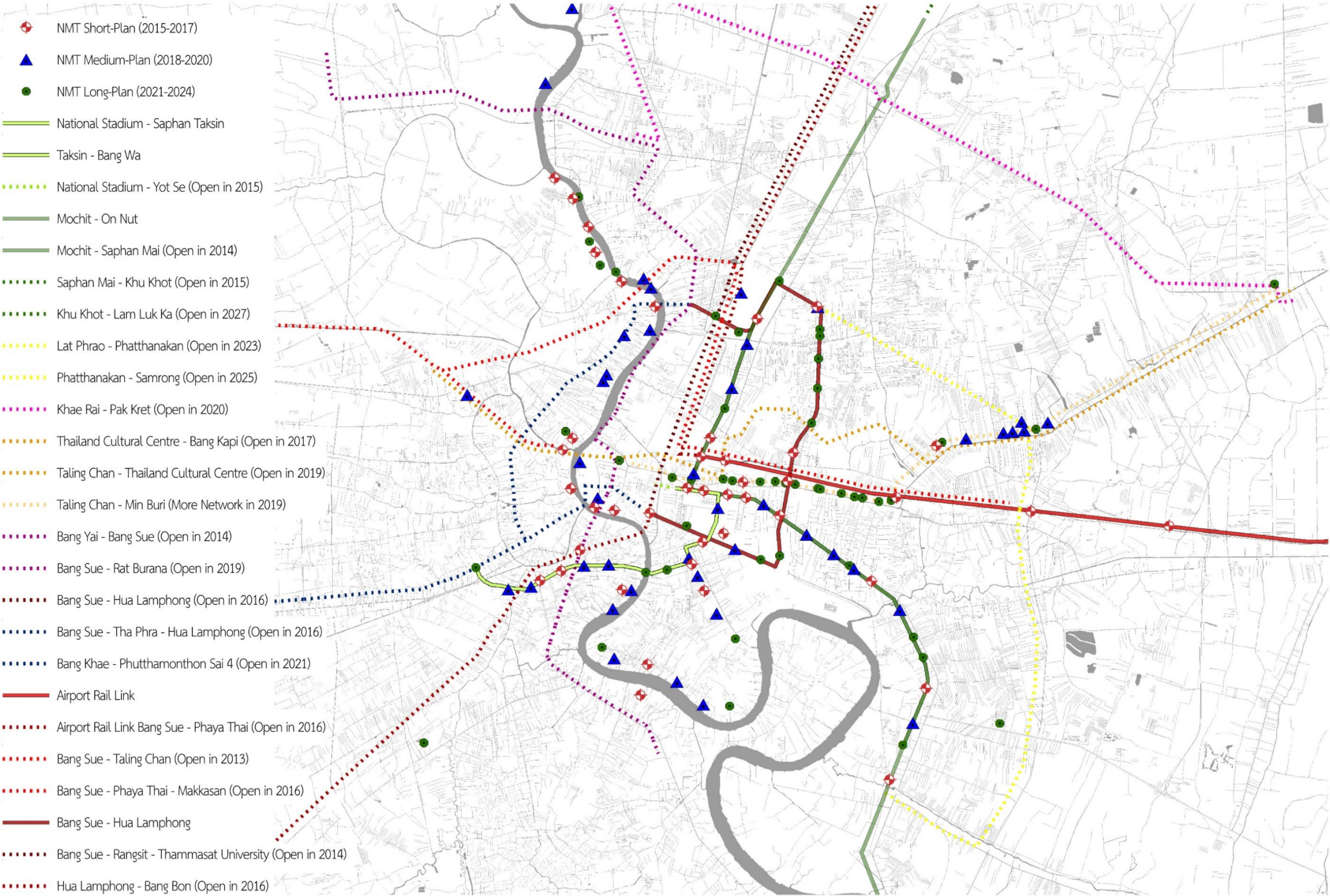


Development Master Plan for Promoting Non-Motorized Transport (NMT) and Redeveloping Public Transport Transit Area in Bangkok Metropolitan



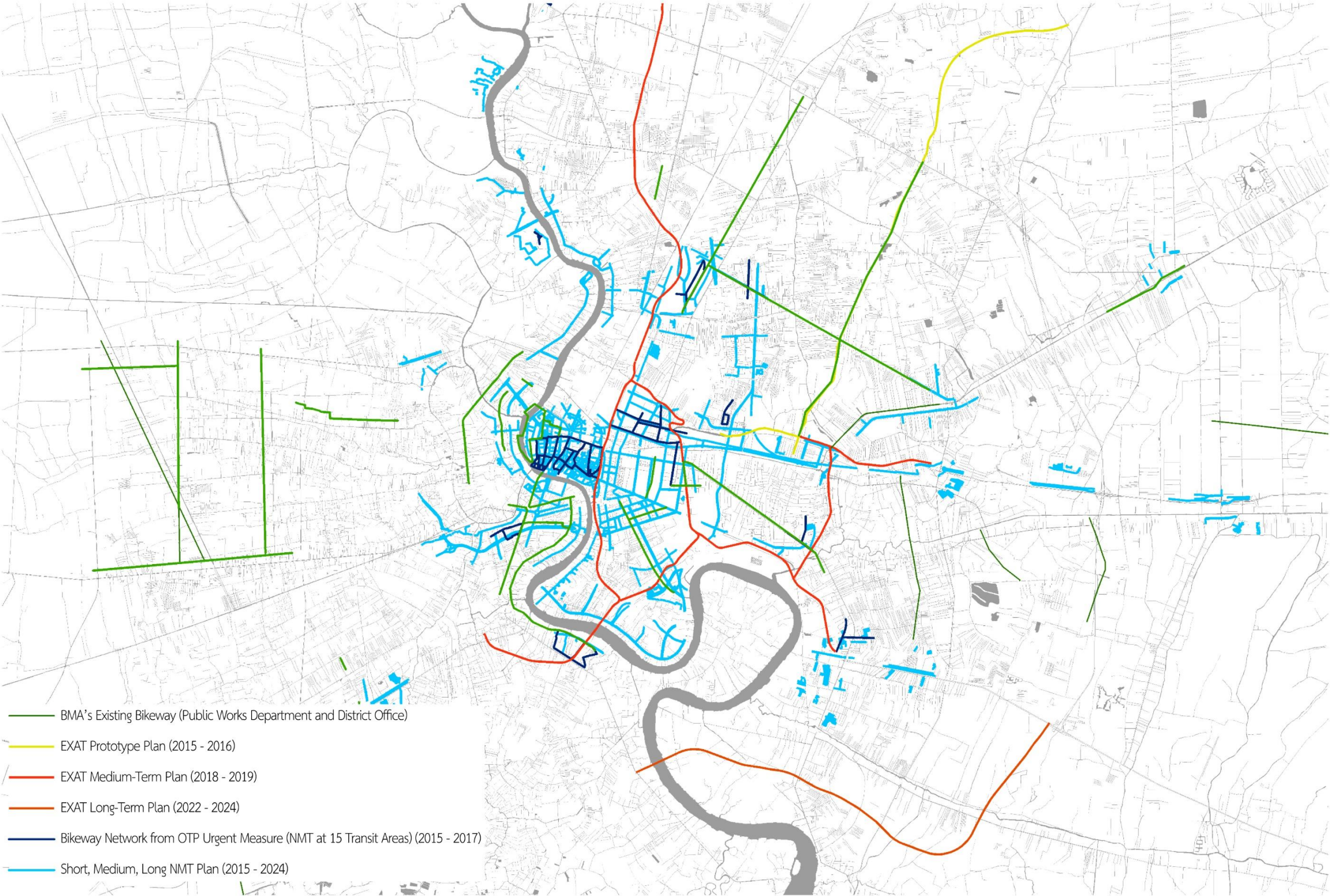


Development Master Plan for Promoting Non-Motorized Transport (NMT) and Redeveloping Public Transport Transit Area in Bangkok Metropolitan



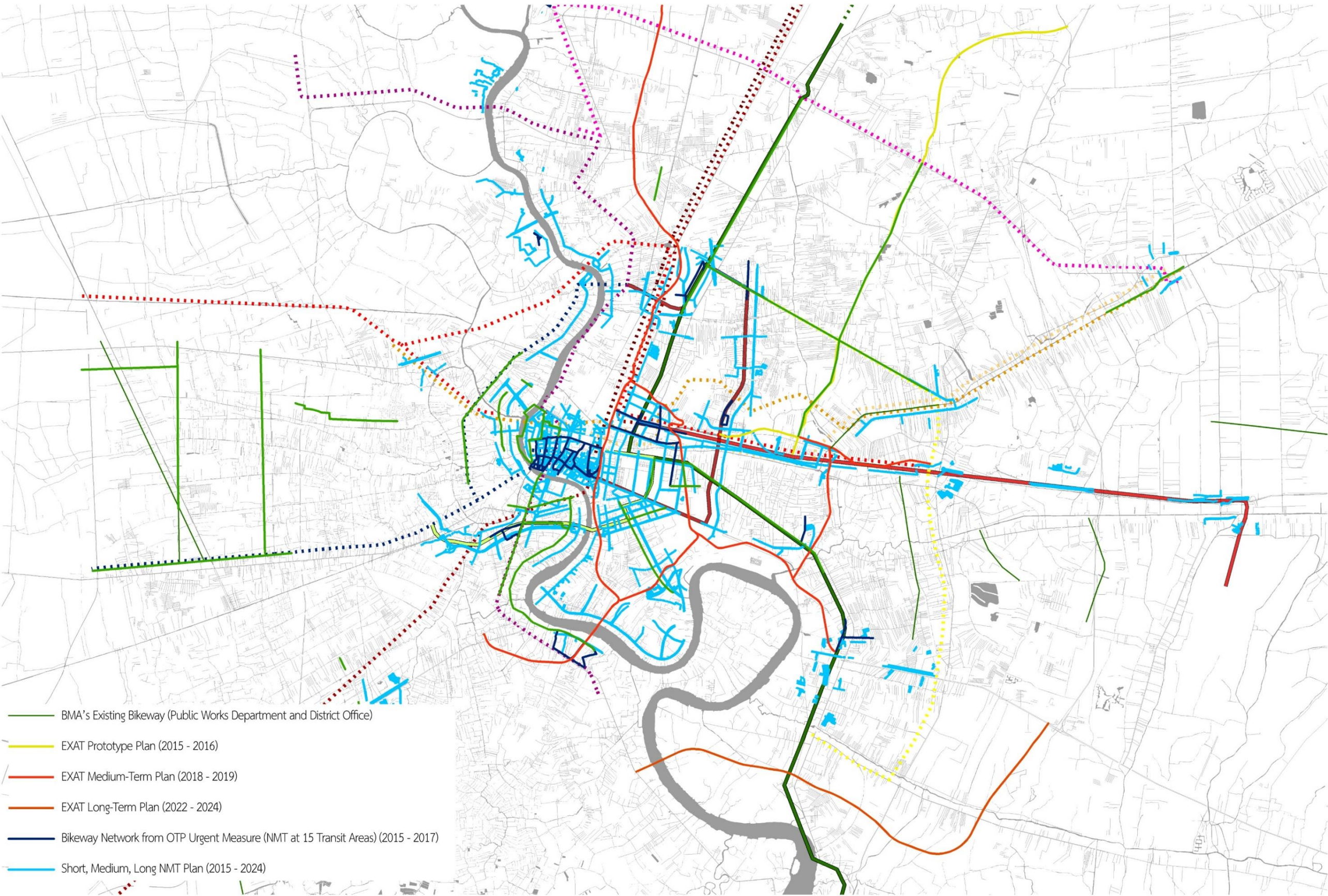


Summary of Existing Bikeway and Development Plan in Bangkok Metropolitan





Summary of Existing Bikeway and Development Plan in Bangkok Metropolitan





Results of the study and analysis on efficiency in reduction of greenhouse gas emission and energy consumption as a consequence of sidewalk and bikeway development in Bangkok and its vicinities:

In analyzing a reduction of greenhouse gas emission due to the development of NMT in Bangkok and its vicinities under this project, we focused on three types of development:

- 1) Development of bikeways in Bangkok;
- 2) Development of a bicycle sharing program; and

Development of commuting connectivity.



For the projects in (1) and (3), we based the analysis primarily on the plan derived from this project study under the assumption that the public bicycle, or bicycle sharing, program is fully developed by 2027.

In the analysis of efficiency in reduction of greenhouse gas emission and energy consumption due to the development of sidewalk and bikeway in Bangkok and its vicinities, we analyzed volumes of CO₂ under the following scenarios:

- **BAU without BTS/MRT:** In this case, we based the study on the modeling and analysis in the project study to devise a master plan on sustainable transport development and climate change solution.
- **BAU with BTS/MRT:** We conducted the study in this case by using secondary data derived from the eBUM model for additional analysis with TEEMP (Transport Emission Evaluation Models for Projects).
- **Implementation of short-term NMT plan:** In this case, we analyzed the efficiency in reduction of greenhouse gas emission following a change of traveling demand in case there is improvement of transport connectivity under the NMT development plan at 44 locations.
- **Implementation of medium-term NMT plan:** In this case, we analyzed efficiency in greenhouse gas emission reduction from a change of traveling demand in case there is improvement of transport connectivity under the NMT development plan at 44 additional locations, making up a total of 88 locations.
- **Implementation of long-term NMT plan:** In this scenario, we analyzed efficiency in greenhouse gas emission reduction from a change of traveling demand in case there is improvement of transport connectivity under the NMT development plan at 52 additional locations, making up a total of 140 locations.

It is found from the analysis that, for the current year (2014), the development of rail transport systems under BTS and MRT projects is estimated to help reduce greenhouse gas (CO₂) emission by as high as 2.83 Mt CO₂e or 1,380 ktOE or equivalent to benzene consumption of about 1,030 million liters. After full completion of rail transport system development by 2030 as planned, the estimated volume of greenhouse gas (CO₂) reduction will reach 5 Mt CO₂e or 2,440 ktOE or equivalent to benzene consumption of around 1,800 million liters.

By comparing with all of the three phases of the NMT development plan in the short, medium and long terms under which a total of 140 transport connectivity locations will be developed and are expected to impact a shift of traveling modes more towards public transport and non-motorized mobility, it is discovered that in 2026, when all

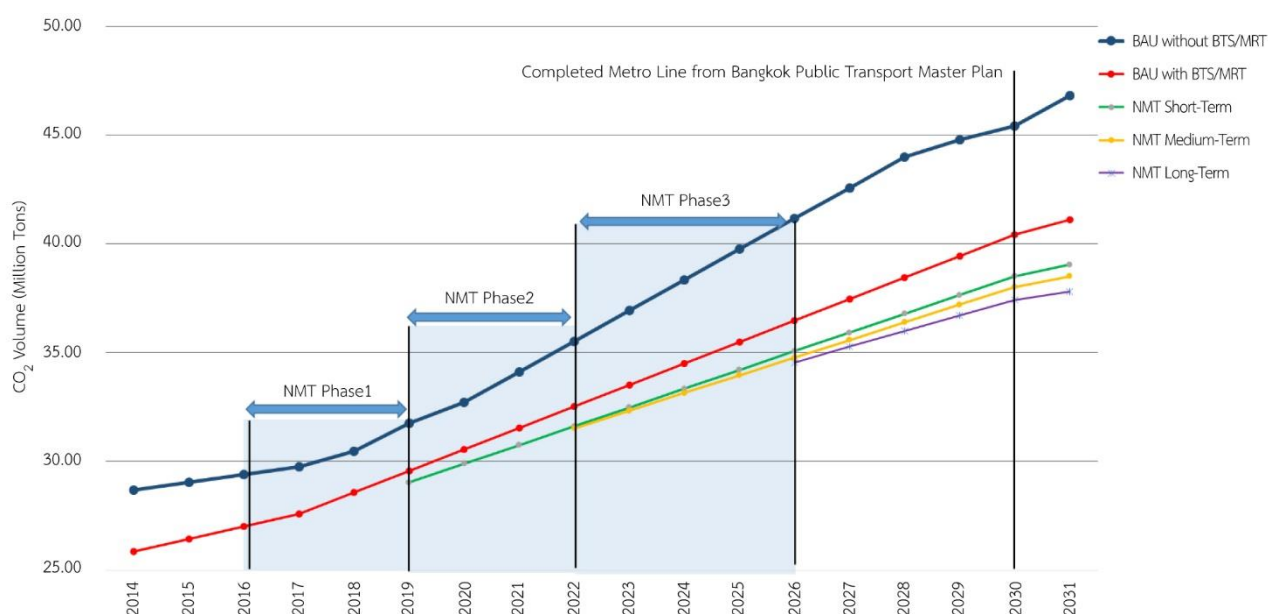


of the three NMT development phases will be accomplished, the greenhouse gas (CO₂) emission will be reduced by 8 Mt CO₂e or 3,900 ktoe or equivalent to benzene consumption of approximately 2,900 million liters.

Comparison of CO₂ Volume in Bangkok and Its Vicinities in Cases of BAU and NMT Development in Three Phases (unit: Mt CO₂e)

Year B.E.	BAU without BTS/MRT	BAU with BTS/MRT	NMT Short term	NMT Medium term	NMT Long term	Remark
2557	28.68	25.84 (2.84)	-	-	-	Base year
2560	29.76	27.58 (2.18)	-	-	-	-
2562	31.74	29.56 (2.18)	29.03 (2.71)	-	-	NMT Short term was completed
2565	35.53	32.53 (3.00)	31.52 (4.01)		-	NMT Medium term was completed
2569	41.17	36.48 (4.69)	34.55 (6.62)			NMT Long term was completed
2573	45.43	40.44 (4.99)	37.43 (8.00)			Completed Metro line from Bangkok public transport master plan

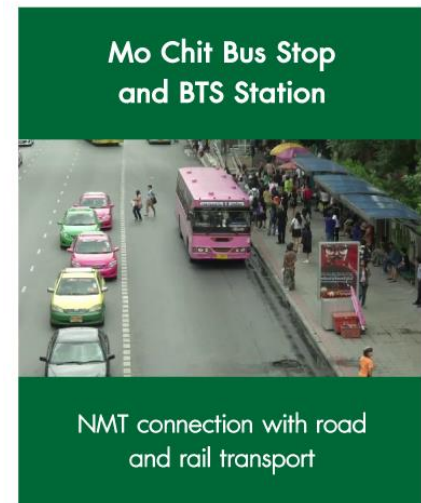
Remark: BAU (Business As Usual): BAU without BTS/MRT is based on data derived from the project study to devise a master plan on sustainable transport development and climate change solution. Short-term NMT: Implementation of the short-term plan of NMT project. Medium-term NMT: Implementation of the short-term and medium-term plans of NMT project. Long-term NMT: Implementation of the short-term, medium-term and long-term plans of NMT project. T





Pilot policy and measure for Mo Chit Bus Stop and BTS Station area:

Infrastructure Inspection Factors	Current Status
Width of sidewalk (m.)	2.6-3.0
Sidewalk condition	Moderate
Pleasant & shady surrounding	Moderate
Sidewalk continuity (in 400-m radius)	Uninterrupted throughout the route
Adequate lighting	Visible throughout the route
Safe crosswalk (in 500-m radius)	Pedestrian bridge/ signal light available
Format of sidewalk	Available on both sides of the road
Handicap ramp	Available but incompletely
Flat path	Available
Sidewalk roofing	Interrupted
Bikeway	None
Park & bike	None



Problems prevalent in the area of Mo Chit Bus Stop and BTS Station This area covers bus stops on both sides of the road, i.e. in front of Chatuchak Park and BTS Park & Ride. It accommodates different types of vehicles such as public buses, taxis, passenger vans, motorcycle taxis and private cars. The recommended policy and measure for the area improvement are as follows:

- Kiss and ride areas for public transport vehicles should be organized and clearly separated by vehicle type. A bus stop space should be more than 50 meters long.
- Kiss and ride space for smaller vehicles such as taxis and passenger vans should be able to accommodate 8-10 taxis/vans.
- Route intersection area should be clearly marked.
- Distinct kiss and ride signs for each type of public transport vehicles should be provided.
- A physical boundary should be specified in order to enforce passengers to wait in the designated area.
- Roofing that links BTS and MRT stations should be improved.
- Pollution reduction measure should be launched for the area under the skytrain station, which is stale-smelling, by installing, for example, ventilators and vaporizing pipes to remove pollutants out of such area.

From a micro simulation in the area of Mo Chit Bus Stop and BTS Station, it is found that air pollution is more concentrated in the area beneath the skytrain station on the northbound route, or in the 400-500 meters section, which is heavily crowded with public transport vehicles either picking up or dropping off their passengers. The area is also congested due to traffic at nearby intersection. Meanwhile, air pollution on the opposite side (southbound) is concentrated in the area close to Lat Phrao intersection down to the station. Here are the results in case there is improvement under the project plan:

Northbound: CO₂ will be lowered in the 300-550 meters section and the sharpest CO₂ reduction will be in the 500 meters section at a rate of 1.85 Kg/hour.

Southbound: CO₂ can be reduced all along the road, especially in the 550-900 meters section with a reduction rate of more than 10 kg/hour.

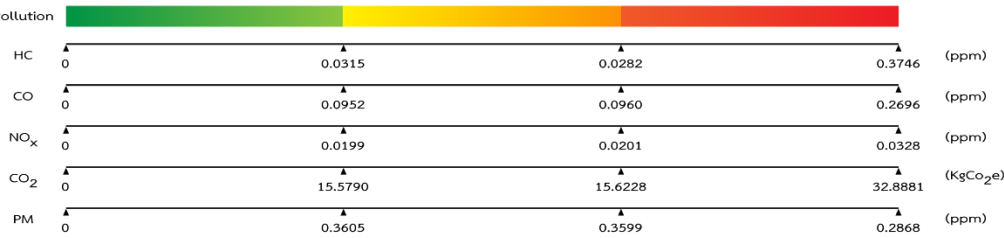




Analysis results of emission around bus stop and BTS Mo Chit station

Remark:

- a) Traffic congestion in front of Chatuchak Park together with the unpleasant ambience under the skytrain station is the main cause of poorer air quality than other sections. Streamlining of kiss and ride management is recommended.
- b) Air pollution, after improvement, is worsened due partly to better traffic flow in Section a, which relatively results in more congestion in Section b, and partly to slower traffic in such area.
- c) The long queue of traffic at the intersection causes a high quantity of CO₂ emissions in that area. Improvement of traffic and signal light management will lead to better traffic flow and pollution reduction.



Pollution			50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	Total
Northbound	without improvement	HC	0.0271	0.0265	0.0263	0.0265	0.0269	0.0282	0.0328	0.0428	0.0495	0.0428	0.0278	0.0259	0.0258	0.0261	0.0261	0.0261	0.0260	0.0261	0.5393
		CO	0.0948	0.0943	0.0941	0.0943	0.0947	0.0960	0.1001	0.1085	0.1138	0.1085	0.0955	0.0937	0.0936	0.0939	0.0940	0.0939	0.0938	0.0939	1.7515
		NOx	0.0199	0.0199	0.0198	0.0199	0.0199	0.0201	0.0205	0.0215	0.0221	0.0215	0.0200	0.0198	0.0198	0.0198	0.0198	0.0198	0.0198	0.0198	0.3636
		CO2	15.4108	15.3116	15.2794	15.3041	15.3855	15.6228	16.3737	17.8034	18.6257	17.8055	15.5462	15.1976	15.1819	15.2243	15.2414	15.2279	15.2158	15.2279	284.9854
		PM	0.3566	0.3575	0.3578	0.3576	0.3568	0.3546	0.3480	0.3375	0.3325	0.3375	0.3553	0.3587	0.3588	0.3584	0.3582	0.3583	0.3585	0.3583	6.3609
	with improvement	HC	0.0275	0.0278	0.0288	0.0266	0.0266	0.0268	0.0273	0.0288	0.0296	0.0298	0.0270	0.0263	0.0262	0.0264	0.0264	0.0263	0.0263	0.0264	0.4910
		CO	0.0957	0.0950	0.0969	0.0948	0.0948	0.0950	0.0955	0.1069	0.0976	0.0978	0.0952	0.0945	0.0945	0.0946	0.0946	0.0945	0.0946	0.0946	1.7183
		NOx	0.0201	0.0201	0.0202	0.0200	0.0200	0.0200	0.0201	0.0203	0.0203	0.0203	0.0200	0.0199	0.0199	0.0199	0.0199	0.0199	0.0199	0.0199	0.3608
		CO2	15.5535	15.5536	15.7908	15.3887	15.3899	15.4186	15.5213	16.867	15.9192	15.9600	15.4729	15.3379	15.3232	15.3515	15.3552	15.3355	15.3392	15.3478	279.2066
		PM	0.3583	0.3577	0.3561	0.3599	0.3599	0.3596	0.3586	0.3561	0.3549	0.3546	0.3591	0.3604	0.3605	0.3603	0.3602	0.3604	0.3604	0.3603	6.4575
southbound	without improvement	HC	0.0256	0.0244	0.0247	0.0248	0.0247	0.0252	0.0267	0.0315	0.0452	0.0763	0.1300	0.1799	0.2552	0.3321	0.3626	0.3604	0.3540	0.3746	2.6781
		CO	0.0897	0.0886	0.0888	0.0890	0.0889	0.0893	0.0908	0.0952	0.1064	0.1282	0.1597	0.1853	0.2201	0.2527	0.2649	0.2640	0.2615	0.2696	2.8328
		NOx	0.0188	0.0187	0.0187	0.0188	0.0187	0.0188	0.0190	0.0195	0.0207	0.0229	0.0256	0.0275	0.0298	0.0318	0.0325	0.0325	0.0323	0.0328	0.4395
		CO2	14.5845	14.3563	14.4101	14.4333	14.4217	14.4987	14.7815	15.5790	17.4256	20.4610	24.0196	26.4650	29.3569	31.7392	32.5729	32.5149	32.3432	32.8881	396.8514
		PM	0.3373	0.3395	0.3390	0.3388	0.3389	0.3381	0.3354	0.3285	0.3157	0.3013	0.2911	0.2868	0.2835	0.2819	0.2815	0.2816	0.2814	0.2814	5.5818
	with improvement	HC	0.0220	0.0216	0.0221	0.0222	0.0222	0.0223	0.0226	0.0226	0.0225	0.0228	0.0242	0.0224	0.0225	0.0233	0.0256	0.0363	0.0728	0.1180	0.5681
		CO	0.0801	0.0798	0.0803	0.0804	0.0803	0.0804	0.0807	0.0807	0.0807	0.0809	0.0823	0.0805	0.0806	0.0814	0.0835	0.0928	0.1185	0.1448	1.5686
		NOx	0.0169	0.0169	0.0169	0.0170	0.0170	0.0170	0.0170	0.0170	0.0170	0.0170	0.0172	0.0170	0.0170	0.0171	0.0184	0.0210	0.0232	0.0232	0.3178
		CO2	12.9822	12.9202	13.0110	13.0317	13.0234	13.0410	13.0914	13.1040	13.0903	13.1434	13.3955	13.0546	13.0745	13.2212	13.6274	15.2154	18.8311	21.7742	252.6326
		PM	0.3079	0.3085	0.3076	0.3074	0.3074	0.3073	0.3068	0.3066	0.3068	0.3063	0.3039	0.3071	0.3069	0.3055	0.3018	0.2896	0.2719	0.2637	5.4230



Pilot policy and measure for Phayathai BTS Station area:

Infrastructure Inspection Factors	Current Status
Width of sidewalk (m.)	3.1-3.5
Sidewalk condition	Excellent
Pleasant & shady surrounding	Moderate
Sidewalk continuity (in 400-m radius)	Uninterrupted throughout the route
Adequate lighting	Visible throughout the route
Safe crosswalk (in 500-m radius)	Available but incompletely
Format of sidewalk	Available on both sides of the road
Handicap ramp	Available
Flat path	Available
Sidewalk roofing	Interrupted
Bikeway	None
Park & bike	None



Phaya Thai BTS Station



NMT connection
with rail transport

Problems prevalent in the area of Phayathai BTS Station There is still a lack in designing of commuting connectivity for pedestrians and bicyclists. A risk-prone area is at Si Ayutthaya Intersection as there are no crosswalk and pedestrian-crossing lights. The pedestrian crossing is instead far away from the intersection and, hence, is seldom used. As such, accident frequently takes place at this intersection. Moreover, bike path is interrupted by railway. No improvement has yet been adequately made in roadway surface, traffic calming equipment and warning equipment for safety purposes. The recommended policy and measure for the area improvement are as follows:

- Some sections of the bike path in this area can be shared with the sidewalk, but the shared-use lanes must be clearly marked.
- The existing smart kiss and ride should be improved by increasing the physical boundary created from, for example, planter boxes or barrier beams in order to enforce passengers and public transport vehicles to orderly wait in the designated areas.
- Problem arising from motorcycle taxis driving on footpath should be solved.
- Commuting in Si Ayutthaya Intersection area can be managed by installing pedestrian-crossing lights and a clear physical boundary and providing curb ramps to enable pedestrians to cross the road in a fast and orderly fashion.

From a micro simulation in the area of Phayathai BTS Station, it is found that air pollution is concentrated in the intersection area on both sides of Phayathai BTS Station. The amount of pollutants is greater in Si Ayutthaya Intersection area than at the junction of Phetchaburi Road. After the area improvement in the simulation, it is obvious that the traffic flow can be improved, particularly in the BTS Station area. In overall, the post-improvement impacts are as follows:

Northbound: CO₂ will be lowered throughout the route, notably in the 200 meters section with the sharpest CO₂ reduction of 1.05 Kg/hour.

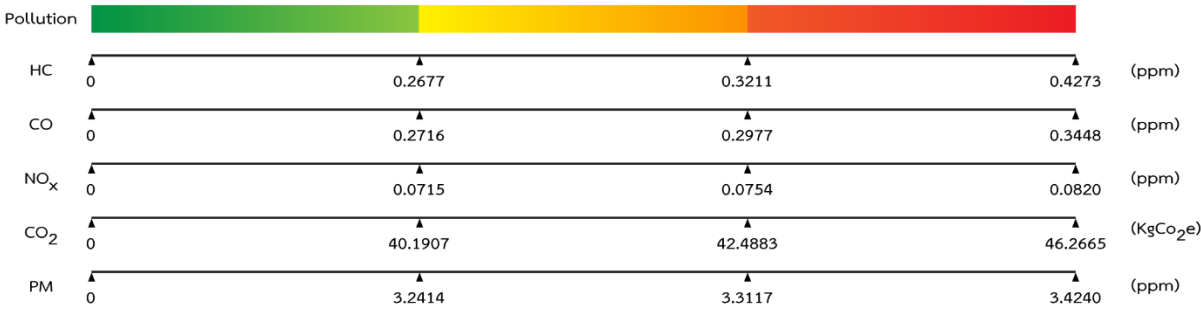
Southbound: Similar to the northbound, CO₂ will be lowered throughout the route, with the sharpest CO₂ reduction in the 500 meters section at a rate of 1.21 Kg/hour



Remark:

Analysis results of emission around BTS Phaya Thai Station

- a) Air pollution is stronger in this section due to heavy and slow traffic from a long queue at the intersection. Area improvement, including efficient traffic light management, will help reduce air pollution in such area.
- b) The long queue of traffic from Phetchaburi Road leads to a high volume of air pollution near Phetchaburi Intersection. Area improvement can ease the air pollution in the said intersection area.

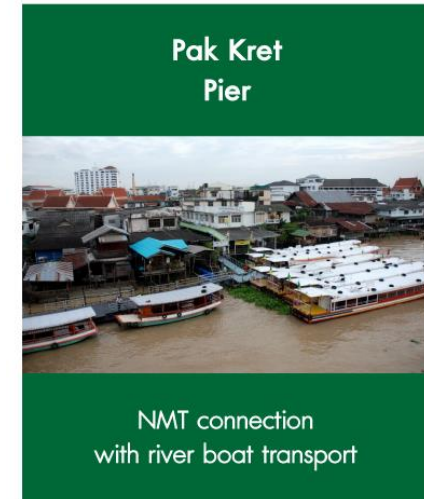


Pollution			50	100	150	200	250	300	350	400	450	500	550	Total
Northbound	without improvement	HC	0.0373	0.0380	0.0381	0.0413	0.0382	0.0382	0.0385	0.0387	0.0411	0.0522	0.1018	0.5034
		CO	0.0778	0.0783	0.0783	0.0807	0.0785	0.0784	0.0786	0.0788	0.0806	0.0884	0.1183	0.9167
		NOx	0.0248	0.0249	0.0249	0.0254	0.0249	0.0249	0.0250	0.0250	0.0254	0.0271	0.0327	0.2849
		CO2	13.4106	13.4853	13.4957	13.8445	13.5126	13.5063	13.5401	13.5657	13.8193	14.9005	18.3236	155.4041
		PM	1.3883	1.3910	1.3913	1.4035	1.3919	1.3917	1.3929	1.3938	1.4026	1.4400	1.5531	15.5400
	with improvement	HC	0.0354	0.0358	0.0358	0.0359	0.0359	0.0361	0.0363	0.0366	0.0383	0.0470	0.0977	0.4708
		CO	0.0738	0.0741	0.0741	0.0743	0.0742	0.0744	0.0745	0.0748	0.0761	0.0822	0.1129	0.8655
		NOx	0.0235	0.0236	0.0236	0.0236	0.0236	0.0236	0.0237	0.0237	0.0240	0.0254	0.0312	0.2694
		CO2	12.7314	12.7764	12.7804	12.7962	12.7883	12.8180	12.8360	12.8742	13.0608	13.9223	17.4628	146.8467
		PM	1.3188	1.3204	1.3205	1.3211	1.3208	1.3219	1.3225	1.3238	1.3304	1.3602	1.4774	14.7378
southbound	without improvement	HC	0.4248	0.3838	0.3542	0.3211	0.3123	0.2984	0.2887	0.2677	0.2557	0.2492	0.2328	3.3888
		CO	0.3448	0.3266	0.3132	0.2977	0.2935	0.2868	0.2821	0.2716	0.2656	0.2623	0.2538	3.1980
		NOx	0.0820	0.0795	0.0776	0.0754	0.0748	0.0738	0.0731	0.0715	0.0705	0.0700	0.0686	0.8167
		CO2	46.2665	44.8594	43.7772	42.4883	42.1298	41.5485	41.1300	40.1907	39.6336	39.3205	38.5114	459.8559
		PM	3.4240	3.3827	3.3505	3.3117	3.3009	3.2832	3.2704	3.2414	3.2242	3.2144	3.1891	36.1923
	with improvement	HC	0.4273	0.3642	0.3531	0.3153	0.3018	0.2843	0.2720	0.2534	0.2442	0.2323	0.2191	3.2570
		CO	0.3436	0.3156	0.3106	0.2931	0.2865	0.2779	0.2718	0.2625	0.2578	0.2516	0.2447	3.1108
		NOx	0.0813	0.0775	0.0768	0.0735	0.0733	0.0720	0.0711	0.0696	0.0689	0.0679	0.0668	0.7987
		CO2	45.8968	43.7173	43.3093	41.4284	41.2839	40.5353	39.9910	39.1366	38.6959	38.1063	37.4297	449.5304
		PM	3.3841	3.3200	3.3078	3.2512	3.2468	3.2239	3.2072	3.1807	3.1670	3.1485	3.1272	35.5643



Pilot policy and measure for Pak Kret Pier area:

Infrastructure Inspection Factors	Current Status
Width of sidewalk (m.)	2.6-3.0
Sidewalk condition	Excellent
Pleasant & shady surrounding	Excellent
Sidewalk continuity (in 400-m radius)	Interrupted
Adequate lighting	Visible in some sections only
Safe crosswalk (in 500-m radius)	None
Format of sidewalk	Available on both sides of the road
Handicap ramp	Available
Flat path	Available
Sidewalk roofing	Interrupted
Bikeway	None
Park & bike	Available



Problems prevalent in the area of Pak Kret Pier It is found that the entrance to Pak Kret Pier is heavily crowded with both vehicles and pedestrians. For pedestrians, the sidewalk is narrowed by street stalls and there are no ramps available for the elderly and the disabled. Moreover, a large number of vehicles are parked on the roadsides and in the area beneath the expressway, which is an obstacle to bikeway development. The recommended policy and measure for the area improvement are as follows:

- The walkway to the pier should be improved for an even level and ramps should be provided where steps occur.
- Sidewalk should be expanded to ensure more convenience and safety and should be at a different level from street stall area and have a noticeable sign so as to prevent sidewalk occupation by vending stalls. Ramps should be provided where there are steps to facilitate commuting by the elderly and the disabled. Crosswalk should be escalated to the same level as the sidewalk in order to slow down vehicle speeds and facilitate walking. Obstructions and caution signs should be provided where the sidewalk intersects with the bikeway/roadway.
- Parking area should be partly allocated and developed as a bikeway. Bicycle lane should be separated from roadway and sidewalk for the safety of cyclists and pedestrians.

From a micro simulation in the area of Pak Kret Pier, it is found that air pollution is concentrated in the intersection area and becomes thinly spread in the area approaching the pier. In view of this, for the sidewalk and bikeway improvement, we seek to allow the least possible occurrence of traffic conflicts in the intersection area by using empty space under the expressway and the original parking space for developing into bikeways. From this project, it is found that:



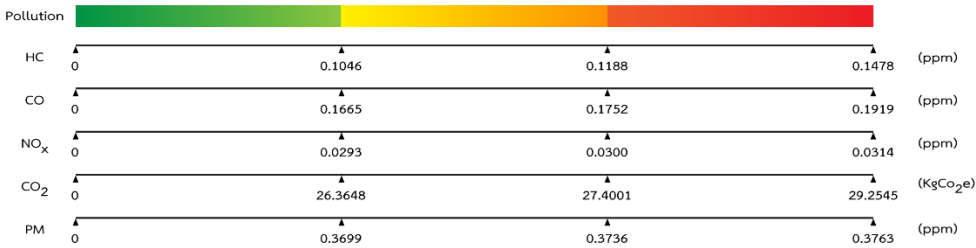
Northbound: CO₂ will be lowered throughout the route, particularly in the 300 meters section with the sharpest CO₂ reduction of 1.26 Kg/hour.

Southbound: CO₂ will be reduced throughout the route by more than 2 Kg/hour, notably in the 150 meters section with the sharpest CO₂ reduction of 2.26 Kg/hour.

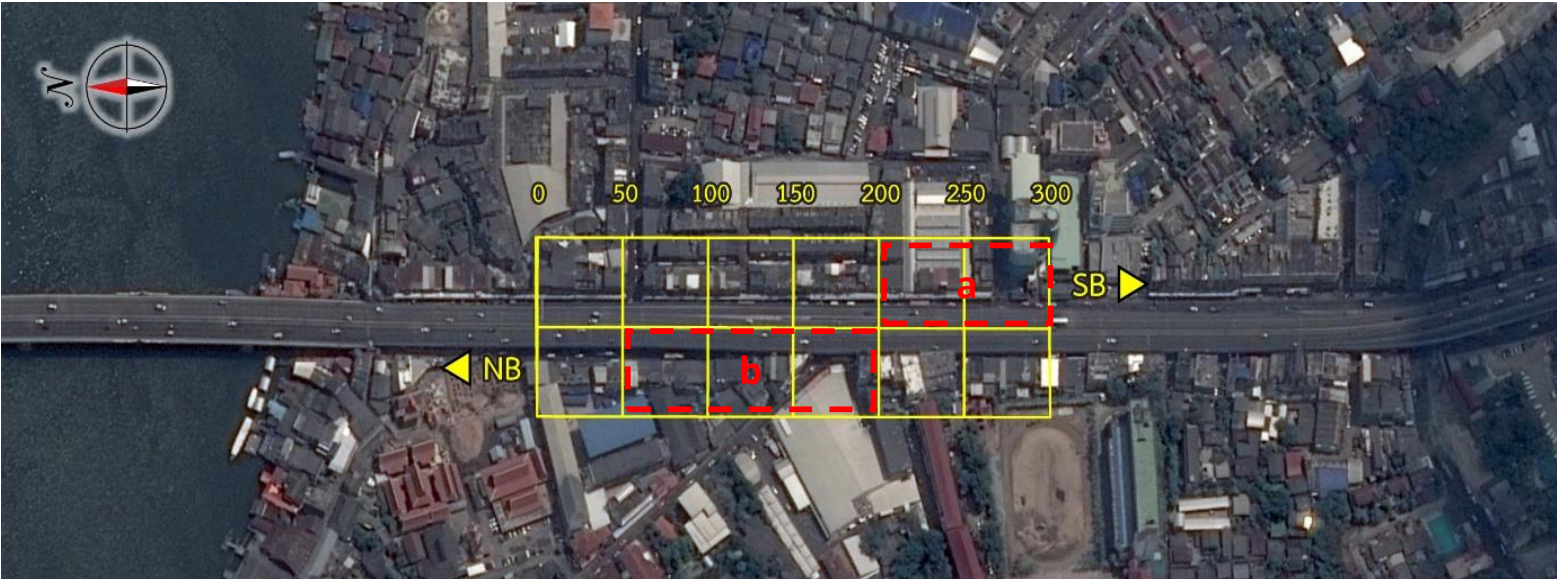


Remark:

- a) The high pollution amount found in the intersection area before entering the pier is caused by slow traffic and queue length. Thus, intersection traffic management will help to improve traffic flow and relatively reduce air pollution in that area.
- b) This is a community area with heavy commuting. A clear boundary should be set forth, particularly where sidewalk, bikeway and roadway intersect, in order to improve commuting flow. Besides, vehicle parking management in such area will, based on this analysis, lead to minimized pollution in the area.



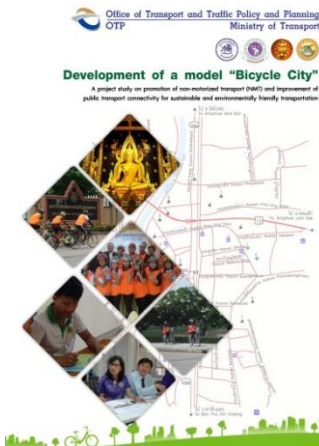
Analysis results of emission around pier Pak kret



Pollution			50	100	150	200	250	300	Total
Northbound	without improvement	HC	0.1046	0.1042	0.1040	0.1188	0.1478	0.1309	0.7103
		CO	0.1665	0.1662	0.1661	0.1752	0.1919	0.1823	1.0481
		NOx	0.0293	0.0292	0.0292	0.0300	0.0314	0.0306	0.1798
		CO2	26.3648	26.3327	26.3221	27.4001	29.2545	28.2104	163.8846
		PM	0.3755	0.3757	0.3757	0.3722	0.3699	0.3699	2.2363
	with improvement	HC	0.1028	0.1020	0.1019	0.1152	0.1347	0.1125	0.6690
		CO	0.1653	0.1648	0.1647	0.1730	0.1845	0.1713	1.0237
		NOx	0.0292	0.0291	0.0291	0.0298	0.0308	0.0297	0.1777
		CO2	26.2269	26.1641	26.1536	27.1473	28.4506	26.9485	161.0910
		PM	0.3760	0.3762	0.3763	0.3730	0.3693	0.3736	2.2444
southbound	without improvement	HC	0.0925	0.0873	0.0891	0.0892	0.0945	0.0785	0.5310
		CO	0.1399	0.1367	0.1378	0.1379	0.1411	0.1311	0.8245
		NOx	0.0242	0.0239	0.0240	0.0240	0.0243	0.0234	0.1438
		CO2	21.9812	21.5986	21.7342	21.7388	22.1205	20.9135	130.0867
		PM	0.3034	0.3046	0.3042	0.3042	0.3030	0.3070	1.8263
	with improvement	HC	0.0823	0.0772	0.0784	0.0798	0.0847	0.0703	0.4727
		CO	0.1255	0.1224	0.1231	0.1240	0.1270	0.1181	0.7402
		NOx	0.0218	0.0215	0.0216	0.0216	0.0219	0.0211	0.1294
		CO2	19.7528	19.3770	19.4646	19.5740	19.9243	18.8388	116.9314
		PM	0.2741	0.2754	0.2751	0.2747	0.2736	0.2773	1.6502



“Summary of recommendations on establishment of a pilot Bicycle City”



We selected “**Phitsanulok Municipality**” as a pilot province for establishing a model “Bicycle City.” Based on the study results, we have devised a bicycle city master plan, aiming to encourage a shift in commuting mode to bicycling and to relatively reduce motorized transportation. We will firstly place the main focus on cycling for tourism and recreational purposes before expanding to bicycling for daily transportation. A bikeway network development plan is divided into four phases, with an estimated total budget of THB 13 million. Details of **Phitsanulok Municipality Bikeway Network Development Plan** are as follows:

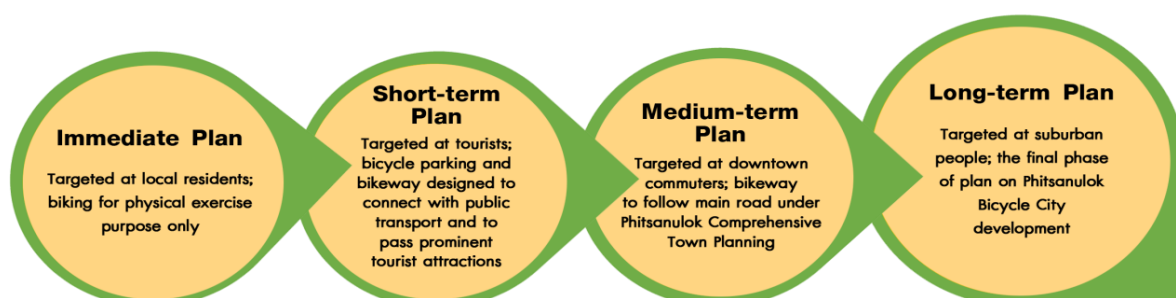
Immediate plan (2016-2018) is formulated based on the pilot bikeway planning of Phitsanulok. Targeted at the local residents, the plan primarily aims to promote bicycling solely for physical exercise, thus having no impact on reduction of pollution in urban areas created by motorized transport. The immediate plan features two bike routes:

- ✓ Bikeway around the city ditch with a length of about 2.20 kilometers on Phra Ruang and Phra Lu Roads in Nai Mueang Sub-district, Mueang Phitsanulok District, Phitsanulok Province;
- ✓ Bikeway around Chomnan Park with a length of approximately 2.30 kilometers in Nai Mueang Sub-district, Mueang Phitsanulok District, Phitsanulok Province.

Short-term plan (2019-2021) is targeted at tourists to Phitsanulok. The main bicycle parking is set to be in the compound of Phitsanulok railway station. The bike route passes tourists spots, with a total length of about 13.22 kilometers. The short-term plan still does not focus on reduction of vehicle use by non-residents such as tourists.

Medium-term plan (2022-2024) will be focused on commuters in the inner part of the city, with the bikeway running along the main road under Phitsanulok Comprehensive Town Planning. In this phase, the bikeway will link a greater number of significant places, having a total length of approximately 24.09 kilometers.

Long-term plan (2025-2027) is targeted at people living outside the urban areas. The ultimate goal of this final phase of the plan to develop Phitsanulok as a bicycle city is to increase commuting volume in downtown areas with traveling less by motor vehicles than by bicycles. Therefore, the key change and success factor of the long-term plan is to encourage people living in the suburban areas to shift their commuting behaviors more towards bicycling, which is the main goal of the long-term plan. In this phase, the bikeway length is approximately 23 kilometers







Results of the study and analysis on efficiency in reduction of greenhouse gas emission and energy consumption as a consequence of bikeway development under the model “Bicycle City” development plan:

In the analysis of a reduction of greenhouse gas emission due to the development of NMT project in Phitsanulok Municipality, we analyzed the project development based on the four phases of the bikeway network development plan. The analysis results suggest that, given development of bikeway under the pilot project and the short-term plan, which are highly feasible in the present circumstances, Phitsanulok Municipality will be able to reduce CO₂ emission by about 65,475 Mt CO₂e or save energy by 31.95 ktoe, representing total benzene consumption reduction of 180 million liters in 2037.

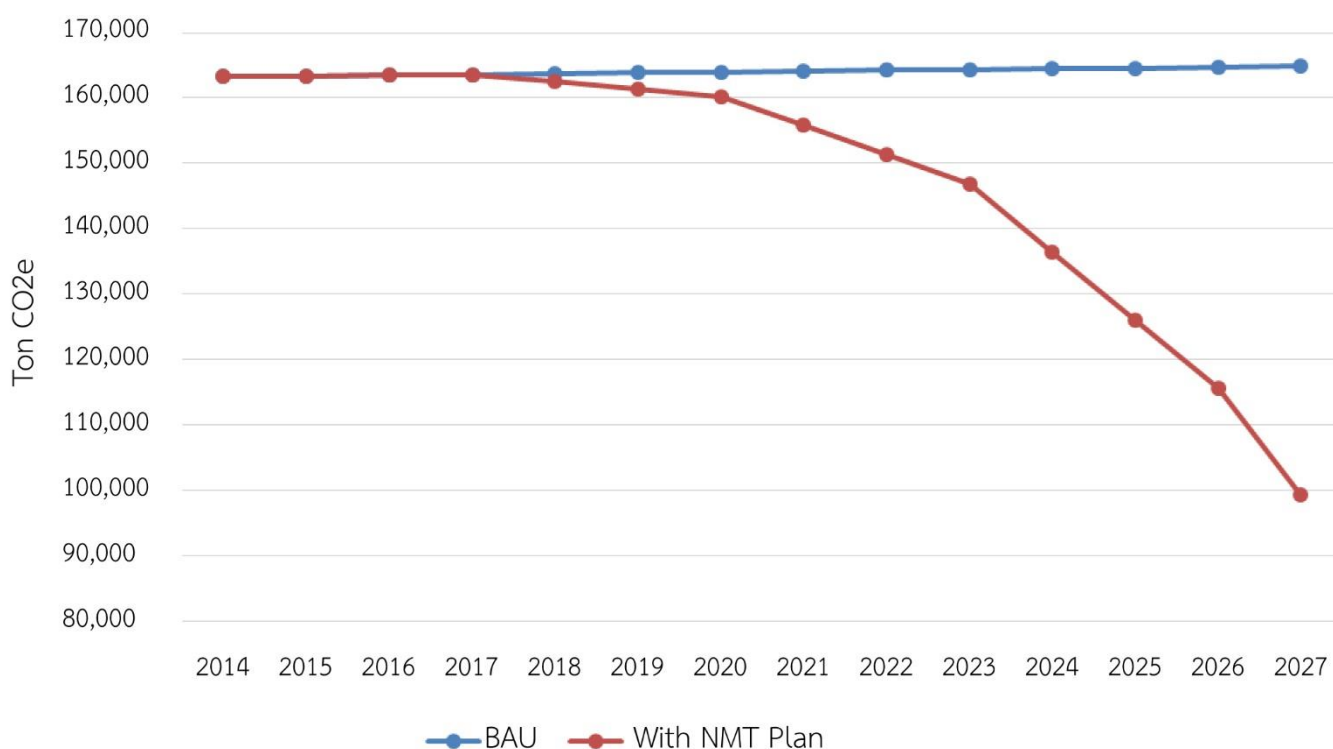


Comparison of CO₂ Volume in Phitsanulok Municipality in Cases of BAU and NMT Plan Implementation

(Unit: Mt CO₂e)

Year	BAU	NMT Plan Implementation
2557	163,236	163,236
2560	163,604	163,604
2565	164,217	151,357
2570	164,830	99,355

Remark: BAU (Business As Usual): Implementation of all three phases of NMT development plan.



Remark: The analysis and forecast are based on assumptions under TEEMP.



“Results of activities in stakeholders’ participation and public relations for project promotion”

We arranged stakeholders’ participation activities during the plan consideration and preparation process in the stage of formulating the designing concept for a pilot project in Bangkok/its vicinities and a model bicycle city in the province. Stakeholders were encouraged to participate in initiating a concept. We also arranged public relations activities to promote a commute by bicycle.

The stakeholders’ participation activities were organized in both Bangkok and the model “Bicycle City.” The activities in Bangkok were performed through an orientation program and a concluding session on the project held among agencies from both the public and the private sectors.



For the bicycle city project, we arranged a brainstorming workshop to come up with a project designing concept with engagement of people and concerned officials in the pilot area.

We additionally implemented public relations programs for project promotion through various forms of media in order to promote and disseminate information about non-motorized mobility, including:

(1) Radio, newspaper and leaflet, as well as advertising board to publicize details of the project, and video to promote NMT

(2) NMT promotion campaign organized in collaboration with OTP through the project, titled “OTP Brings Happiness to Lampang People by Energy Use Reduction and City-Wide Bicycling,” at Khelang Nakhon Public Park, Lampang Province

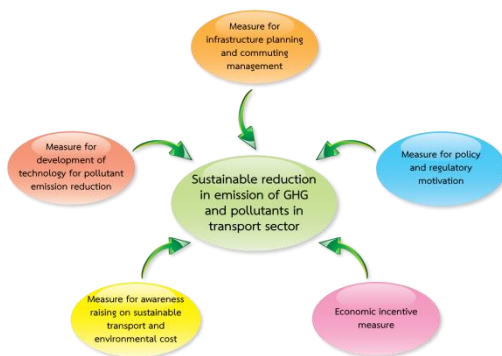
(3) Seminars for knowledge and technology transfer to organizations in Asian countries, including a seminar for knowledge and technology transfer in Asian countries held in Shanghai, the People’s Republic of China, and a seminar for knowledge and technology transfer in Asian countries held in Suwon, the Republic of Korea





“Suggestions on next stage project operation”

“Guidelines on continuous project operation for sustainable transport development”

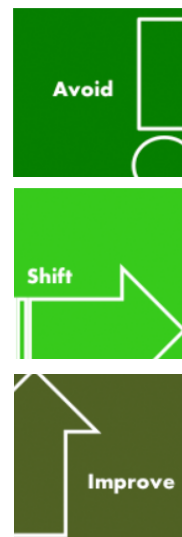


The project study on promotion of NMT and improvement of public transport connectivity for sustainable and environmentally friendly transportation is one of the projects aiming to develop a sustainable transport system. There are five measures for achieving sustainable transport system development, as follows

1. Measure for infrastructure planning and commuting management

This measure helps to develop an efficient transport system that can contribute to strong and sustainable economic expansion, consisting of

- **Avoid/Reduce:** A policy to encourage people to avoid or reduce unnecessary commutes by means of appropriate integration of town planning with transport planning such as promotion of poly centric development, land development around a mass transit station, etc.
- **Shift/Maintain:** A policy to encourage people to shift away from private vehicles to other higher efficiency and environmentally friendly travel modes such as public transport, bicycling, walking, etc.
- **Improve:** A measure to develop vehicles and improve vehicle efficiency out of their existing structure by employing energy saving technology, alternative energy, and so on.



From the overall project operation, it is evident that the project on promotion of NMT and improvement of public transport connectivity for sustainable and environmentally friendly transportation has the main objective that is consistent with the **Shift/Maintain** measure. Given, however, that the project finally does not become as successful as expected, the approach to other project that promotes other measures may be implemented simultaneously. For instance, the **Improve** measure could also be adopted by promoting the use of electric bicycle potentially among the group of people who dislike pedaling, or are unable to pedal, a bicycle. The project may provide support for electric bicycle purchase through pricing and spare part support. Furthermore, transport connectivity development or area development that will lead to the least volume of commuting, or the **Avoid** measure, could be another alternative to indirectly promote non-motorized transport. Once the commuting distance of local residents has been minimized, they may find the NMT an attractive choice and relatively shift to this travel mode



2. Measure for policy and regulatory motivation



This measure is the key approach to implementing the NMT master plan and the model bicycle city master plan. It helps to stimulate commuters to travel less by private cars and to shift more to public transport. Among the measures adopted are car-free zoning, car use control based on license plate numbers, a promoted use of efficient car engines, regular vehicle check-up and maintenance, etc.



3. Economic incentive measure

This is a mechanism for fee or tax collection to make a possession or use of vehicles more costly and also for providing a subsidy to those traveling by public transport. By so doing, commuters will be motivated to travel by mass transport or other eco-friendly modes rather than by private cars. The measures include parking fee

control/collection, road user charges during rush hours, higher tax rates levied on highly polluting vehicles, mileage-based vehicle insurance premium charges, subsidy for public transport commuters, etc.



4. Measure for awareness raising on sustainable transport and environmental cost

This measure is instrumental in enhancing people's knowledge and understanding about the importance and necessity of sustainable transport development and will play a pivotal part in making other measures practicable and acceptable with people's cooperation, including the car-free day event, bicycle rental/lending program in urban areas, walking street project, and promotion of environmentally friendly driving.

5. Measure for development of technology for pollutant emission reduction

Under this measure, the technology for engine, fuel, car assembling equipment, and intelligent transport and traffic system (ITS) is used for vehicle quality upgrade to increase energy efficiency and reduce pollutants from exhaust emission, and also for commuting management. Moreover, technology is used to increase convenience for commuters and facilitate traffic flow for pollution reduction, comprising promotion of eco-friendly cars (hybrid, electric or fuel cell vehicles), traffic information for drivers, parking guidance system, etc.



Apart from the continuous project operation according to the proposed master plan under this project, the improvement and increase of projects to support other measures as discussed above are also crucial to a success in the endeavor to achieve sustainable transport development.



“Guidelines on continued project operation”

Based on our project operation experience, there is still demand for further study and operation in various aspects that should be continuously supported and pushed for. They include, among others, demand for use of the project output for continuous development. Such demand was recognized during the course of this project study. The recommended areas of additional study and development are as follows:

1. Ongoing development of the bicycle city

From the results of the project study on promotion of NMT and improvement of public transport connectivity for sustainable and environmentally friendly transportation, one of the achievements and the knowledge acquired is the study of model “Bicycle City” development, the major outcome of which includes knowledge, guideline and procedure for study and development of bikeways in other provinces. The guideline and model so derived consist of:

- Approach to data compilation for bikeway planning and development
- Approach to a study and planning on bikeway development
- Format of arrangements for community hearing (about map)
- Approach to and format of planning on public relations and promotion of bicycling

Apart from the above-mentioned planning guideline and format, the experience and lesson learned from the formulation of the model “Bicycle City” master plan of Phitsanulok Municipality help to ensure the project’s readiness for more efficient operational development in the future. Thus, it is recommended that an ongoing project operation in bikeway development in other areas should be taken into consideration due to preparedness in terms of both knowledge and experience. It is further recommended that the bikeway development project planning may preliminarily be expanded to two target areas. One is a group of tourist destination cities and the other is a group of provinces that are crucial to the country’s infrastructure development such as cities located on the dual-track railway route or the target provinces where high-speed train stations will be located.

2. Translation of the transport connectivity development master plan into practice

In addition to the model “Bicycle City” development, the implementation of measure/policy for public transport connectivity development in Bangkok and its vicinities has resulted in an outlining of immediate, short-term, medium-term and long-term development plans as a guideline for further support and pushing up on a detailed study and budgeting. As such, the support and pushing up of the said plan to be translated into practice is another critical mission that should be continuously carried on in line with the established future plan.

3. Development of a systematic NMT database

In the sustainable transport development process, one of the key elements that has been overlooked is a transport and traffic monitoring and database system, especially for project success measurement. In this project study, we have made a survey, analysis and forecast on CO₂ emission in case of BAU compared with NMT plan implementation. Despite that, in the ongoing phase of the project, there should be a planning on continuous data collection, which is crucial and needs to be coordinated by agencies from all concerned sectors to ensure that data are available on



a continuous and standardized basis for an accurate analysis of the project success and also for a study on future planning.

In the database development, there should be a study and designing of appropriate and essential data compilation and a guideline on data use for an analysis with respect to designing and continuous development planning and analysis of CO₂ emission volume both before and after project implementation.

Aside from the data and analytical approach recommended to be additionally studied and developed, all fundamental factors for CO₂ emission analysis should be studied and formulated into standard principles to be commonly applied across the country and should be acceptable and consistent with international standards. These factors include, for instance, a suitable multiplier of CO₂ emission from vehicles that should be stipulated as a standard factor applied to all projects and by all agencies nationwide. Currently, the applicable multiplier is varied and referenced from different sources. Some projects use the IPCC standard, while OTP has developed a multiplier from the project study to devise a master plan on sustainable transport development and climate change solution. This, however, is deemed as a crucial issue that needs prior approval from concerned authorities before being adopted as a standard factor. Standardization of such factor is indispensable, if the government intends to concretely put in place the Measure, Report and Verification or MRV process in the transport sector.

4. Pushing for an amendment to laws and measures for NMT promotion

One of the project study results is the outcome of a review of NMT-related laws and measures. The study, as presented in Chapter 2, reveals that some of the laws, measures and standards relating to or promoting NMT still do not fully cover this issue or are not strictly or seriously applied. Accordingly, to push for an amendment to the NMT-related laws, measures and standards is considered to be another mission that should be carried out in the ongoing project implementation. The process to push for the said legislation amendment is a sensitive issue and needs to be supported by all concerned sectors.

5. Study on a sound and effective campaigning approach for Thailand

Similar to the outcome of the study on relevant laws, measures and standards, there was, under this project study, a review of some sample measures and activities in NMT promotion campaigning, notably a campaign on bicycle culture overseas. Among the measures implemented are indirect promotion activities such as an event to build up familiarity with and positive attitude towards non-motorized mobility and direct promotion activities such as a parade or festival to campaign for cycling demand in a community. It is apparent that besides the guideline on infrastructure development and law enforcement, a guideline on campaigning, promotion and raising of awareness and positive attitude towards NMT is also a crucial element. Thailand still needs a study on approach to or method of proper campaign for low-carbon society development so as to institute a definite and systematic guideline for the responsible parties. The study may be conducted through an actual experiment or a brainstorming among those who have experience in bicycle city development or community development.

6. Study and development of technology for NMT and public transport promotion

The development of technology for NMT and public transport promotion in this section has a different objective from the “measure for use of technology for pollutant emission reduction” earlier discussed in Item 9.2.1.



The development of technology for NMT and public transport promotion may concern with promotion of non-motorized mobility and commuting by public transport through the following technologies:

- A mobile application which allows users to walk and jog with fun (such as a program that records number of walking steps on each day and converts them into the energy burned)
- A data program to support planning and commuting by public transport

Creation of an online social network for an exchange of information on traveling, bicycle use, and approach to continuous development from system users