# DECARBONIZATION PATHWAY IN THAILAND's TRANSPORT SECTOR TOWARD 2050

Piti Pita[1], Pornphimol Winyuchakrit[1], Bundit Limmeeechokchai[1], Hanaoka Tatsuya[2]

[1]Sirindhorn International Institute of Technology, Thammasat University, Thailand

[2]National Institute for Environmental Studies, Tsukuba, Japan

## INTRODUCTION

Increasing average global surface temperature causes natural catastrophic effects; glacial retreat, arctic shrinkage, precipitation change, sea level rise, extreme weather and La Niña and El Niño, called the global warming effect. This effect is driven by increasing greenhouse gas emissions (GHGs), concerned both developed and developing countries. The problems are not unrecognized only at this moment, but these have been tackled for a long period also. Thus, all nations desire to find suitable decarbonization pathways.

The global emissions, reported by 194 countries, increased from 33.82 Gt $CO_2$eq in 1990 to 48.28 Gt $CO_2$eq in 2013 (CAIT, 2017). This resulted in increasing average global surface temperature by 0.6°C during the same period (NASA, 2014). However, as reported in transport information from one-third of the countries, emissions in the transport sector was about 3.93 to 6.17 Gt $CO_2$eq in 2000 to 2013, respectively (CAIT, 2017).

In Thailand, the transport sector was the largest energy consuming sector, accounted for more than 40 percent of total energy consumption. Generally, the transportation mode consists of road, air, water and rail. In Thailand, roads, which contributed almost 80 percent of energy consumption in the transport have been a major transportation mode. Road transport is divided into passenger and freight. Regarding the energy statistic information during 2000 to 2013, the consumption in passenger was more than 60 percent of the energy consumption in road transport. In the emission aspect, Thailand's third biennial update report reported that the transport sector was the second largest emission source. Although the share of emissions in this sector had decreased from 51.54 percent in 2000 to 50.64 percent in 2016 due to important role of biofuels implementation since 2003, the emissions had increased from 47.86 Mt $CO_2$eq to 68.26 Mt $CO_2$eq, and accounted for 2.24 percent of AAGR during the same considered period.

## OBJECTIVES & SCOPES

The transport sector is one of the important contributors of GHG emissions. For all the above reasons, implementation of emissions reduction in this sector, especially in the road transport, is a significant endeavor that can help to prevent increasing the average global surface temperature. However, the questions are how mitigation measures or mitigation policies are appropriate for reducing GHG emissions in the road passenger transport. Therefore, this study aims at formulating decarbonization pathway scenarios of Thailand's road transport. The studied period for GHG mitigation by the AIM/EndUse is 2015-2050. This study assesses the potential of GHG mitigation by the use of renewable energy and energy efficiency in Thailand's NDCs and identifies advance technologies and fuel substitution in the road transport sector in order to achieve the 2.0°C global climate target.

## METHODOLOGY

This study assessed three main scenarios. Firstly, the BAU scenario is formulated as the base case. Secondly, the 2D2050 and 1.5D2050 scenarios are formulated to understand the level of GHG emissions that Thailand's transport sector should endeavor to achieve in order to meet the Paris Agreement's goal. Finally, the extended NDC scenario or the ExNDC2050 scenario comprises many mitigation measures, for example electric (EV100) and bio-fuel substitution (BE100) during 2030-2050 that will push the GHG reduction level to achieve the 2-degree or 1.5-degree targets. The important assumption for technical model setting within this scenario is its steady share, continuing from the share setting in the base year (see Table 1).

**Table 1** The assumption for technical model and service demand setting

| Scenario | Share of service demand setting | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Historical | | | NDC period | | | Extended NDC | | | |
| | 2005 | 2010 | 2015 | 2020 | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
| **BAU** | Current account | | | Constant after 2015 | | | | | | |
| **ExNDC2050** | Current account | | | NDC target | | | Constant after 2030 | | | |
| **EV100** | | | | | | | 25 | 50 | 75 | 100 |
| **EB100** | | | | | | | 25 | 50 | 75 | 100 |

## RESULTS

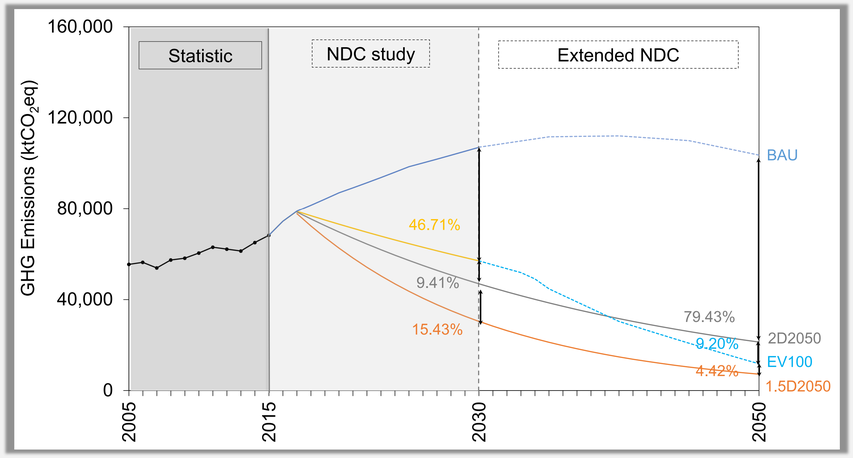


**Figure 1** GHG emissions in the EV100 scenario in Thailand's transport sector

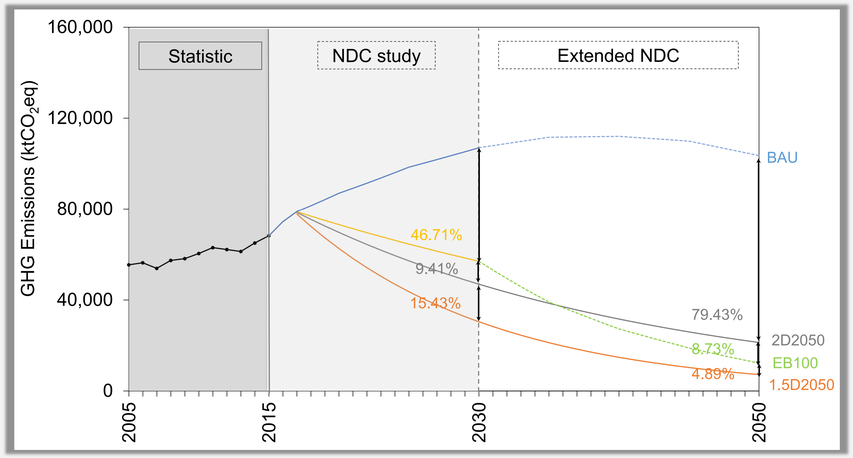


**Figure 2** GHG emissions in the EB100 scenario in Thailand's transport sector

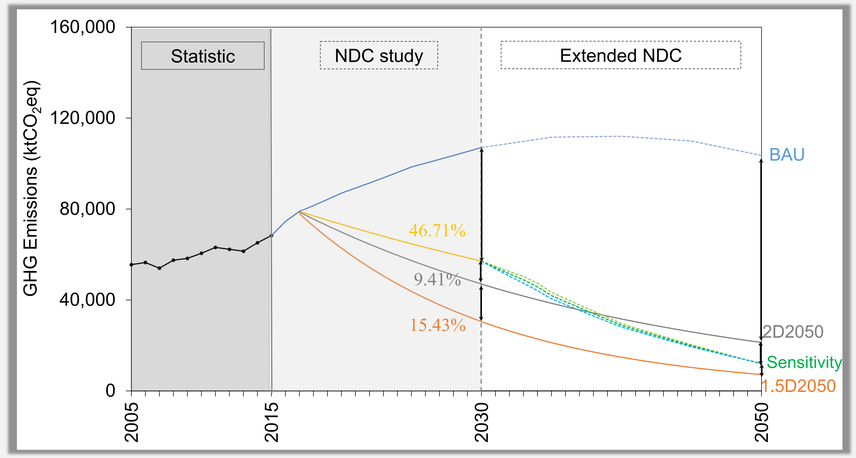


**Figure 3** GHG emissions in transport sector in sensitivity scenario

In the BAU, energy consumption in the transport sector will increase from 26,536 ktoe in 2015 to 38,260 ktoe in 2040 and 36,789 ktoe in 2050. The corresponding GHG emissions in the BAU will increase from 73,931 kt$CO_2$eq in 2015 to 107,035 kt$CO_2$eq in 2030 and 103,552 kt$CO_2$eq in 2050. In the ExNDC2050 scenario, GHG emissions will be reduced by 79,490 kt$CO_2$eq in 2030 and 75,926 kt$CO_2$eq in 2050. The emission pathway in the ExNDC2050 scenario will be higher than the 2-degree target.

In the EV100 scenario, the EV battery will be fully implemented in Thailand's road transport sector by 2050. All vehicles in the road transport will be driven by BEV to achieve zero tailpipe emissions. Figure 1 shows GHG emissions in the transport sector in the EV100 scenario when the BEV fully replace conventional vehicles. The figure show that Thailand can achieve the 2-degree target in the EV100 scenario.

In the EB100 scenario presents analyses of biofuels used in road transport. Biofuels will fully replace conventional gasoline and diesel in 2050 to achieve Thailand's decarbonized society. The biofuels used in road transport in the EB100 scenario will contribute a GHG emission reduction of 91,289 kt$CO_2$eq in 2050, which will account for an AAGR of 88.16% when compared to the BAU. (see Figure 2) Both ethanol (E100) and bio-oils (B100) in road transport can help Thailand to achieve the 2-degree target in 2050. However, Thailand's 1.5-degree target cannot be achieved. In the EB100 scenario, E100 and B100 requirements in 2050 will be 18,377 litres and 25,332 litres. This information is in-line with the AEDP2018. The production capacities of both ethanol and bio-oils in the AEDP2018 are higher than the requirement in the EB100 scenario.

Results show that GHG emissions in road transport in the EV100 and EB100 scenarios will help Thailand to achieve the 2-degree target in 2050. For the 1.5-degree target in 2050, the additional emission reduction of 5% will be needed.

**Sensitivity 1:** Combined 75% BEV and 25% bio-fuels (EV75EB25)

**Sensitivity 2:** Combined 25% BEV and 75% bio-fuels (EV25EB75)

The two sensitivity analyses show achievement of the 2-degree target. In 2050, GHG emissions in EV75EB25 will be reduced by 47,944 kt$CO_2$eq, and GHG emissions in EV25EB75 will be reduced by 47,700 kt$CO_2$eq. (see Figure 3) Results conclude that the strong implementation of both BEV and biofuels will provide decarbonization pathways to achieve 2 °C in the transport sector.

## CONCLUSION

Thailand's NDC measures in the transport sector are not in-line with the 2-degree and 1.5-degree targets. GHG emissions in the transport sector will be in-line with the 2-degree target when the BEV, E100 and B100 are fully implemented in 2050. The 2-degree target can be achieved when the combined measures of the BEV and the biofuels are implemented in the proportion of BEV to bio-fuels of 75:25 or 25:75.

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