



# Summary for Policy Makers

## Economic Analysis of Climate-Proofing Investment in Road and Rail Transport Sectors (Investment and Financial Flows Assessment)

### UNDP Thailand/NDC Support Project: Delivering Sustainability through Climate Finance Actions in Thailand (NDC Support)

To  
United Nations Development Programme  
(UNDP)

By  
National Energy Technology Center (ENTEC)



+ UNDP's  
Core Donors

## List of Abbreviations

BAU	Business as usual
BB	Bureau of the Budget
BOI	Office of Board of Investment
BOT	Bank of Thailand
CBA	Cost-Benefit Analysis
CFE-DM	Center for Excellence in Disaster Management and Humanitarian Assistance
CGD	Comptroller General's Department
CIF	Climate Investment Fund
CoP	Conference of the Parties (to the UNFCCC)
DDPM	Department of Disaster Prevention and Mitigation
DOH	Department of Highways
DMC	Disaster Management Center
DPM Act	Disaster Prevention and Mitigation Act 2007
DPSIR	Driving Force-Pressure-State-Impact-Response Framework
DPT	Department of Public Works and Town & Country Planning
DRM	Disaster Risk Management
DRR	Department of Rural Roads
EHIA	Environmental and Health Impact Assessment
EIA	Environmental Impact Assessment
ETS	Emission Trading System
FF	Financial Flows
FTI	Federation of Thai Industries
GCF	Green Climate Fund
GEF	Global Environment Facility
GHG	Greenhouse Gas
HDPE	High-Density Polyethylene
I&FF	Investment and Financial Flows
IF	Investment Flows
INDC	Intended Nationally Determined Contribution
LAO	Local Administrative Organization
LEDS	Low Emission Development Strategy
LT-LEDS	Long-Term Low Emission Development Strategy
MOF	Ministry of Finance
MSE	Mechanically Stabilized Earthwall
MNRE	Ministry of Natural Resources and Environment
NAMA	Nationally Appropriate Mitigation Action
NAP	National Adaptation Plan
NDC	Nationally Determined Contribution
NESDB	Office of the National Economic and Social Development Council
O&M	Operation and Maintenance
OECD	Investment Framework for Green Growth
ONEP	Office of Natural Resources and Environmental Policy and Planning
OTP	Office of Transport and Traffic Policy and Planning
PISU	Private Investments in State Undertakings
PPP	Public-Private Partnership
RID	Royal Irrigation Department

SCCF	Special Climate Change Fund
SDGs	Sustainable Development Goals
SEC	Securities and Exchange Commission
SEP	Sufficiency Economy Principle
SEPO	State Enterprise Policy Office
SLB	Sustainability-linked Bond
SRT	State Railway of Thailand
TD	Treasury Department
TGO	Thailand Greenhouse Gas Management Organization
TMD	Thai Meteorological Department
UNFCCC	United Nations Framework Convention on Climate Change

## Executive Summary

Climate change has emerged as a critical threat to the world, and countries have been searching for ways to implement countermeasures to mitigate its consequences and adapt to the changes. Climate-proofing countermeasures generally require significant investment and an enabling financial mechanism. In Thailand, transportation sector has a great potential in reducing the greenhouse gas emission and has played an important role in addressing the threat. On the other hand, the sector itself is prone to climate change impacts, and suffered a number of climate events, though there has not been a concrete national strategy or action plan for climate-proofing investment in the sector. Under the UNDP Thailand/NDC Support Project: Delivering Sustainability through Climate Finance Actions in Thailand, a cost-benefit analysis (CBA) of climate-proofing investments in particular roads and rails at risk was performed, and the selected countermeasures were proved economically feasible with high benefit-cost ratio and short payback period. However, CBA delivers insights only for specific cases, and it calls for an alternative tool to deliver a bigger picture of the climate-proofing investment in the transportation sector in Thailand.

Investment and financial flows (I&FF) assessments, which can provide information on existing and required investment, as well as necessary changes and increases in investments, is performed, targeting climate adaptation countermeasures in the transportation sector in Thailand. These assessments consider all roads under the purview of the Department of Highways (DOH) or the Department of Rural Roads (DRR) and all rails responsible by the State Railway of Thailand (SRT). The baseline scenario and adaptation scenarios are determined following the UNDP guidelines. The baseline scenario includes general and planned emergency investments by government on roads through DOH and DRR, and on rails through SRT. Unfortunately, since climate related investment in transportation sector have not been distinguished from other investments, government investment and financial flows are forecasted based on average total budget in the past. The scenario also includes funding under the public private partnership (PPP) scheme, and foreign loans and aids. Literature review shows that Thailand has a clear policy direction and a detailed plan for climate mitigation in all relevant sectors, though the information on adaptation targets and plans is limited, and it is nearly nonexistent for the transportation sector. Therefore, rather than determining a specific adaptation scenario, this assessment proposes a matrix of possible and viable climate adaptation countermeasures along with their resulting investments, and target roads and rails that are prone to climate change impacts being classified into tiers. The matrix is consulted with key stakeholders including the Office of Transport and Traffic Policy and Planning (OTP), DOH, DRR, and SRT to determine the reasonable total investment to be used for the development of investment and financial flows of the adaptation scenario. For both scenarios, two different timeframes are adopted based on the milestones in the NDC, namely 2022 – 2030 (progressive adaptation case) and 2022 – 2050 (moderate adaptation case).

In the course of the selection of climate-proofing countermeasures, technical and political viability is thoroughly inspected. Technically and economically viable countermeasures for roads are: drainage system improvement, ditch lining, installation of box culverts, laying the road higher, asphalt concrete resurfacing, and mechanically stabilized earthwall (MSE). Viable countermeasures for rails are: installation of box culverts, construction of a steel or concrete bridge, sleeper replacement, and ballast refill. The unit price of each

countermeasure is also estimated. In order to evaluate political viability of the investment, a map of involved stakeholders is developed. Based on the map, issues that may arise from political and social perspectives are identified, including construction right and ownership of target sites, political and regulatory risks, cooperation with local administrative organizations, project delay, public acceptance and competing benefits, and patronage or clientelistic relation between politicians and citizen.

In order to formulate the aforementioned climate-proofing investment matrix, criteria for the selection of target roads and rails are established. Target roads are those owned by DOH and DRR and located near a canal or a river. Target rails should either be close to a mountain or run perpendicular to a waterway. Target roads are classified into three tiers: tier 1 includes one- and two-digit national highways, tier 2 includes three-digit national highways, and tier 3 includes four-digit national highways and all rural roads. Target rails are classified into two tiers: tier 1 covers Northern, North-eastern, and Southern lines, and tier 2 covers Eastern and Maeklong lines. The matrix can then be developed by matching the categorized countermeasures with the classified roads and rails and identifying the total investment corresponding to the combination of each countermeasure and each tier into each cell.

The matrix is presented individually to OTP, DOH, DRR and SRT to select the appropriate scope of investment. It is suggested that road countermeasures should be applied only to tiers 1 and 2 roads. Only MSE should be implemented to all target roads, while drainage system improvement, ditch lining, installation of box culverts, and road leveling and resurfacing are assumed to be applied only to 5% of the target roads. For target rails, only the installation of box culverts and the construction of a steel or concrete bridge are assumed to be applied to tier 1 rails. Table S1 and S2 shows the estimated investments for climate adaptation in roads and rails, respectively. Total investments for climate adaptation in roads and rails become 13.1 and 0.4 billion THB, respectively.

Table S1 Matrix for climate adaptation investment on road infrastructures (million THB)

Tier	Flood management		Flood avoidance		Structure reinforcement
	Drainage system improvement	Ditch lining	Water passage (box culvert)	AC resurfacing & laying the road higher	Mechanically stabilized earthwall
1	420	11	4	112	2,426
2	1,427	37	13	379	8,238

Table S2 Matrix for climate adaptation investment on rail infrastructures (million THB)

Tier	Flood management	
	Water passage (box culvert)	Water passage (concrete bridge construction) and water passage (steel bridge construction)
1	332	110
2	N/A	N/A

The cumulative discounted investment flow (IF), financial flow (FF), and operation and maintenance (O&M) cost estimates by investment type, investment entity, and funding source of the baseline scenario are then developed. Figures S1 and S2 show the estimates for progressive adaptation case and moderate adaptation case, respectively. Figures S3 and S4 show the annual IF, FF, and O&M estimates. The investments from domestic governmental organizations, i.e., DOH, DRR, and SRT, are substantially larger than international loans/aids or investment from private corporations through public-private partnership (PPP). Since Thailand heavily relies on road transportation, cumulative IF, FF, and O&M estimates of DOH and DRR are significantly larger than those of SRT. Emergency budgets planned for unexpected climate events are several orders smaller than the total budget. Yet the emergency budget can be hidden in other budget items which makes it impossible to distinguish it from the total budget. In addition, in an event of a devastating disaster, such as the 2011 Thailand floods, a separate emergency budget is approved by the cabinet to be used for the aftermath. Therefore, the small amount of the emergency budget does not necessarily mean that the actual emergency expenses are small.

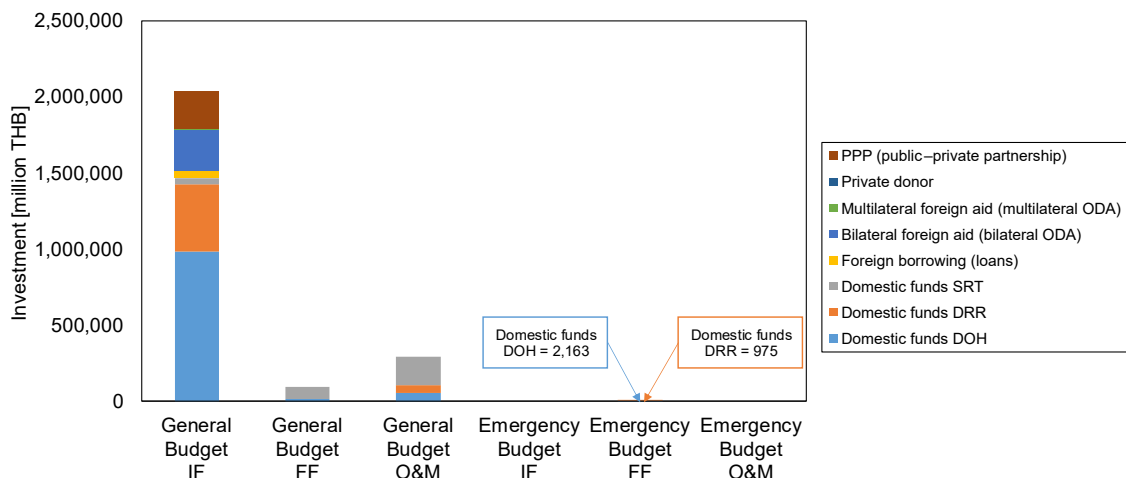


Figure S1 Baseline scenario: cumulative discounted IF, FF, and O&M estimates by investment type, investment entity, and funding source (progressive adaptation case)

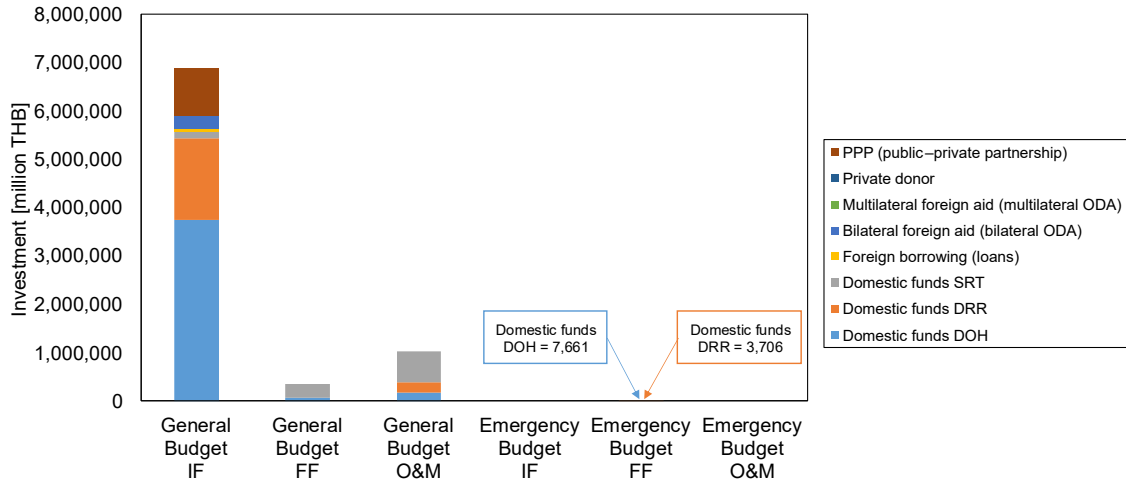


Figure S2 Baseline scenario: cumulative discounted IF, FF, and O&M estimates by investment type, investment entity, and funding source (moderate adaptation case)

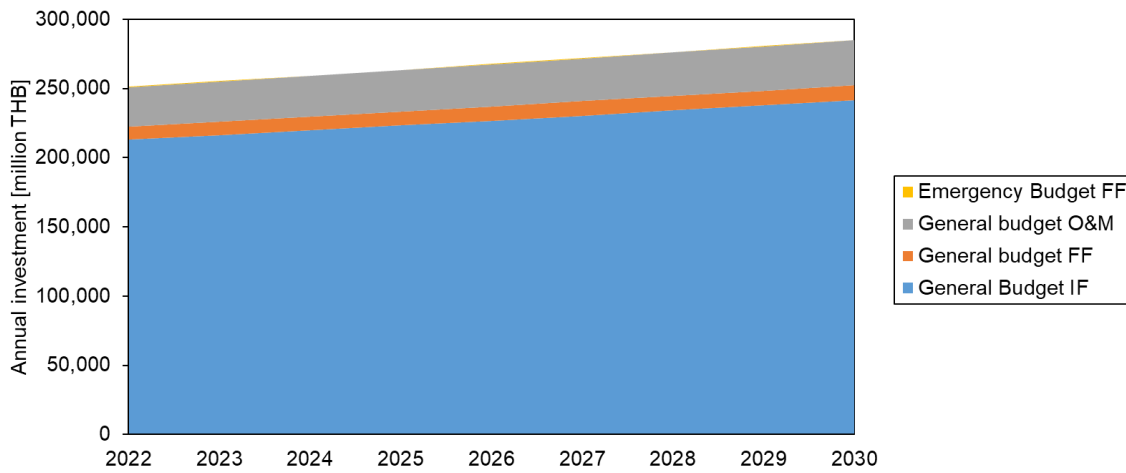


Figure S3 Baseline scenario: annual IF, FF, and O&M estimates by investment type (progressive adaptation case)

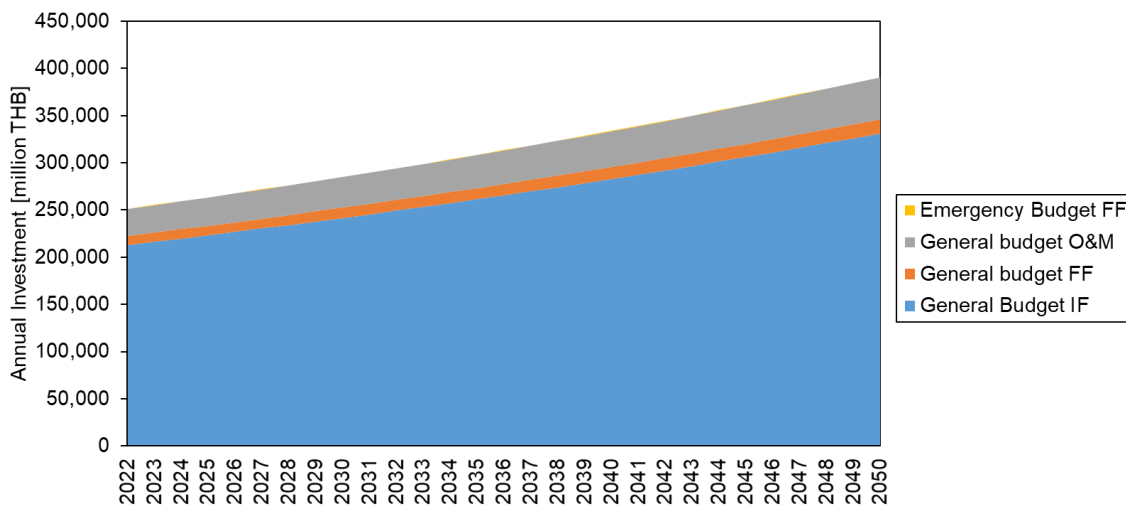


Figure S4 Baseline scenario: annual IF, FF, and O&M estimates by investment type (moderate adaptation case)

Taking into account the investment on climate-proofing countermeasures based on consultation with OTP, DOH, DRR, and SRT, the cumulative discounted investment flow (IF), financial flow (FF), and operation and maintenance (O&M) cost estimates by investment type, investment entity, and funding source of the adaptation scenario are developed. Figures S5 and S6 show the estimates for progressive adaptation case and moderate adaptation case, respectively. Figures S7 and S8 show the annual IF, FF, and O&M estimates. The total investment on climate-proofing countermeasures is smaller than the general budget by one to two orders, and the emergency budget is smaller than the investments in countermeasures by an order. Gradual decrease of the emergency budget is illustrated in Figures S7 and S8. Note that the decrease in the moderate adaptation case is much slower than the progressive adaptation case. The total investment on climate adaptation countermeasures is stretched to the period of 2022 – 2050 in the moderate adaptation case, which is the reason to the smaller annual IF, FF and O&M estimates.

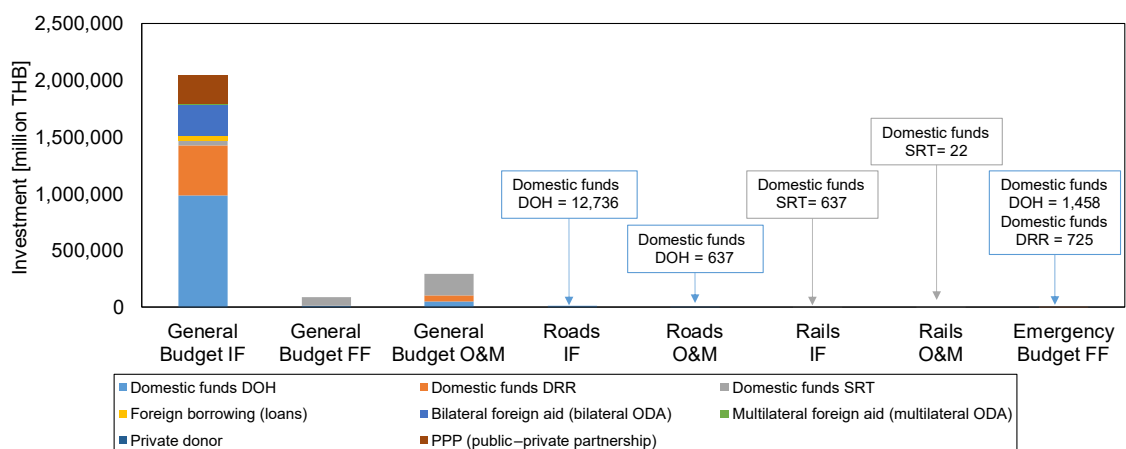


Figure S5 Adaptation scenario: cumulative discounted IF, FF, and O&M estimates by investment type, investment entity, and funding source (progressive adaptation case)

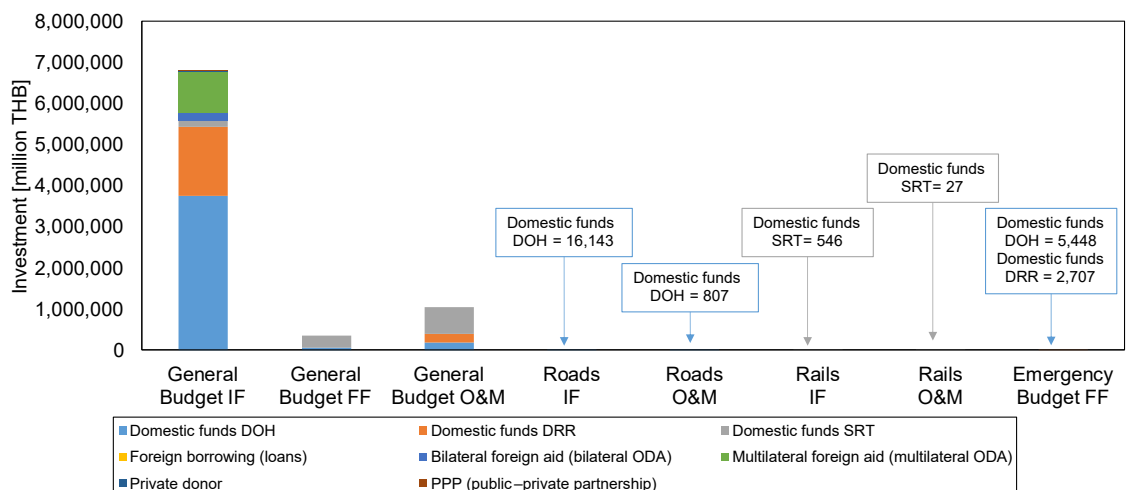


Figure S6 Adaptation scenario: cumulative discounted IF, FF, and O&M estimates by investment type, investment entity, and funding source (moderate adaptation case)

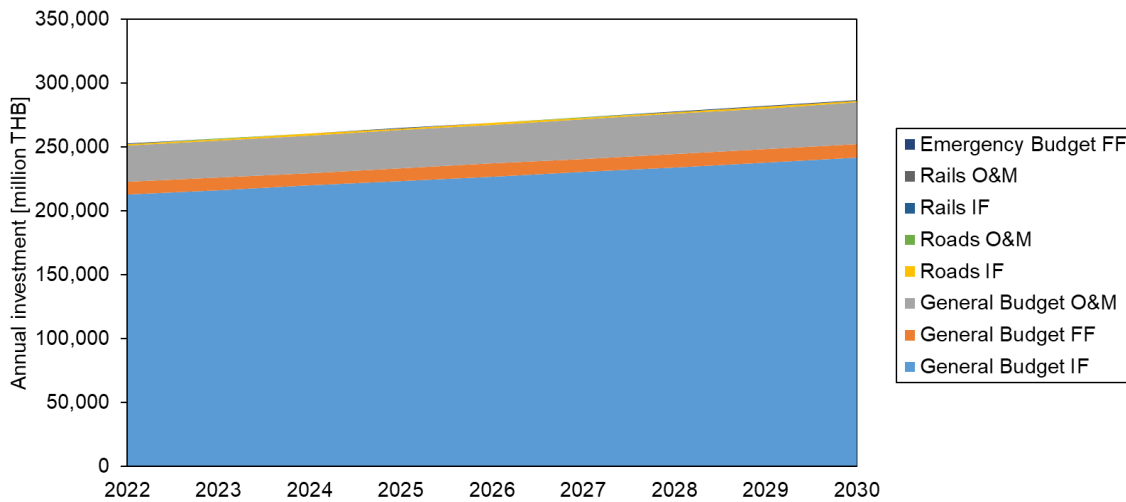


Figure S7 Adaptation scenario: annual IF, FF, and O&M estimates by investment type (progressive adaptation case)

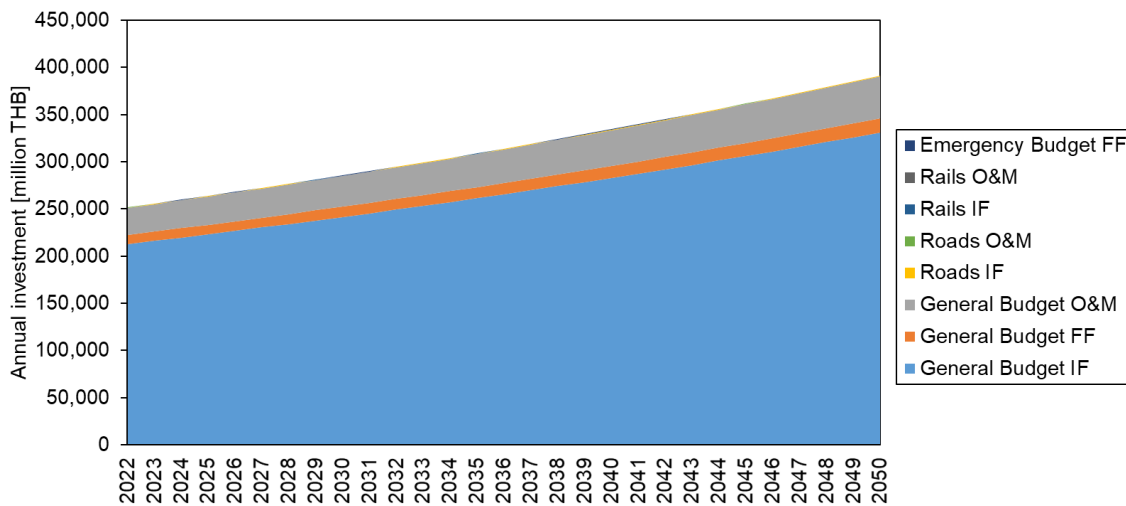


Figure S8 Adaptation scenario: annual IF, FF, and O&M estimates by investment type (moderate adaptation case)

Finally, the incremental investment can be obtained by subtracting annual IF, FF, and O&M estimates of the baseline scenario from the adaptation scenario. Incremental annual IF, FF, and O&M estimates by investment type of progressive adaptation case and moderate adaptation case are shown in Figures S9 and S10. General budgets are balanced out, the investments on climate-proofing countermeasures remain, and the emergency budgets return negative values. In the moderate adaptation case, the incremental annual investments are smaller, and the decreases in emergency expenses are slower. However, with increasing intensity of climate change, the non-quantifiable emergency expenses might significantly increase. In total, approximately 13 – 14 billion THB is additionally needed to enhance the climate adaptability of the transport infrastructure.

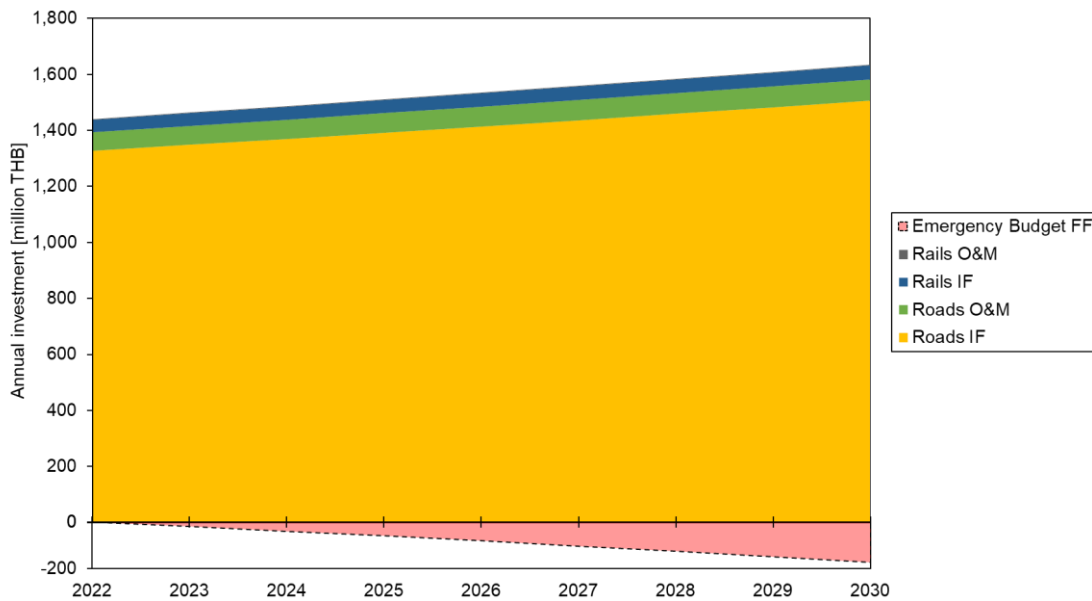


Figure S9 Incremental annual IF, FF, and O&M estimates by investment type (progressive adaptation case)

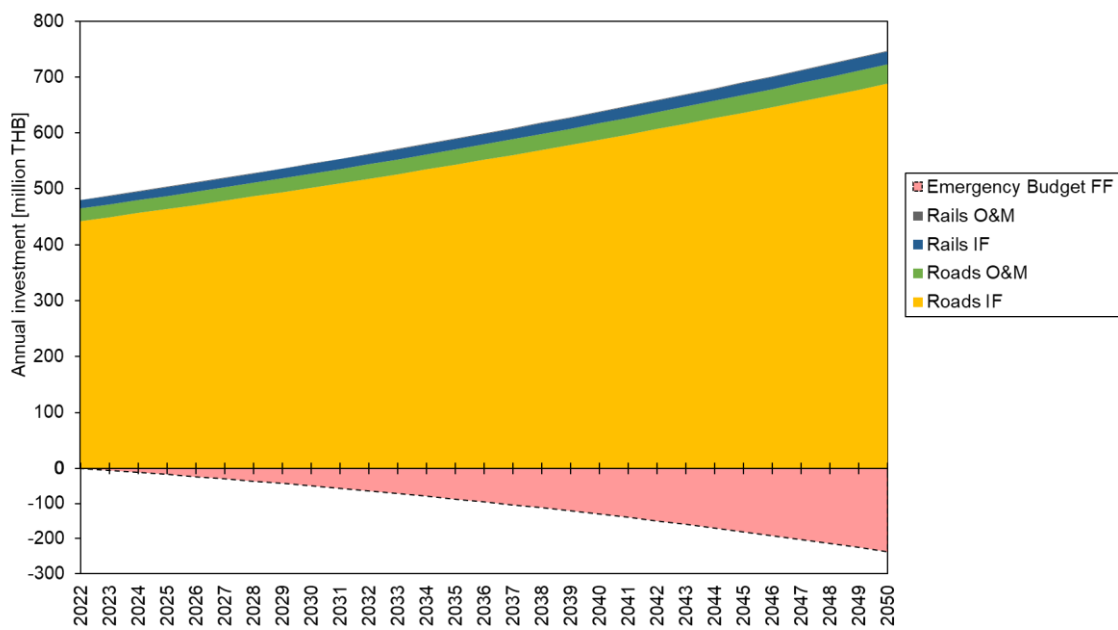


Figure S10 Incremental annual IF, FF, and O&M estimates by investment type (moderate adaptation case)

Since the annual government investment budget allocated for DOH, DRR, and SRT is much larger than the annual investment and operation and maintenance expenses for the proposed climate adaptation countermeasures, it would not be very difficult to allocate budget to climate adaptation investment once the relevant stakeholders realize the necessity and the benefits from the investment. In addition, there are several policy options to facilitate and accelerate government investment. Carbon tax is a means adopted by many countries to receive revenue in terms of tax from greenhouse gas emitters and use it to invest in climate change mitigation and adaptation. Besides, if climate adaptation investments can be included as a part of the carbon credit scheme, or if we can establish a separate scheme similar to it, the private sector will be able to contribute to climate adaptation in the transportation sector.

The private sector can also play a vital role in climate adaptation investment, especially when the government provides incentives to expedite private investment, which can be in terms of financial incentives or tax exemptions. Sustainable banking, sustainable financing, and sustainability-linked bonds can further facilitate the investment. Furthermore, private sector can join hands with government to invest on climate adaptation via Public-Private Partnership (PPP) scheme. Another option that would support government green investment is international funds. However, it should be noted that recent funding concentrates on low-income economies while Thailand is categorized as an upper-middle income economy.

In short, this assessment identified target roads and rails classified into tiers as well as climate adaptation countermeasures. It pointed out the possible required investments and their flows, involved stakeholders and the way they interact, and the policy options to enable and facilitate the investment. The next step would be to motivate the stakeholders to actually invest on climate adaptation. Meetings or workshops to urge other indirect stakeholders' awareness on the importance of climate adaptation investment and the necessity of timely implementation of the countermeasures are needed. Hands-on activities to deepen the understanding on the countermeasures, the ways to facilitate the investment, and the ways to successfully implement the countermeasures and sustain the resulting infrastructure are also required. In addition, studies to thoroughly explore domestic funding entities and mechanisms that can contribute to climate-proofing investments, as well as to identify external funding that can be obtained from private sector or international funds should be conducted. Further meetings or workshops to discuss the plausible climate-proofing investment model that suit the economic, political, and societal contexts of Thailand, along with discussion on how to actually acquire the funds for climate-proofing investment is also recommended. Finally, a pilot project to explore the practicalities of different climate adaptation countermeasures and their applicability to selected target roads or rails and estimate the actual expenditure on those countermeasures needs to be carried out to validate the results of this investment and financial flows assessment.