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# Carbon Neutral Transport Corridors: Reducing emissions from freight and forestry in the EWEC

*Feasibility study report (DRAFT)*

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Feasibility study report

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# EXECUTIVE SUMMARY

## Introduction

Climate change poses a major threat to economic and social development. Two climate change related concerns of regional relevance are: the need to reduce carbon emissions from energy and transport, and the need to increase carbon stocks through the maintenance and expansion of forests. This study has investigated the feasibility of implementing a Carbon Neutral Transport Corridor (CNTC) in the GMS as a way of managing direct and induced carbon emissions arising from transport projects in economic corridors.

## Rationale

In the GMS, Economic Corridors have been established to enhance investments in transport, energy, and telecommunications in the region. These corridors improve transport connectivity and facilitate trade, and are designed to ensure the flow of development benefits to marginalized and poor communities in rural areas. One of the flagship initiatives under the GMS Program, the GMS East West Economic Corridor (EWEC) links key trade centres and ports in Lao PDR, Myanmar, Thailand and Viet Nam. Immediate development impacts from the corridor include increased investment and transport connectivity. There is an increasing realization that the competitiveness of EWEC and other corridors need to be improved by increasing resource use efficiency and by reducing impacts on ecosystems and the environment.

## Carbon footprint of the GMS EWEC and scope of a Carbon Neutral Transport Corridor

Transport is responsible for 12% of energy related GHGs globally and 9% in the GMS. Building roads increases greenhouse gases directly by facilitating an increase in traffic, and indirectly, by facilitating land use change as a result of improved access to previously inaccessible landscapes. Greenhouse gases emitted as result of traffic on the EWEC were around 1 million tonnes $CO_2$ in 2005, with a threefold increase expected by 2025 under a business as usual scenario. Freight traffic is seen to be responsible for 60% of emissions, even though freight vehicles account for only 30% of traffic activity. In order to understand the magnitude of emissions resulting from deforestation and land use change a carbon stock assessment was conducted of one EWEC province, Savannakhet in Lao PDR. The analysis showed that CO2 emissions due to the loss of carbon stocks were around 0.75 million tonnes of CO2 annually over the last two decades – this is more than 10 times the emissions from traffic on the EWEC road in Savannakhet.

A Carbon Neutral Transport Corridor can be defined as the area surrounding a road transport network that realizes net zero greenhouse gas emissions against a baseline through a parallel process of reducing emissions through increased efficiency, and offsetting unavoidable emissions through protection and enhancement of forest ecosystems and increased natural sequestration. In order to understand the feasibility of this concept, two alternative low carbon scenarios were evaluated: 1) reducing emissions through freight fuel efficiency, and 2) offsetting emissions through forest sequestration. It was found that carbon emissions from the EWEC could be reduced by 90% against a 2005 baseline by 2020, of which 25% reduction is attributable to low carbon / fuel efficient freight interventions and 65% offset is due to reforestation of areas in Savannakhet province categorized with above 50% suitability for reforestation. Over fifteen years (2011 to 2025), a cumulative 7.95 million

tonnes CO2 could be reduced from the EWEC by implementing both transport and forestry interventions which is equivalent to 43% of cumulative emissions from the business as usual scenario against a 2005 baseline.

## Green / low carbon freight interventions for the GMS

A background assessment of the freight sector found multiple factors that influence freight fuel efficiency in Lao PDR, Thailand and Viet Nam:

- Fragmented institutions: The freight sector in the Thailand, Lao PDR and Viet Nam is dominated by road transport with freight tonnage by road making up 84%, 79% and 71% of freight tonnage respectively in 2009. The road freight transport industry is highly fragmented in all three countries with the majority of truck operators being classed as small and medium sized enterprises, and operating small fleets of less than 10 trucks. Due to the small size of operators, a large proportion of the industry (to a larger extent in Lao PDR and Viet Nam) continue to be fuel inefficient, lack logistics management skills and techniques, have a poor regard for safety and are capital deficient. Institutionally, there are strong industry and goods transport associations in Thailand (such as the Federation of Thai Industries, regional transport associations) and, to a lesser extent, in Viet Nam. However, these are still at a very initial stage in Lao PDR.
- High fuel costs: Fuel costs make up between 40 – 60% of overall operating costs for road transport companies, and in turn result in high logistics costs in these countries. Successive hikes in fuel costs, lower trading volumes, increased competition and system inefficiencies have led to increased transportation costs making it difficult for SME freight operators to realize a sustainable profit margin.
- Aging vehicles and a lack of alternative fuels: The age of trucks in these countries has a significant impact on the fuel efficiency of the freight sector in general. The sector is burdened by an ageing freight fleet most of which is well over 10 years on average, though this is more prevalent in Lao PDR and Viet Nam where the average age of the fleet is between 15-20 years. In Lao PDR and Viet Nam, the absence of any large truck manufacturing or assembly facilities and the high cost of new trucks have led to increased import of second hand trucks (less than 5 years old) from US, Korea and China. Access to alternative fuels is limited and the main fuel type use for heavy vehicles in the three countries is diesel, with the exception of CNG in Thailand.
- Barriers to procuring new vehicles: The main barriers to procuring new vehicles are risk and lack of access to finance. In Viet Nam, it was found that high interest rates in Viet Nam (around 20% to 25%) and not enough cash stops SMEs from investing in fleets. At a province level (in Da Nang) unpredictable demand for services hinders business development and procurement for companies. In Lao PDR, due to the immature nature of the industry and the relatively small size of Lao transporters, some are unable to get access to bank finance.
- Inefficient use of fleets: Companies surveyed during the EWEC feasibility study reported 25 – 50% of trips running empty which illustrates a clear mismatch of fleet and load carrying capacities. This in turn results in overloading of vehicles as normal practice which increases fuel

consumption and has implications for road safety and for the quality of road infrastructure. Fuel use is further increased by the prevalence of poor driving patterns such as speeding, idling and disregarding safe driving practices.

Freight fuel efficiency measures applicable to the EWEC countries evaluated included a) Implementation of fuel standards; b) Upgrade of national fleets due to replacement of older vehicles; c) Deployment of cleaner fuels; d) Retrofitting vehicles with green technologies; e) Improving driver behaviour with eco-driving capacity building; and, f) Improving freight efficiency by enhancing logistics management capacity. Based on the sector assessment, it was found that there is a need to develop institutional mechanisms to deploy interventions at a company level while driving the development of policy interventions at a national level. Pilot projects are proposed in each country which bundle capacity building and awareness of technologies with a financing mechanism at a local level. It is proposed that these projects cater to SME freight companies in EWEC provinces, and that institutional arrangements bring together government partners, local associations and academic experts. The main focus of the projects will be:

- Low carbon technologies: The pilot should include two parts: first, enabling access to energy efficient technologies for trucks1 which have been tested in a local setting; and second, developing a revolving fund mechanism to enable SME freight operators to access funds to purchase retrofit equipment as required. In time this funding mechanism could be extended to vehicle upgrades as well.
- Eco-driving training for freight companies: This project would build the capacity of existing institutions / service providers in the countries so as to provide access to regular eco-driving training for freight. It will include identifying and developing training materials, testing on a small sample, facilitating the development of existing institutions to provide and monitor eco-driving training for freight operators.
- Logistics management: This project would build capacity of transport associations in the region to facilitate access to relevant management techniques and skills, networking and information on logistics by freight operators. This would enable freight companies to reduce empty running and increase fuel efficiency per unit load carried.

## Natural regeneration of forest for poverty reduction and carbon sequestration

There are two routes by which forests can contribute to offsetting emissions from other sectors such as transport. The first is through measures to reduce emissions from deforestation and forest degradation that may be exacerbated by the presence of a road that allows access to forest areas. The second is through the restoration of forest by tree planting on land that has already been cleared of forest, but is not being fully or effectively utilized for agriculture or other productive purpose.

[1] I.e. those that have been tested successfully in the region (e.g. China) - optimum sizing of tires, equipment to monitor tire pressure regularly and aerodynamic equipment to decrease the air resistance of the vehicle

### Conservation of existing carbon stocks

The estimated current forest carbon stock in Savannakhet Province in Lao PDR is in the range 50-70 million tonnes and the current average annual loss in carbon stock in the province is estimated at around 200,000 tonnes. Investment in forest protection and management in the province could make a significant contribution to overall reduction in $CO_2$ emissions. A reduction of about 10% in the annual loss of carbon stocks in Savannakhet province alone would reduce emissions by an amount comparable with one of the interventions in the transport sector.

This approach has the further advantage that forest that would have been disturbed, but is protected from encroachment and uncontrolled tree felling, will then grow and begin to sequester additional carbon. This would be a relatively cost-effective way to offset transport emissions, since little investment is required and the main cost involved is the provision of financial incentives to local communities and the transaction costs associated with establishing a baseline level of emissions and monitoring the carbon stocks to confirm the reductions in emissions.

### Increasing sequestration of CO2 through tree plantations

The analysis of land suitable for reforestation within the buffer zone of the section of the EWEC that passes through Lao PDR, suggests that there is a total of about 196,300 ha of land that conforms with 50% or more of the criteria for suitability, of which about 50% is in small patches of <250 ha. Most of the land that has been classed as suitable for carbon sequestering plantations is on slopes between 15 and 30% and so should be managed primarily for soil protection, water conservation and biodiversity, to provide economic benefits in addition to those from the CO2 sequestration. Some of the areas that have been identified as potentially suitable may have secondary forest that has established on land formerly used for shifting cultivation, and participatory land-use planning (PLUP) will be needed to ensure that the community are willing and able to refrain from using the land again. In such situations the natural regrowth of the forest could provide a very low cost means for CO2 sequestration, with the main payments being to the community to protect the forest, rather than planting trees.

# I. INTRODUCTION

## A. Background

1. Climate change poses a major threat to economic and social development. The first phase of the Greater Mekong Subregion (GMS)[2] Core Environment Program Biodiversity Conservation Corridors Initiative (CEP-BCI) has assessed the feasibility of climate change interventions that could lead to substantial investments to promote low carbon and climate resilient development. Two climate change related concerns of international and regional relevance are: the need to reduce carbon emissions from land use change, energy and transport, and the need to increase carbon sequestration through the maintenance and expansion of forests. In 2007, a CEP-BCI study assessed the preliminary scope for implementing a Carbon Neutral Transport Corridor (CNTC) in the GMS as a way of managing direct and induced carbon emissions arising from transport projects in these economic corridors. The report highlighted that the focus of initial study should be the GMS East-West Economic Corridor (EWEC) spanning Myanmar, Thailand, Lao PDR and Viet Nam.

2. This report documents the feasibility study which has defined the scope and boundaries of a CNTC, investigated the feasibility of the concept and evaluated potential interventions. The structure of the report is as follows: this first section outlines the background and methodology of the study, Section II presents an overview of trade and transport in the GMS EWEC, Section III analyzes the carbon footprint of the EWEC, and Sections IV and V discuss the feasibility of freight fuel efficiency and forestry interventions. Finally, Section VI presents recommendations.

## B. Feasibility study methodology

### 1. Study components

3. A prefeasibility study in 2007 under the CEP-BCI Phase 1 considered the carbon emissions resulting from the GMS North-South and East-West Economic Corridors, and found that freight transport emissions were higher than those from passenger transport. As a result, the scope of the CNTC feasibility study was to identify interventions along the GMS East-West Economic Corridor to:

- Reduce emissions from freight transport
- Reduce and offset emissions through reforestation / sequestration

4. The main aim of the study was to identify the technical, policy and financial feasibility of implementing defined initiatives to reduce emissions from the EWEC. The study objective was to develop recommendations for pilot projects, driven by national governments and private sector companies in the region, which could be implemented under CEP-BCI Phase II. The overall study framework is shown in Figure 2. The main components of the study included:

[2] The Greater Mekong Subregion (GMS) comprises Cambodia, the People's Republic of China, Lao People's Democratic Republic, Myanmar, Thailand, and Viet Nam.

- **Carbon footprint assessment of greenhouse gases (GHGs) from the EWEC (transport and forestry):** A variation of the TEEMP[3] model was used to analyze GHG emissions from transport (2005 to 2025) under a Business-as-usual scenario, and an analysis of changes to biomass along Route 9 (2001 to 2008) helped identify the impact of EWEC in terms of land use change.
- **A review of transport policy in Thailand, Lao PDR and Viet Nam:** This was a desk based review of the policy framework in each country with respect to energy efficiency in road freight transport, supplemented by interviews and consultations with key experts and relevant government authorities in each country.
- **Freight business climate assessment:** This included a survey of freight companies based in nine provinces in Thailand, Lao PDR and Viet Nam, followed by a workshop bringing together key operators, manufacturers and experts from the freight field to discuss a way forward for energy efficiency in freight and logistics.
- **A carbon sequestration assessment:** This sub-component of the study has included a field assessment of carbon stocks and a spatial multi-criteria assessment of potential land available for reforestation / carbon sequestration in Savannakhet province (Lao PDR).
- **Assessments of potential pilot / policy options:** The main recommendations emerging from different parts of the study have been evaluated in terms of their potential to reduce carbon emissions.

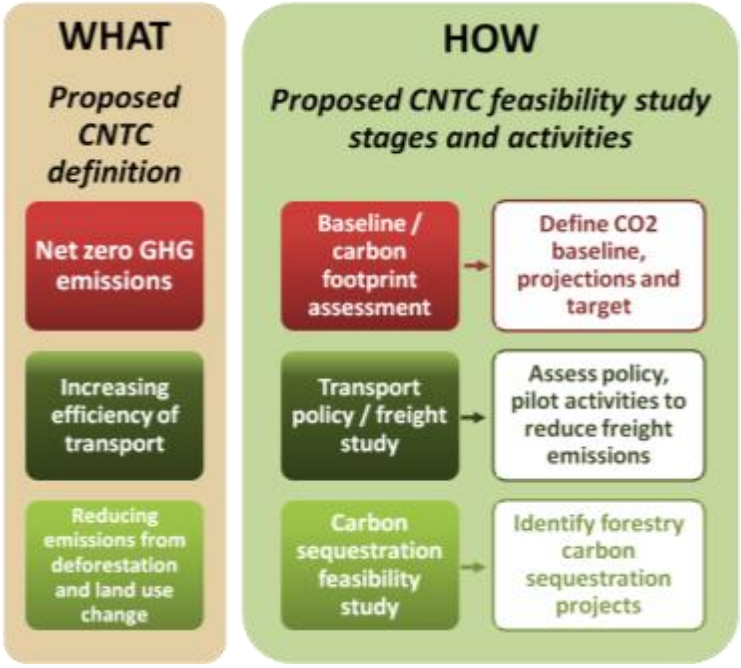


**Figure 1. Feasibility study components**

[3] The Transport Emissions Evaluation Models for Projects (TEEMP) have been developed by CAI Asia with support from ITDP, ADB, Cambridge Systematics and UNEP-GEF. These were initially developed as part of an analysis of ADB transport projects and are now used to evaluate GEF transport projects.

5. Forestry related assessment focussed on Savannakhet province in Lao PDR. This was to facilitate a more in-depth analysis of context specific forestry issues in an area and the development of solutions at a province level. Additionally, the most significant development impacts resulting from the GMS EWEC have been noted in provinces in Lao PDR and Viet Nam and forestry related impacts are also likely to have occurred most in these areas.

## 2. Engagement of stakeholders and experts in the study

6. The process of conducting the study has catalyzed **engagement of stakeholders** and initiation of links between EOC and partners who will be key in taking the results and recommendations from the study forward. This includes building momentum among freight operators with respect to fuel efficiency and vehicle upgrades, developing a better understanding of and communication with transport ministries in each of the countries and building partnerships with expert organizations and potential implementing partners in this field. The study began with scoping workshops in each of the countries with key government and other partners. This helped establish the framework for the study and the definition of a carbon neutral transport corridor. The desk based policy review was presented to a group of government stakeholders in each country to validate the review and define gaps and recommendations. The recommendations for pilot projects were developed after a series of consultations with transport agencies and freight associations in each country.

7. Strategic partnerships were built with **experts and academic institutions**. The carbon footprint model for the EWEC was developed in conjunction with and reviewed by experts from the Clean Air Initiatives for Asian Cities (CAI-Asia). The assessment of biomass changes in Savannakhet was conducted by the Swiss National Center for Competency in Research (NCCR) of University of Bern (program based in Lao PDR). The analysis of biomass stocks in Savannakhet province, which included both GIS and field assessments, was conducted as part of a PhD thesis by a student at the Asian Institute of Technology.

8. Engaging and building a community with **private sector freight companies** and vehicle manufacturers was a particular focus of activities. The survey of freight companies culminated in a regional workshop for companies that highlighted the main issues and experiences related to fuel efficiency. Based on feedback received during the workshop, a two-day training course was conducted by the Mekong Institute and Clean Air Initiatives for Asian Cities (CAI-Asia) in Khon Kaen. During this workshop companies applied the Green Trucks Toolkit (developed by CAI-Asia) to fuel consumption data from their vehicle fleets in order to evaluate the costs and benefits of different fuel efficiency interventions for their fleet. These activities helped define the recommendations for pilot projects in the last chapter of this report.

# II. TRADE AND TRANSPORT IN THE GMS EAST-WEST ECONOMIC CORRIDOR (EWEC)

## A. Overview of the GMS East-West Economic Corridor

9. In the GMS, Economic Corridors have been established to enhance investments in transport, energy, and telecommunications in the region[4]. Described as the backbone and arteries of the Greater Mekong Subregion (GMS) Economic Cooperation Program (ECP), these corridors improve transport connectivity and facilitate trade, and are designed to ensure the flow of development benefits to marginalized and poor communities in rural areas. These corridors are areas where increased development is expected – development that is likely be accompanied by negative environmental impacts, including an increase in carbon emissions from the use of fossil fuels. With initial road transport corridors almost complete, there is an increasing realization that the competitiveness of these corridors needs to be improved by increasing resource use efficiency and by reducing their impact on ecosystems and the environment.

10. The GMS East West Economic Corridor (EWEC) is one of the flagship initiatives under the GMS ECP. It covers around 1,320 kilometres as a continuous land route between the Andaman Sea in the Indian Ocean and the South China Sea[5] and traverses 11 provinces[6] across the four countries. Approximately 7.9 million people live in the EWEC corridor provinces and the corridor has a combined GPP of $12.3 billion in 2009. The socioeconomic profile of the EWEC is given in Table 1 below.

**Table 1: Socio-economic profile of EWEC provinces in 2009 (excluding Myanmar)**

| | **GPP** (USD/ per capita) | **Population** | | | **Population density** *persons / km²* | **Poverty incidence** | **Land area** | |
|---|---|---|---|---|---|---|---|---|
| | | '000 persons | % Rural | % Female | | | km² | % forest cover |
| **Lao PDR** | | | | | | | | |
| Savannakhet | 908.6 | 890.5 | N/A | 50.6 | 41 | 10.0 | 21,774.0 | 51.5 |
| **Thailand** | | | | | | | | |
| Tak | 2,220.5 | 519.7 | 77.0 | 49.3 | 32 | 20.7 | 16,406.7 | 77.5 |
| Phitsanulok | 2,123.8 | 845.6 | 78.7 | 50.9 | 78 | 8.0 | 10,815.9 | 36.8 |
| Khon Kaen | 2,376.7 | 1762.2 | 78.0 | 50.4 | 162 | 5.6 | 10,886.0 | 11.8 |
| Kalasin | 1,324.8 | 980.2 | 70.3 | 50.2 | 141 | 27.0 | 6,946.7 | 10.8 |
| Mukdahan | 1,305.3 | 338 | 78.5 | 49.9 | 78 | 8.5 | 4,339.8 | 33.0 |
| **Viet Nam** | | | | | | | | |
| Danang | 1,423.7* | 894.5 | 13.1 | 50.7 | 697 | 3.5* | 1,283.4 | 36.6 |

[4] The GMS countries adopted the economic corridor approach to development during the 8th GMS Ministerial Meeting held in Manila in 1998. The approach aims to improve and enhance investments in transport, energy, and telecommunications in the region (ADB, 1998).

[5] Asian Development Bank. Strategy and action plan for the Greater Mekong Subregion East–West Economic Corridor. Mandaluyong City, Philippines: Asian Development Bank, 2010.

[6] These are as follows: Viet Nam – Da Nang, Thua Thien Hue, and Quang Tri; in Lao People's Democratic Republic (Lao PDR) – Savannakhet; in Thailand – Mukdahan, Kalasin, Khon Kaen, Phitsanulok, and Tak; and in Myanmar – Mawlamyline and Myawaddy.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Thua Thien Hue | 864.7 | 1087.6 | 64.0 | 50.6 | 215 | 13.7* | 5,062.6 | 58.1 |
| Quang Tri | 789.5 | 598.6 | 72.0 | 50.7 | 126 | 25.9* | 4,747.0 | 46.5 |

* Data is for 2008. Source: Thailand National Statistics Office, General Statistics Office of Viet Nam, Lao PDR Statistical Yearbook 2009; CEP-BCI (2012) Macroeconomic assessment of BCI provinces in Viet Nam; UN-PEI (2011) Report on Economic, Social and Environmental Costs and Benefits of Investments in Savannakhet Province.

## B. Trade and logistics performance in EWEC countries

### 1. Trends in GMS trade

11. The freight and logistics sector plays an important role in trade development in GMS countries. The sector has expanded significantly in the last two decades, largely due to rapid increases in exports in the GMS as a whole. From 1995 to 2007, the growth rate of merchandized exports in the GMS averaged 11% per annum, while that of merchandized imports was recorded at 9% per annum[7]. Intra-regional trade has also been increasing – for example, exports from Thailand to other GMS countries increased from 5% in 1995 to 15% in 2007, and intra-regional imports to Viet Nam increased from 10% in 1995 to 27% in 2007[8]. Lao PDR, which is a land-locked state, is more dependent on neighbouring countries for trade - intra-regional GMS trade in Lao PDR made up as much as 53% of exports and 83% of imports in 2007.

### 2. Logistics performance

12. Globally, improving the performance of a country's logistics sector has become important due to the strong links between economic development and logistics. The cost of logistics determines the competitiveness of a country, with higher costs impacting the price of goods and services on a global scale. In Thailand costs of the logistics sector makes up about 17% of the country's GDP (2010)[9] and included the cost of transport, inventory costs and administrative costs. Whereas inventory and holding costs have been decreasing year on year causing the overall cost of logistics to reduce since 2001, analyses of trends show that the cost of transport continues to grow. Estimates for Viet Nam show logistics cost accounting for 25% of GDP in 2010[10]. In comparison, logistics costs of developed countries like the United States and Japan account for about 8-9%.

13. The most recent evaluation of logistics performance (i.e. the Logistics Performance Index) shows that Lao PDR, Thailand and Viet Nam were ranked at 118th, 35th and 53rd of 155 countries in terms of overall logistics performance, respectively. Thailand and Viet Nam received their poorest scores with respect to timeliness of logistics whereas quality of logistics service score was the weakest for Lao PDR. Logistics performance is directly related to the cost and efficiency of transport services.

[7] JICA, 2011. The comprehensive study on the logistics system in Lao PDR.

[8] IMF, 2009. Direction of Trade Statistics (DOTS) Data Online, downloaded 11 February 2009.

[9] NESDB (2010) and Thailand Logistics Report (2010)

[10] Viet Nam Business Forum Magazine (2010)

| Logistics performance - World ranking out of 155 countries | | | |
|---|---|---|---|
| | Lao PDR | Thailand | Viet Nam |
| Customs | 113 | 39 | 53 |
| Infrastructure | 132 | 36 | 66 |
| Logistics quality and competence | 137 | 39 | 51 |
| Timeliness | 89 | 48 | 76 |
| Overall global ranking | **118** | **35** | **53** |

**Figure 2. Logistics Performance Index in EWEC countries (Source: World Bank, 2010)**

14. At national level, the modes of transport used for freight and logistics have a direct impact on efficiency and on overall logistics performance. In all three EWEC countries, in terms of tonnage, the largest share of freight volumes are carried largely by road transport – around 79%, 84% and 71% of freight tonnage in Lao PDR, Thailand and Viet Nam respectively in 2009[11]. In contrast, when considering freight activity (as measured by ton.km) and value marine and air transport also play an important role, particularly in transporting cross-border freight. For example, around 65% of exports and imports in Thailand in 2009 were transported by sea and around 27% was transported by air, while only 6% was transported by road[12]. In Viet Nam, marine transport is responsible for 67% of overall freight activity but only 9% of overall tonnage. Figure 11 shows the modal split in terms of freight transport in each of the three EWEC countries.

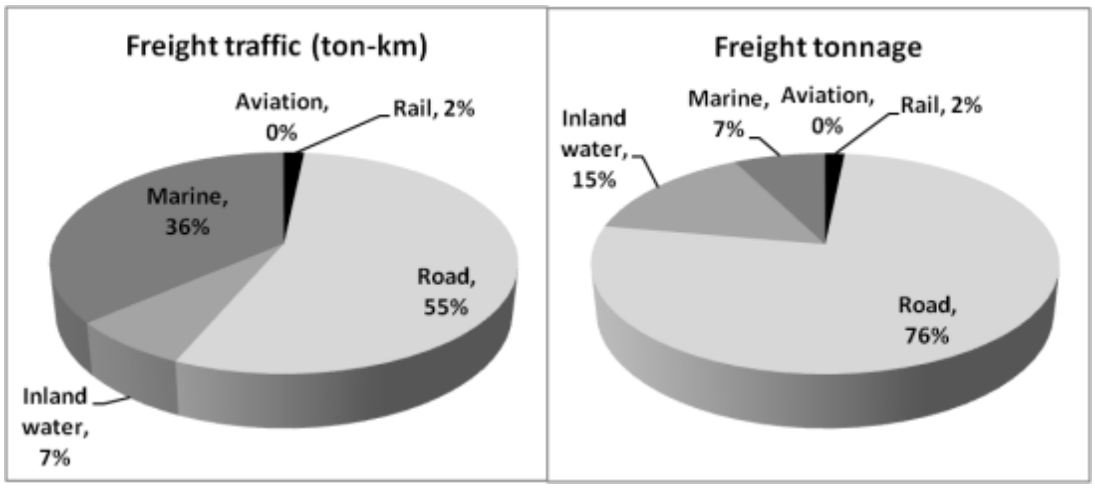


**Figure 3. Freight traffic and tonnage by different modes in Thailand, Lao PDR and Viet Nam in 2009**

[11] Lao Statistical Yearbook (2009), General Statistics Office of Viet Nam (accessed October 2011) and Thailand Transport Statistics (2009).

[12] Thailand Transport Statistics 2009

## C. Development impacts of EWEC investments

15. The initial EWEC Strategy and Action Plan (SAP) was developed around a series of road upgrade and construction projects to create a transport corridor connecting key trade centers and ports in Lao PDR, Myanmar, Thailand and Viet Nam. Development of the road transport corridor went hand in hand with improvements in telecommunications and energy infrastructure, tourism, and a regulatory environment. With most of the original infrastructure development projects nearing completion, the focus is now on transforming transport corridors into economic corridors by improving the policy and regulatory framework, enhancing trade facilitation, and increasing resource use efficiency.

16. Immediate impacts of EWEC interventions have been recorded. Investment in EWEC provinces have increased significantly according to project evaluations in Lao PDR and Viet Nam: annual investment in agriculture and forestry, industry and services in Savannakhet, Lao PDR increased to $422 million in 2006 as compared with $107 million for the whole of 1996–2003, while 23 new industrial units were seen to be operating in Viet Nam at the time the project was completed[13]. Transportation times along the corridor roads also reduced significantly, leading to increases in the number of bus services offered, tourist arrivals, increased traffic and increased trade. Table 2 shows trade at EWEC border crossing points which have increased since the inception of the EWEC. The impact of infrastructure can clearly be seen in these figures – the increase in export and imports at the Mukdahan / Savannakhet border can be attributed to the completion of the Second Friendship Bridge between Lao PDR and Thailand at the end of 2006[14].

**Table 2: Trade at selected EWEC border crossing points (million USD)**

| Year | Mukdahan / Savannakhet | | Dansavanh / Lao Bao | |
|---|---|---|---|---|
| | Lao PDR imports from Thailand | Thailand imports from Lao PDR | Lao PDR imports from Viet Nam | Viet Nam imports from Lao PDR |
| **2000** | 138.27 | 36.31 | n/a | n/a |
| **2001** | 110.03 | 21.66 | n/a | n/a |
| **2002** | 99.74 | 22.04 | 13.71 | 11.9 |
| **2003** | 100.60 | 19.97 | 1.90 | 22.27 |
| **2004** | 146.00 | 16.81 | 3.11 | 32.47 |
| **2005** | 145.16 | 25.80 | 5.59 | 49.18 |
| **2006** | 168.56 | 78.82 | 13.97 | 107.31 |
| **2007** | 259.59 | 166.08 | 12.65 | 117.71 |

Source: Banomyong (2008)

17. An increase in traffic along the corridor has also been recorded in part due to improvement of infrastructure[15] – Figure 2 shows the gradual increase in traffic activity for different vehicle types, particularly freight, along EWEC roads in Thailand. However, increases in traffic, trade and commodity flows along the corridor overall have fallen short of the scale of impact originally expected. This is partly due to the limited port expansion that occurred at both ends of the corridor, and due to issues in fully

[13] ADB (2008). Project Completion Report for GMS East West Corridor Project – Viet Nam and Lao PDR.

[14] Banomyong, 2008. The GMS East-West Economic Corridor Logistics Benchmark Study.

[15] In Thailand this increase is also attributable to increasing trends in GPP, the development of economic hubs such as Khon Kaen and the development of other transport corridors such as North-South Economic Corridor.

implementing the GMS Cross Border Transport Agreement (CBTA). In order to rectify this, the governments of Thailand, Lao PDR and Viet Nam are discussing expanding the agreement to include main freight demand centres like Bangkok, Ha Noi and Vientiane as a way of increasing cross border trade on the EWEC.

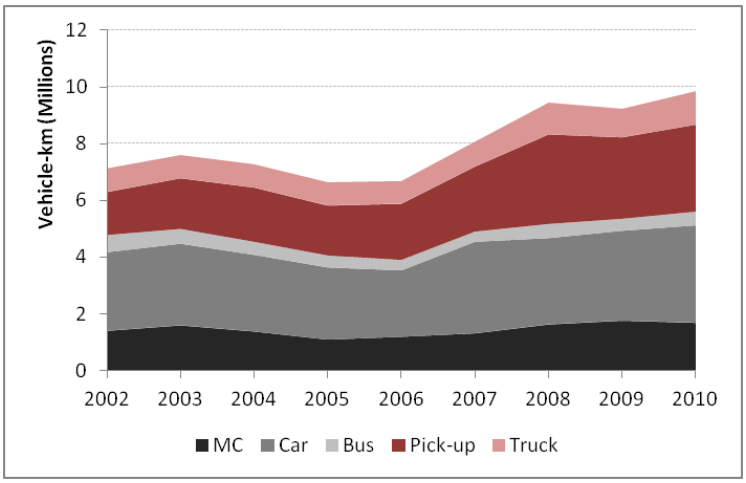


**Figure 4. Traffic activity along the EWEC in Thailand between 2002 and 2010 by vehicle type**

# III. GREENHOUSE GAS EMISSIONS BASELINE AND SCENARIOS FOR THE EWEC

## A. Direct and induced greenhouse gases from transport

18. Transport was responsible for 12% of greenhouse gas emissions (GHGs) in 2007[16]. Transport infrastructure has a direct carbon impact in that it facilitates an increase in traffic, and (particularly in developing countries), it has an additional induced carbon impact in that it facilitates land use change by providing access to previously inaccessible landscapes. In the GMS, transport was responsible for 9% of GHG emissions, and land use change and forestry was responsible for 26% of emissions in 2005 as seen in Figure 2 (a). Further, these emissions are expected to increase year on year as seen in Figure 2 (b) - various projections show that within South and Southeast Asia GHG emissions from transport will see a three to five fold increase by 2030 (if no new policies are introduced to tackle these emissions), making Asia responsible for 31% of global transport emissions by 2030[17].

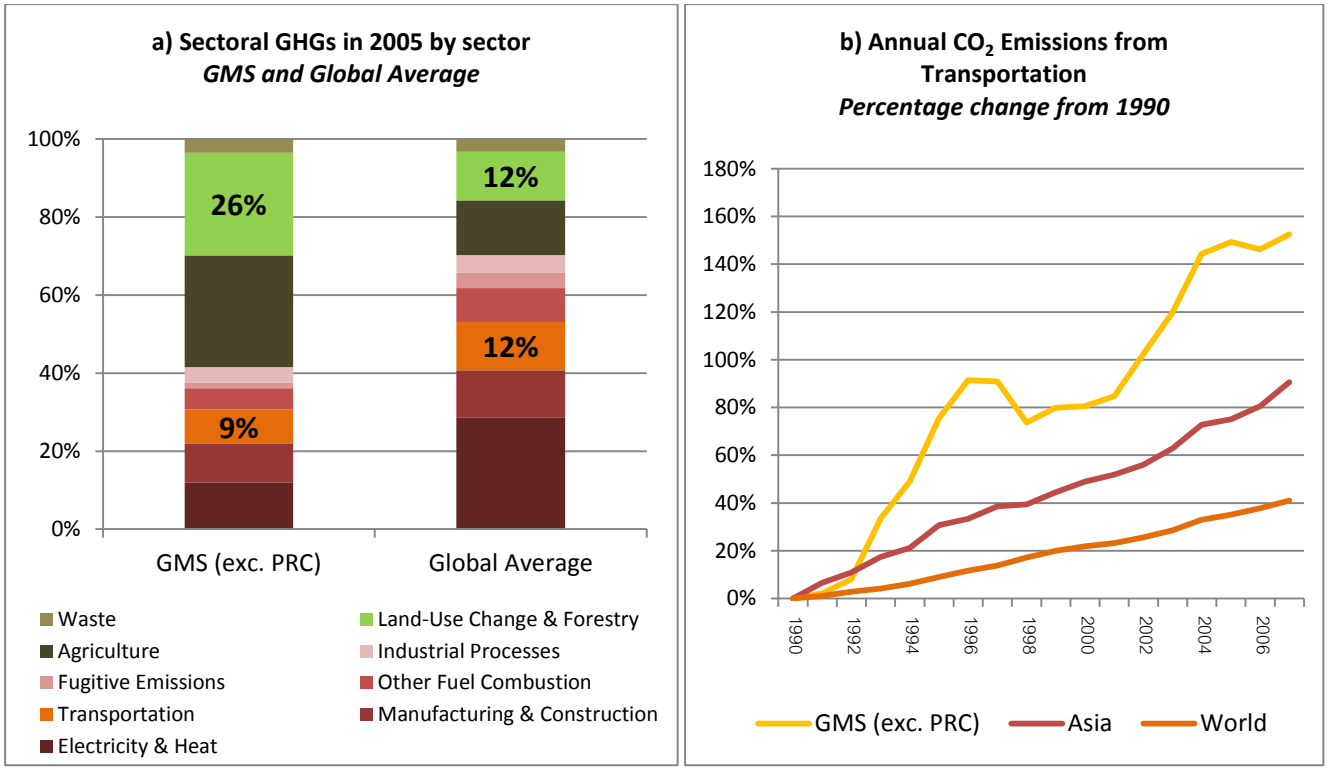


**Figure 5. Trends in GHG emissions from the transport sector in GMS countries (Source: WRI, 2010)[18].**

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[16] Climate Analysis Indicators Tool (CAIT) Version 8.0. (Washington, DC: World Resources Institute, 2010).

[17] Schipper, L., Fabian, H., and Leather, J., 2009. Transport and Carbon Dioxide Emissions: Forecasts, Options Analysis, and Evaluation. ADB Sustainable Development Working Paper Series. ADB: Manila.

[18] Climate Analysis Indicators Tool (CAIT) Version 8.0. (Washington, DC: World Resources Institute, 2010).

## B. Defining a Carbon Neutral Transport Corridor

19. The UN defines climate neutrality as ‘a way of living’ that produces zero net greenhouse gas (GHG) emissions. UN (2008) specifies that climate neutrality can be achieved by first **reducing** emissions resulting from an activity and then **offsetting** any residual emissions. An extension of the climate or carbon neutral concept is that of ‘carbon neutral infrastructure’ or ‘zero carbon infrastructure’, where energy efficiency measures are used to reduce the emissions from an infrastructure project, and remaining energy demand is met using renewable energy. Due to the complexity in the nature of carbon accounting, and uncertainty in data collection, current projects around the world that aim to achieve ‘carbon neutral’ status only take into account the emissions resulting as a direct result of the operations of the infrastructure i.e. emissions arising due to the use of fossil fuels ‘on site’. The considerable emissions ‘embodied’ in the construction or demolition of such infrastructure or the emissions that may arise as an indirect result of the project (e.g. induced impact such as fewer emissions being sequestered due to deforestation) are rarely considered. In order to tackle GHGs arising from regional initiatives in the GMS, where there are no GHG reduction targets in place, a more holistic approach to carbon neutral projects is required.

20. In order to identify the impacts of a transport corridor and the focus of potential interventions, it is important to first understand where GHG emissions are likely to arise as a result of the corridor. An estimate of ‘whole life’ carbon for a transport corridor would need to consider GHGs emitted as a direct result of the road project at each of the different stages of the life-cycle, as well as the induced emissions arising as a result of the outcomes of the project. However, accounting for and measuring all the various sources of carbon that may be emitted as a result of one project may not be feasible or necessary. For the GMS, it is important to consider all the *significant* sources of emissions resulting from the corridor and to understand which interventions could achieve the greatest reduction in carbon emissions. As shown in Figure 1, the main sources of emissions across the life cycle of a road project occur during the ‘use phase’ of the road corridor and include i) Emissions from increasing traffic along the corridor and ii) Decreased carbon sinks due to deforestation of the land around the corridor. Based on this a definition for a carbon neutral transport corridor is as follows:

> *A Carbon Neutral Transport Corridor is the area surrounding a road transport network that realizes net zero greenhouse gas emissions against a baseline through a parallel process of reducing emissions through increased efficiency, and offsetting unavoidable emissions through protection and enhancement of forest ecosystems and increased natural sequestration.*

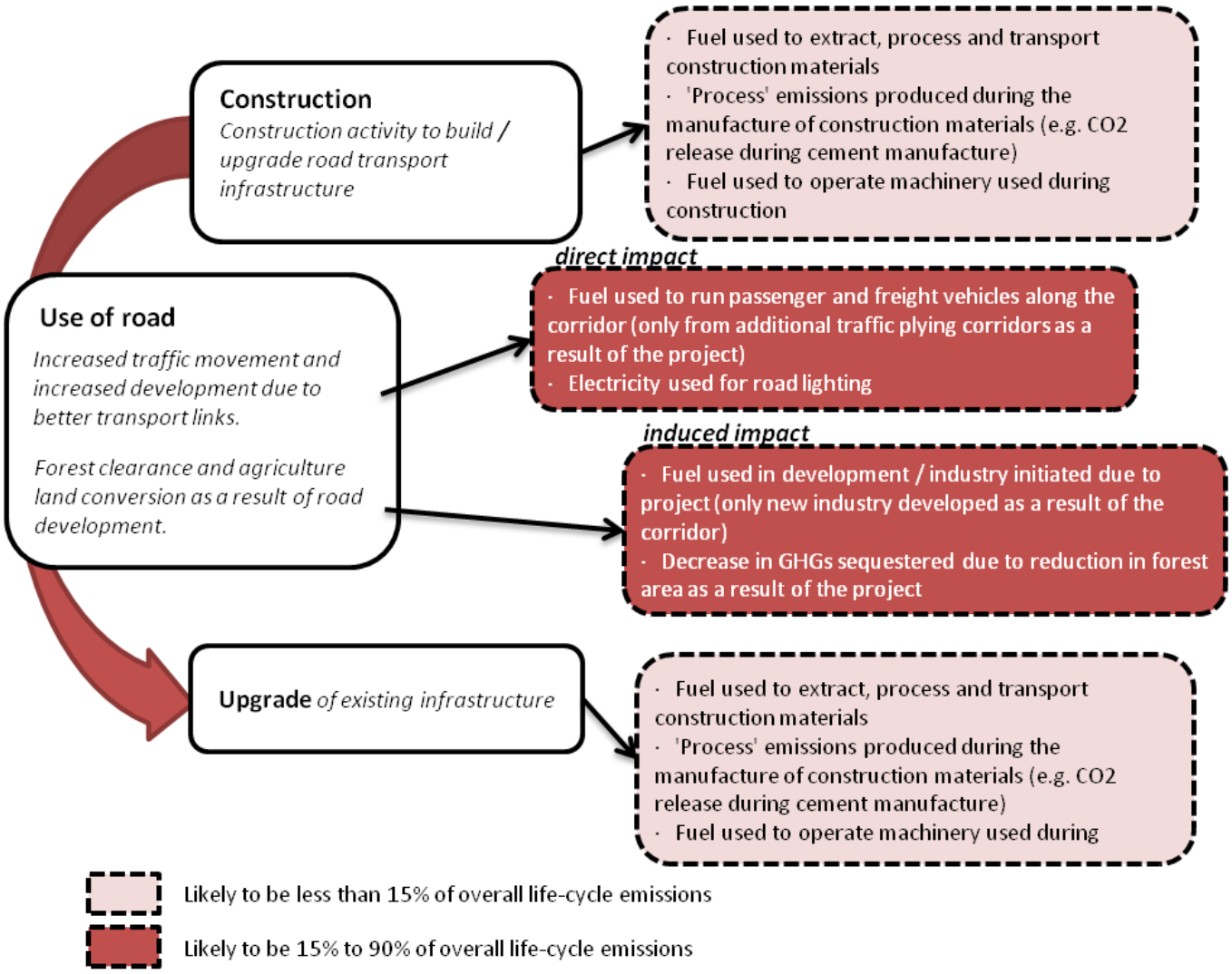


**Figure 6. Sources of greenhouses gases throughout the life-cycle of a GMS transport corridor[19]**

## C. Carbon footprint of the EWEC

21. The first source of emissions i.e. greenhouses gases (GHGs) arising due to road transport on the EWEC were estimated using a variation of the ASIF[20] (Activity – Structure – Fuel Intensity – Emission Factor) framework and building on the TEEMP model[21]. In this model traffic activity was

[19] Based on information from 1) ADB, 2010. Reducing Carbon Emissions from Transport Projects. ADB: Manila. 2) Fraser et al. 2007. Report on a preliminary assessment of the scope for implementing a Carbon Neutral Transport Corridor in the GMS. EOC: Bangkok. And 3) Switalski, A., 2005. The Ecological Effects of Roads in the Brazilian Amazon: Current Status and Prospects for the Future. Road-RIPorter, Volume 10:3. http://www.wildlandscpr.org/road-riporter/autumn-equinox-2005-volume-10-3 . Accessed on 07.10.10.

[20] Ibid Footnote 3

[21] The Transport Emissions Evaluation Models for Projects (TEEMP) have been developed by CAI Asia with support from ITDP, ADB, Cambridge Systematics and UNEP-GEF. These were initially developed as part of an analysis of ADB transport projects and are now used to evaluate GEF transport projects.

subcategorized based on vehicle type, age and fuel type allowing for a realistic picture of the conditions along the corridor to be simulated. Fuel efficiency factors[22] were calibrated for different speeds based on the volume of traffic and capacity of the road – this allowed for the impact of speed on fuel use to be factored into the assessment. Emissions from traffic were calculated for a twenty year time period and 2005 was taken as the baseline year[23]. Estimates for 2005 to 2010 were based on actual data and whereas projections[24] for 2010 to 2024 were based on a Business-as-usual (BAU) scenario. As shown in Table 3, this scenario assumes that current trends in traffic growth, fuel use and fleet structure will continue over the next two decades.

**Table 3: Business-as-usual scenario for the EWEC**

| Parameter | Main assumptions |
|---|---|
| **Transport activity** | Traffic will continue to grow over time in parallel with increases in population and GDP. Freight traffic will grow at a greater rate than passenger traffic. |
| **Vehicle types and age** | As there are currently no policies in place in any of the countries to regulate in-use freight truck age, the fleet structure for trucks (i.e. number of vehicles of different types and ages) will remain constant over time. |
| **Fuel type** | Diesel and gasoline will continue to be the main type of fuel used by vehicles along the EWEC, except in cases where there are current policy targets to increase the use of alternative fuels. For example, due to aggressive targets and policies for CNG in Thailand, vehicles using this fuel will increase at current rates over time. In the case of biofuels, targets for biofuel deployment during the twenty year period will be met in Thailand and Viet Nam. |
| **Fuel consumption** | Fuel consumption over time for different vehicle types will vary based on global transport projection models – for example, the efficiency of bus fleets is expected to remain the same over time as vehicle size is expected to offset efficiency gains from technological improvements. In the case of heavy vehicles, the fleet average fuel consumption will increase by 1% every five years due to improvements in vehicle engines and technology. |

22. As shown in Figure 4, greenhouse gas emissions from the EWEC are estimated to be just over 1 million tonnes $CO_2$ in the baseline year 2005, increasing to just over 1.5 million tonnes $CO_2$ in 2010. These results are comparable to estimates from a prefeasibility study in 2007 and when calibrated

[22] These factors were collected from freight operators based along the EWEC for different categories of heavy commercial vehicles (HCVs).

[23] As initial EWEC road upgrade projects under the GMS Economic Cooperation Program were completed between 2004 and 2006, the baseline year for this analysis was assumed to be 2005.

[24] Traffic activity along the EWEC was projected based on trends for the previous decade calibrated against projections from a 2006 GMS Transport Model that analyzed demand-side factors and supply side constraints affecting a GMS-wide transport network (GMS Transport Strategy).

against national estimates of transport emissions[25]. Additionally, GHG emissions projections (under the BAU scenario) are seen to increase to just over 3 million tonnes $CO_2$ by 2025. Even though freight vehicles (i.e. Light Commercial Vehicles [LCVs] and Heavy Commercial Vehicles [HCVs]) are responsible for only 30% of overall traffic activity, these vehicles are seen to be responsible for over 60% of GHG emissions. This is due to the fuel efficiency of trucks being far lower than that of passenger vehicles, and the dominance of diesel fuel among freight vehicles.

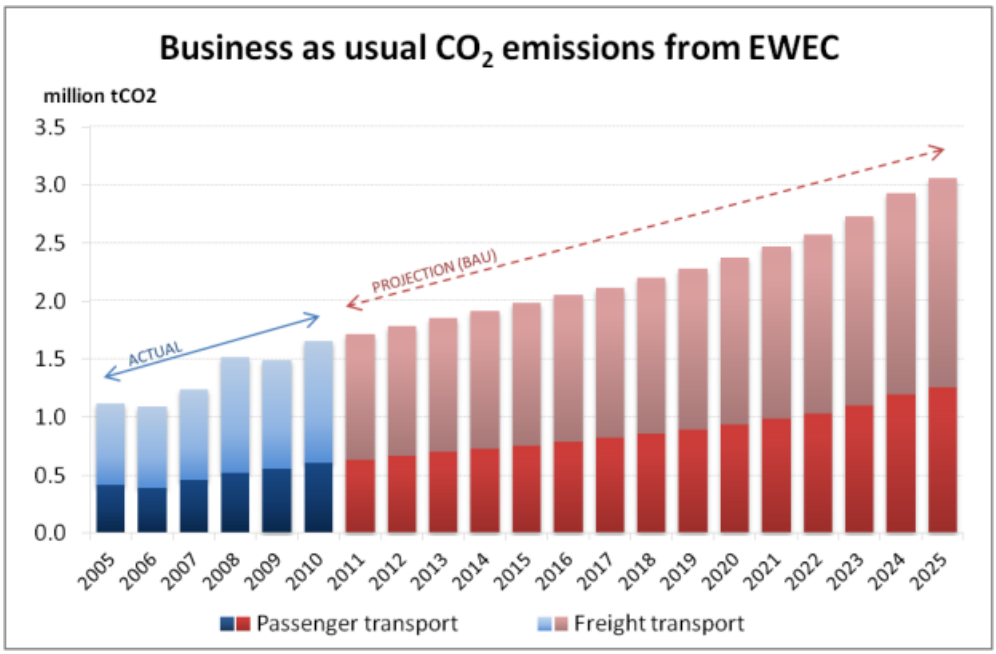


**Figure 7. GHG emissions from the East-West Economic Corridor (EWEC) from 2005 to 2025.**

23. The geographic distribution of emissions is proportionate to the length of the corridor in each country and is affected by the condition and size of the roads as well as the location of urban areas and freight demand / supply centres. As shown in Figure 5, road sections in Lao PDR produce only fraction of the emissions produced in sections in Thailand (particularly around Khon Kaen) and Viet Nam (between Dong Ha and Da Nang). This is a reflection of freight and goods movement and the location of economic hubs across the three countries. Thailand sees larger volumes of domestic freight traversing the EWEC which connects urban agglomerations such as Khon Kaen, Phitsanulok and Sukhothai. In Viet Nam, Da Nang is a rapidly developing port situated along the main highway which connects northern and southern provinces in the country. In Lao PDR, estimates for section 7 are slightly larger than those for 8 due to the traffic the situation of an urban centre, Savannakhet, and traffic from two roads, route 9 and route 13 (north-south).

[25] When compared with emissions estimates from other sources the results given here are seen to be reasonable. Frasier et al. (2007) found that emissions from the EWEC in 2005 were around 1 million tonnes $CO_2$ which are similar to the results here. Also, in Thailand the EWEC is responsible for 1.6% of national traffic activity and fuel sales in EWEC provinces make up 4.5% of national fuel sales, which is comparable to GHG emissions from the EWEC which are equivalent to just under 2% of total transport emissions in the country in 2009.

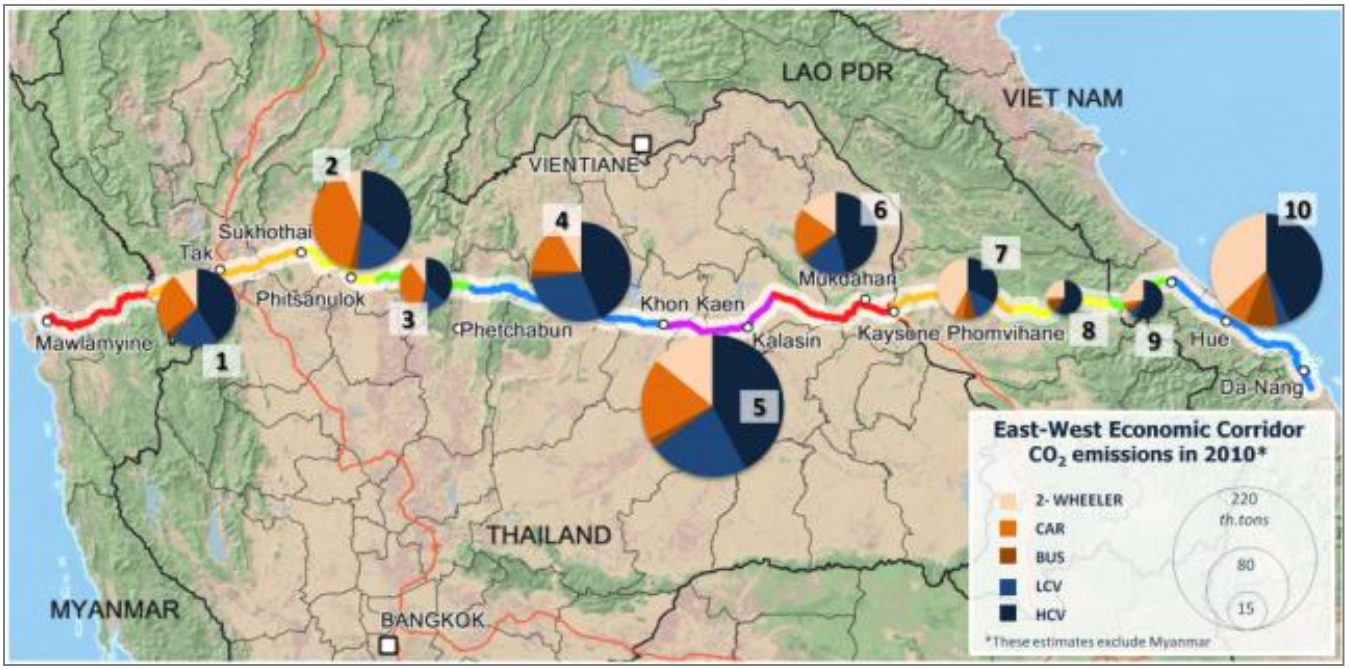


**Figure 8. GHG emissions from different sections of the EWEC in 2010 by vehicle type**

24. The overall footprint of the EWEC shows a sharply increasing trend over time. In contrast, when emissions from freight transport are expressed per unit of activity i.e. per tonne-km, a stable or decreasing trend can be seen. This implies that though traffic activity is increasing over time, under a BAU scenario the carbon intensity or efficiency of the activity will remain the same or decrease. Carbon intensity is dependent on the type of fuel used by freight transport as well as efficiency of the transport fleet. As seen in Figure 6, the carbon intensity of traffic in Thailand is lower than Lao PDR or Viet Nam – in these estimates, this variation is largely due to the increasing use of CNG assumed over time in Thailand which reduces the GHG emissions per unit activity.

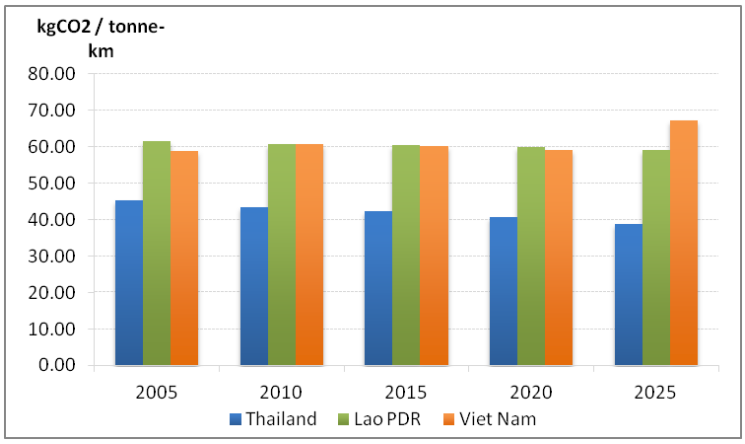


**Figure 9. Average carbon intensity for freight traffic along the EWEC**

## D. Alternate low carbon scenarios for the EWEC

### 1. Reducing emissions from freight through energy efficiency

25. Five main sets of interventions have been evaluated in terms of the carbon savings they would result in if implemented across the corridor. These include: a) Implementation of fuel standards; b) Upgrade of national fleets due to replacement of older vehicles; c) Deployment of cleaner fuels at a national level in the three countries; d) Retrofitting vehicles with green technologies; e) Improving driver behaviour with eco-driving capacity building; and, f) Improving freight efficiency by enhancing logistics management capacity. The main assumptions used in each of the scenarios and resulting carbon savings are shown in Table 6.

**Table 4: Average annual carbon savings associated with recommendations in the CNTC feasibility study**

| Proposed intervention | Annual carbon savings ($tCO_2$) | Main Assumptions |
|---|---|---|
| Fuel standards | 30,000 | 3% increase is seen in fleet fuel efficiency every five years due to improvements in technology and trends in the rest of the world. |
| Vehicle upgrade | 52,500 | 15% of vehicles are upgraded in 2015; new vehicles replace the oldest in the fleet. |
| Deployment of cleaner fuels | 57,000 | Current rates of deployment of biofuels and CNG are accelerated in Viet Nam and Thailand; CNG is introduced in Lao PDR and Viet Nam; biofuel targets are introduced and met in Lao PDR. |
| Vehicle technologies | 81,000 | Vehicle retrofits result in a 10% increase in fuel efficiency; 90% of fleet is retrofitted by 2015, and 100% by 2020. |
| Improved driver behaviour | 63,000 | 10% increase in fuel efficiency due to driver training and regular preventative maintenance. |

26. From this analysis, the greatest potential savings are seen to arise from retrofitting vehicles with aerodynamic equipment and better quality tyres, though improved driver behaviour through better maintenance and eco-driving training is also seen to show significant carbon savings per year. Vehicle upgrades are seen to show smaller carbon savings, partly due to the assumption in this analysis where vehicles are upgraded as a one-off intervention – reducing the overall age of the vehicle fleet by replacing old vehicles in phases and limiting the overall age of the fleet would result in potentially larger savings. Though logistics management will not result in a decrease in absolute carbon emissions, the carbon efficiency of freight movements will increase as shown in Figure 15.

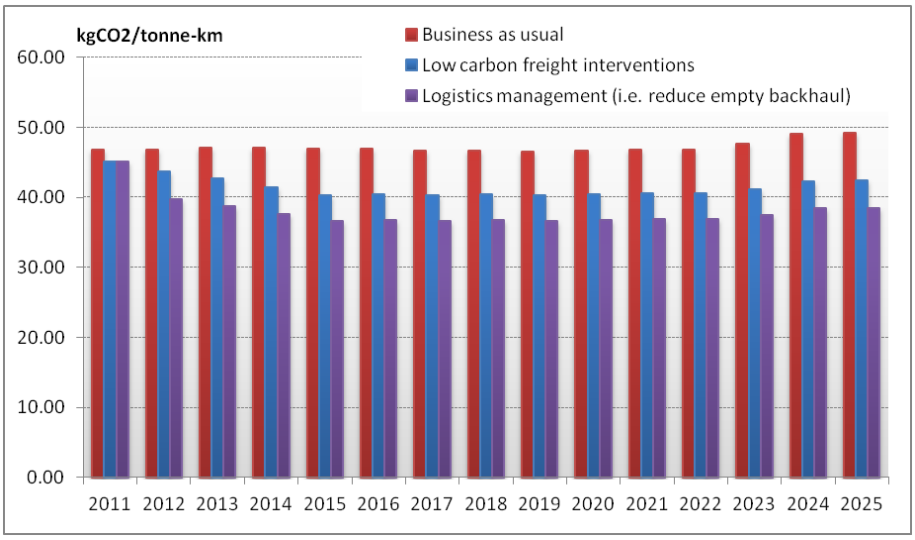


**Figure 10. Carbon intensity of freight activity under alternative scenarios**

27. If the low carbon freight interventions analyzed in this study were implemented $CO_2$ emissions could be reduced by 23% against 2005 levels. Due to projected increases in freight traffic activity, overall emissions will increase irrespective of the scenario. This is to be expected - Thailand, Lao PDR and Viet Nam are in varied stages of development, and robust inter and intra regional trade helps sustain economic growth and reduce poverty. Increasing the efficiency of freight and passenger traffic, however, will continue to be important for these countries and interventions proposed here will address fuel consumption per unit of activity.

## 2. Offsetting emissions through forestry

28. In order to illustrate the potential for carbon sequestration two scenarios are presented to use the land that meets the suitability criteria for plantations of indigenous (slow growing) species that will restore forest cover in time, to something approaching the natural forest. These scenarios represent the extremes between using all the land with >50% suitability and only the land with >70% suitability. It is assumed in both scenarios that the planting would be carried out over a 10 year period and that the $CO_2$ sequestration would follow a growth curve based on *Hopea odorata* (a moderately slow growing indigenous hardwood species) with a Site Index of 11. See Table 7 below.

**Table 5: Areas planted and $CO_2$ sequestered under two scenarios for restoration of forest**

| | Scenario 1 Areas >50% suitable over 10 years with slow growing indigenous species | | | | Scenario 2 Areas >70% suitable only the smallest patches with slow growing species | | |
|---|---|---|---|---|---|---|---|
| | Area planted annually (ha) | Accumulated planted area (ha) | $CO_2$ sequestered (tonnes/an) | | Area planted annually (ha) | Accumulated planted area (ha) | $CO_2$ sequestered (tonnes/an) |
| | | | 3.92 | | | | 3.92 |
| Year | | | | | | | |
| 1 | 3,569 | 3,569 | 19,111 | 1 | 50 | 50 | 270 |
| 2 | 7,139 | 10,708 | 46,904 | 2 | 101 | 151 | 662 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 3 | 10,708 | 21,416 | 85,878 | 3 | 151 | 302 | 1,211 |
| 4 | 14,277 | 35,694 | 135,133 | 4 | 201 | 503 | 1,906 |
| 5 | 17,847 | 53,540 | 197,327 | 5 | 252 | 755 | 2,783 |
| 6 | 21,416 | 74,957 | 279,582 | 6 | 302 | 1,057 | 3,767 |
| 7 | 24,986 | 99,942 | 345,232 | 7 | 352 | 1,410 | 4,870 |
| 8 | 28,555 | 128,497 | 434,360 | 8 | 403 | 1,812 | 6,127 |
| 9 | 32,124 | 160,621 | 535,302 | 9 | 453 | 2,266 | 7,550 |
| 10 | 35,694 | 196,315 | 648,359 | 10 | 503 | 2,769 | 9,819 |
| 11 | | | 817,690 | 11 | | | 11,534 |
| 12 | | | 913,172 | 12 | | | 12,880 |
| 13 | | | 886,434 | 13 | | | 12,503 |
| 14 | | | 974,898 | 14 | | | 13,751 |
| 15 | | | 797,637 | 15 | | | 11,251 |
| 16 | | | 854,703 | 16 | | | 12,056 |
| 17 | | | 957,223 | 17 | | | 13,502 |
| 18 | | | 979,235 | 18 | | | 13,812 |
| 19 | | | 974,706 | 19 | | | 13,748 |
| 20 | | | 974,944 | 20 | | | 13,752 |

29. The scenarios for forest cover restoration suggest that if most of the area considered to be >50% suitable (just in Lao PDR) were restored it could offset about a half of total corridor emissions. On the other hand, restoring only the areas considered to be >70% suitable would offset about a third of the emissions generated in the Lao PDR sections of the corridor. Taking an average plantation establishment cost of about US$800 per ha including overheads and transaction costs, the investment required for the Scenario 1 would be almost US$ 156 million over 10 years, which at current market values for $CO_2$ this would eventually generate annual emission reductions worth around US$ 5 million just from the carbon sequestration, but would bring other economic benefits in the form of soil and water conservation and habitat restoration for biodiversity conservation. Scenario 2 would require an investment of only about US$2.2 million and would generate annual emission reductions worth around US$70,000.

### 3. Feasibility of achieving 'Carbon Neutral' status

30. Overall, carbon emissions from the EWEC could be reduced by 90% against a 2005 baseline by 2020, 25% reduction due to low carbon freight interventions and 65% offset due reforestation of areas with above 50% suitability in Savannakhet (see figure 17). Over fifteen years (2011 to 2025), a cumulative 7.95 million tonnes $CO_2$ could be reduced from the EWEC by implementing both transport and forestry interventions which is equivalent to 43% of cumulative emissions from the BAU scenario against a 2005 baseline.

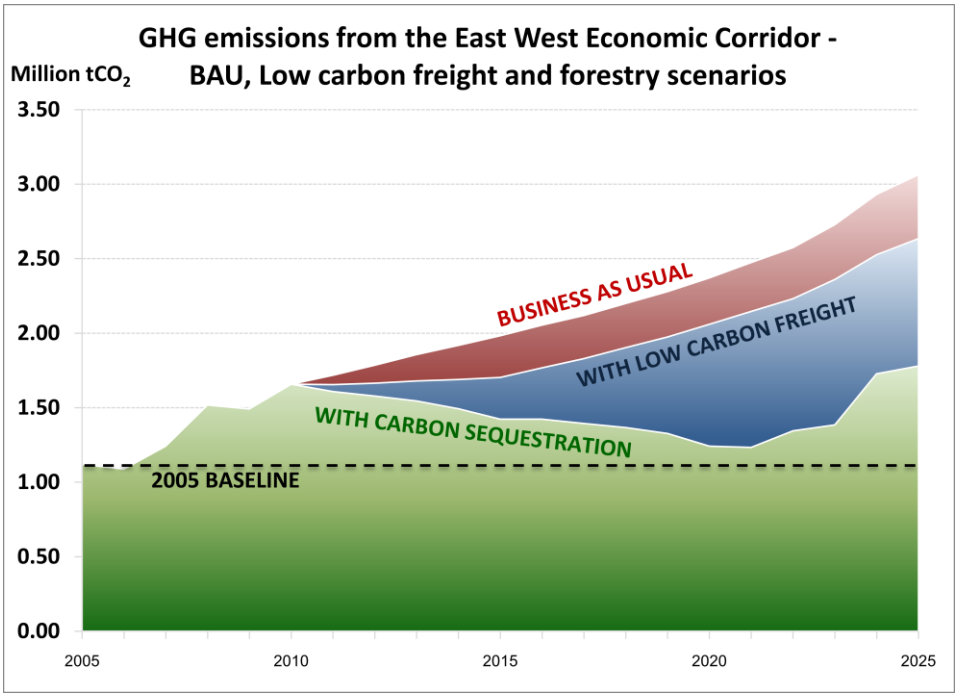


**Figure 11. Business as usual and alternative scenarios for the GMS EWEC**

31. Achieving 'carbon neutral' status would mean that emissions for the corridor in any one year would be the same as those in the baseline year i.e. 2005. The savings described here are significant savings when considering reforestation has only been considered from one of the 14 provinces through which the EWEC runs. Theoretically, if more area were taken into consideration there is likely to be enough sequestration potential in corridor provinces to offset all the transport emissions from the corridor.

32. However, there are multiple reasons why this is unlikely to happen in the near future. First, though land may be suitable for reforestation in Savannakhet (or in other provinces), land availability is a serious issue which will only be exacerbated over time with increasing demands for food, raw materials for industry and energy. Additionally, achieving a subregional carbon neutral corridor would require the development of an offset mechanism i.e. some way of attributing savings from reforestation to carbon emissions from transport which raises its own set of issues related to attribution and accountability. Expecting small and medium scale freight companies to contribute to carbon offsets would easily negate any potential cost savings and economic benefits from fuel efficiency.

## E. Impact of deforestation and biomass change on carbon sinks

33. The impact of deforestation along the EWEC was analyzed using Remote Sensing and Image Analysis techniques and focussed on Savannakhet province in Lao PDR Forest cover was analyzed for three different time periods (present, -5 years, -10 years) by applying supervised classification techniques to medium resolution satellite imagery. This analysis was complemented by field work to collect above ground biomass (AGB) data in Savannakhet province. A second component of the analysis studied the short term dynamics of forest carbon emissions within distance to construction of a corridor road. Changes in biomass (using the Enhanced Vegetation Index [EVI]) within a buffer around

Route 9 (the EWEC road in Lao PDR) were analyzed for an eight year period between 2001 and 2008. This analysis was based on low spatial resolution / high temporal resolution satellite imagery (Moderate-resolution Imaging Spectro-radiometer [MODIS]). The two components of work together present a reasonable picture of carbon stock changes along the EWEC.

34. Based on the forest cover classification (see Figure 7) and field work, the estimated current forest carbon stock in Savannakhet Province is in the range 50-70 million tonnes. Estimates for annual change in this carbon stock from 1982 to 2010 can be derived from national forest cover assessments – these estimates are consistent with the analysis here and suggest that the total carbon stock in Savannakhet province declined from about 75 million tonnes to about 68 million tonnes over the 28 years. Smoothing out the four data points[26] suggests a current average annual loss in carbon stock in the province of about 200,000 tonnes, which if converted to $CO_2$ will yield around 750,000 tonnes annually[27]. In comparison, annual $CO_2$ emissions from transport on Route 9 in Lao PDR are estimated to be 73,000 tonnes or less than 10% of those from deforestation between 2005 and 2010 (see paragraphs 14 to 16).

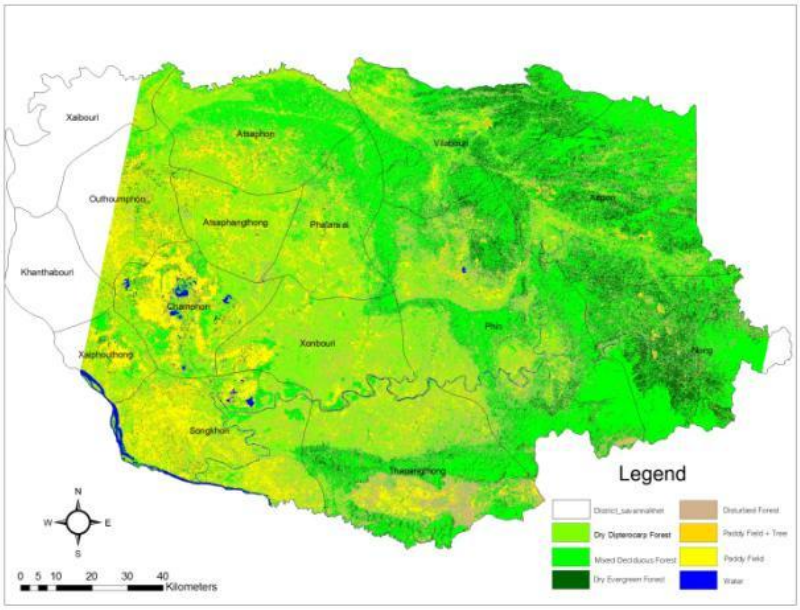


**Figure 12. Forest cover and AGB in Savannakhet province**

35. The analysis of biomass changes along Route 9 focussed on a buffer zone of around 240,000 ha (11% of the province area). This buffer was defined by travel time from the road i.e. <30 minutes, 30-60 minutes, 60-90 minutes, 90-120 minutes and 120-180 minutes[28]. Deforestation 'hotspots' were

[26] I.e. Data for 1982, 1992, 2002 and 2010.

[27] This is comparable with results from a study carried out by the SUFORD project covering about 470.000 ha surrounding the Dong Sithuane Production Forest Area (about 22% of the provincial area). The study found that during the 3 years 2006-2009 a total of about 700,000 tonnes of carbon stocks were lost or more than 230,000 tonnes annually.

[28] Comparison of the travel times and distances show that these segments correspond to distances of approximately <1 km, <2 km, <3 km, <4 km and <6 km.

identified from significant changes in EVI. The analysis showed that average biomass (EVI) is lower near the road and higher at the outer limit of the buffer zone, and deforestation hotspots can be seen closer to the road as shown in Figure 8. The study also suggested that least change in EVI changes are in the middle segment i.e. 60-90 minutes (<3 km) from the road, with increasing changes in biomass recorded near the road and further away from the road. These results are consistent with an expected reduction in vegetative cover near the road due to land clearance and settlement, and also with logging in the more remote areas, some of which would be illegal since much of the forest in the outer zone of the buffer is in Conservation Forest (Protected Areas).

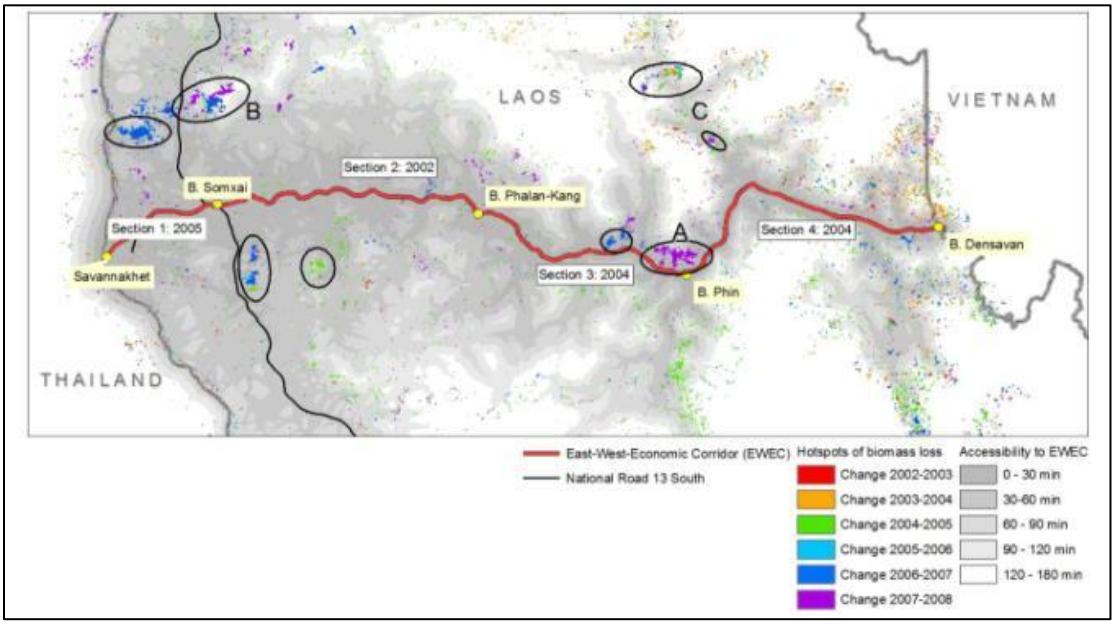


**Figure 13. Overview of hotspots of deforestation based on a sudden drop of EVI yearly means from one year to the next.**

# IV. ISSUES RELATED TO FUEL EFFICIENCY IN THE EWEC FREIGHT SECTOR

## A. Overview of the freight sector in EWEC countries

37. A survey of freight operators was carried out to understand the type and structure of freight transport providers along the EWEC and attitudes towards fuel efficiency measures. It consisted of face-to-face interviews with 56 freight operators and in-depth interviews with key respondents from local government and freight associations in 9 provinces along the EWEC[29]. Interviews were held with multinational logistics companies based in the capital cities who are engaged in cross border transport. Experts from academia and logistics centres of excellence were also consulted through interviews.

### 1. National freight sectors in Thailand, Lao PDR and Viet Nam

38. The size and standard of the freight sectors in the three countries vary. Thailand and Viet Nam have well established freight sectors with a large number of companies of different sizes. Annual freight tonnage in Thailand was 505 million tonnes in 2009 and the number of logistics companies in the country was over 338,000; in Viet Nam annual freight tonnage in 2009 was 699 million tonnes. However, the sector is very fragmented with the majority of service providers being small and medium sized companies as seen from data collected during the survey (see Figure 12)[30]. This is particularly true of the companies based in EWEC provinces in all three countries.

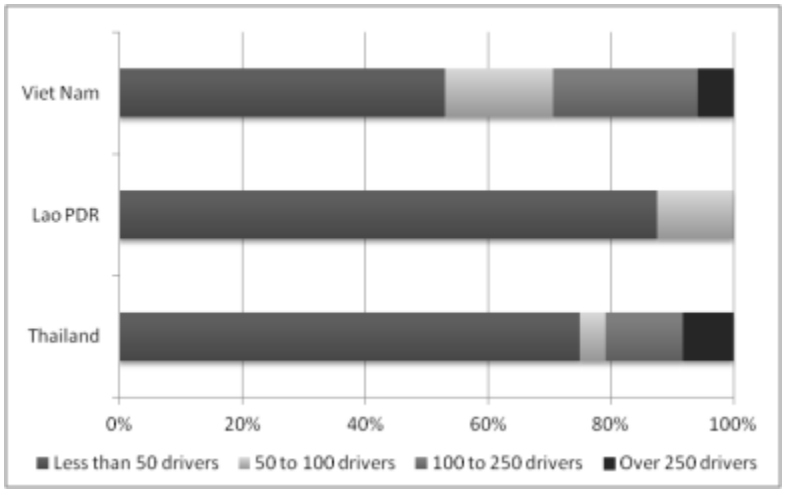


**Figure 14. Companies interviewed classified by number of drivers employed**

39. The freight sector in Lao PDR is immature compared with Thailand and Viet Nam, with only 54 companies registered in the country. Logistics is considered one of the bottlenecks for overall development with the major underlying problems being attributed to empty haulage (which in turn raises

[29] Namely, Savannakhet province in Lao PDR; Tak, Phitsanulok, Khon Kaen, Kalasin and Mukdahan provinces in Thailand and Da Nang, Hue and Quang Tri provinces in Viet Nam.

[30] One of the indicators of a company's transport fleet is the number of drivers employed - most of the companies interviewed were seen to employ less than 50 drivers, whereas a few companies were seen to employ over 100 or 250 drivers in Thailand and Viet Nam. In Lao PDR the largest of the companies interviewed hired only 70 drivers.

the cost of transport), high transport costs, limited transport demand and limited capacity of transport businesses[31]. Savannakhet province is an important point for cross border trade with the major share of exports exiting the country through this province. The main transporters are based around Vientiane whereas transporters in the provinces work through cooperatives / good transport associations.

40. At a regional level, in terms of cross border transport of goods and commodities, the most intensively used route is between Thailand and Malaysia and the fastest growing routes are from Thailand/ Malaysia to the South of China, and from the South of China to Vietnam[32]. At a local level, companies based along the EWEC make use of the roads for either domestic or cross-border transport. From the companies surveyed, the most frequented part of the corridor (measured by number of trips) was seen to be at the Mukdahan/ Savannakhet border crossing, the road between Mukdahan and Kalasin (which is the common route for vehicles from Laem Chabang port to Lao PDR), and route 9 in Lao PDR (which is the transit route for the transport of import/export from/to Thailand, Viet Nam and southern China). The area around Da Nang, on the other hand, was seen to be used less due to the comparitively low volume of cargo coming through the port[33].

### 2. Freight companies and associations

41. There are over 1200 road freight companies registered in the EWEC provinces, with the majority registered close to the major hubs like Khon Kaen and Da Nang, and some close to the border area of Mukdahan. Ownership of these companies varies between private, state-owned and joint ventures between private and public owners. In the EWEC provinces in Thailand most companies interviewed were under domestic ownership, while in Savannakhet, Lao PDR, a number of companies transporting raw materials from the main mining areas in the province were part owned by Thai owners. Overall, road freight companies can be divided into three categories based on their major source of income:

- Road transport / trucking companies – these companies generally own a fleet of vehicles and carry freight load either directly for a client who needs transport services (i.e. a shipping line or manufacturing company) or as a subcontractor for a broker;
- Transport / customs brokerage – these are companies that act as a broker between transport companies and clients who need transport services; they generally do not own or manage vehicles. Some transport brokers also carry out customs brokerage services for clients that require cross border transport.
- Freight forwarders – these companies offer both services i.e. transportation using their own (and subcontracted) fleet and customs brokerage for cross border transport.

42. There are also a number of international logistics companies working in the GMS including 3PLs (3rd party logistics) or multinational freight forwarders. These generally handle most of the consumer

[31] MPWT and JICA, 2010. Comprehensive study on the logistics system in Lao PDR.

[32] From the interviews of MNC 3PLs operating in Thailand, Lao PDR and Viet Nam.

[33] According to the Viet Nam Seaports Association, 2.5% of Viet Nam's sea freight tonnage went through Da Nang port in 2010, compared with 21% through the ports around Ho Chi Minh City and 24% through the northern ports of Hai Phong and Cam Pha.

goods, manufactured items and high-tech goods from multinational shippers / manufacturers (e.g. Samsung, Seagate, Western Digital and Ericsson) moving internationally within the region. The companies fall into two subcategories:

- Multinational companies engaged in freight forwarding or third party logistics ("MNC-3PL") who subcontract much of their actual trucking to local transport companies. Some MNC-3PLs (e.g. TNT) also own some of their own vehicles though this is usually restricted to vehicles used on domestic logistics operations rather than international work.
- Local or regional truck operators (mostly Malaysian or Thai) who have established themselves in the "niche" market of catering to the specific requirements of MNC-3PLs. These companies either partner with similar truckers in neighbouring countries or set up their own subsidiaries in those countries to take over loads at the border.

43. Transport associations in the three countries include national level associations that focus on representing the viewpoints of the sector to the government and local level goods associations that manage the freight forwarding services of a number of smaller transport companies or owner/drivers. The former could either be apex bodies for freight forwarding companies (i.e. Thai International Freight Forwarders' Association [TIFFA], Lao International Freight Forwarders' Association [LIFFA]) or for goods transporters (e.g. Land Transport Federation of Thailand). The latter are more akin to cooperatives in thier function – in Savannakhet, for example, the transport association manages over 300 vehicles. Another type of association relevant to the freight sector are industry associations with members from different industry and manufacturing areas (e.g. Federation of Thai Industries, Chambers' of Commerce). Such associations also provide training for companies and support companies with issues such as access to finance.

44. The level of influence of different associations and their links with government also vary by country. In Viet Nam, the Viet Nam Automobile Transport Association is officially recognized by the government as the focal point for engagement with freight operators. VATA have a fully staffed office at their headquarters, and also maintain regional offices representing regional associations. In comparison, the Land Transport Federation in Thailand is run by volunteers from different freight companies. The individual regional associations in Thai provinces, on the other hand, work independantly and have dedeicated staff at their offices.

## B. Factors affecting fuel efficiency

45. ***Vehicle types and fleet structure.*** The main types and characteristics of fleets being used by companies along the EWEC and neighbouring areas are important to identify potential areas for reducing fuel use. Of the 2600 vehicles covered during the survey, the most common sizes of truck were 18-wheel and 6-wheel trucks. Most of the companies surveyed used 18-wheel trucks as their main truck size[34], with 6-wheel struck providing a good alternative for smaller loads. Major trucks

[34] This largely because 18-wheels vehicles achieve the optimum fuel / load balance for most companies along the EWEC. The fuel consumed by an 18-wheel vehicle is similar to that of a 12-wheel vehicle, though the load capacity (as defined by government regulation) of the former is higher.

brands include Hino, Isuzu and Mitsubishi. Some of the companies surveyed in Viet Nam were making use of second hand imported vehicles from brands like Freightliner.

46. ***Type and cost of fuel used.*** Fuel costs make up 40%-60% of operating costs for freight companies operating along the EWEC depending on the condition of the fleet and type of fuel used. Access to alternative fuels is limited and the main fuel type use for HCVs in the three countries is diesel. The exception to this is Thailand where around 34% of vehicles in the survey were using CNG (mostly reconditioned rather than new CNG vehicles). Despite increasing use of CNG in Thailand in the last five years, a number of companies interviewed stated their reluctance to change their fuel type due to limitations in the supply and quality of CNG available. This is particularly true of north and northeast Thailand – in 2011 there were only seven CNG stations located along the EWEC in Thailand. Companies stated that the inadequate supply of CNG and long waiting times at refilling stations offset savings made due to lower fuel costs.

47. ***Average age of fleet and replacement of vehicles***. The average age of a company's vehicle fleet significantly affects its fuel consumption and related emissions of air pollutants and GHGs. In Thailand, half the national truck fleet are under 10 years old and around 24% of trucks are less than five years old indicating a relatively modern fleet. However, the issue of older trucks does exist, particularly in areas further from Bangkok, with 34% of the national fleet in 2010 or around 280,000 vehicles seen to be over 16 years old. These trends were echoed in the data collected from companies along the EWEC. The age of vehicles was seen to be higher in Lao PDR and Viet Nam, with companies making use of outdated engine technologies. Over 50% of Lao and Vietnamese trucks surveyed were between 15 and 20 years old, and many companies use second hand trucks bought at the age of around 7 years and then used for another 15 to 20 years.

48. Vehicle replacement is another indicator of the age and efficiency of a fleet. Most Thai companies stated that they would replace their vehicle every 5 to 10 years. In Viet Nam and Lao PDR, companies were seen to run their vehicles longer with the average replacement period being 10 – 15 and over 15 years respectively. The main barriers to procuring new vehicles are risk and lack of access to finance. In Thailand, due to favourable interest rates (3% to 5.5%) companies procure their vehicles on credit, lease or using a loan – however, low or unstable demand for goods means that companies are reluctant to invest in new vehicles unless they are awarded a contract that warrants this (i.e. long term or high value with specific standards). In Lao PDR and Viet Nam, access to credit is the main issue. High interest rates in Viet Nam (around 20% to 25%) and not enough cash stops SMEs from investing in fleets. In the Da Nang area, many companies stated that unpredictable demand for services hinders business development and procurement for companies. In Lao PDR, due to the immature nature of the industry and the relatively small size of Lao transporters, some are unable to get access to bank finance.

49. ***Empty running and vehicle loading.*** Empty running or empty back haul also affects the overall efficiency of the overall fleet, attributable to around 25-50% of travelled distances covered by companies surveyed. There are three main causes for empty trips: a) underlying trade volume imbalances; b) restrictions through government agencies on the use of empty equipment for re-loading; and c) market inefficiencies i.e. cargo owners or agents not knowing of empty trucks available for re-loading. One way to minimize empty loads is through networking and collaborating with other freight

companies. Though this was seen to be common practice among MNCs interviewed, smaller transport companies lack the connections / network and capacity to reduce these inefficiencies. Overloading is a common problem with vehicles on the EWEC (particularly in Viet Nam and Lao PDR) with implications for road safety and accident. Many companies (particularly in the Vietnamese sample of the survey) considered overloading as a way of managing fuel cost and maximizing profit. However, as shown in Figure 13, the difference between the fuel consumption of loaded and empty trucks is in the range of 17% to 30% and overloading increases fuel costs while also decreasing the overall life of the vehicle.

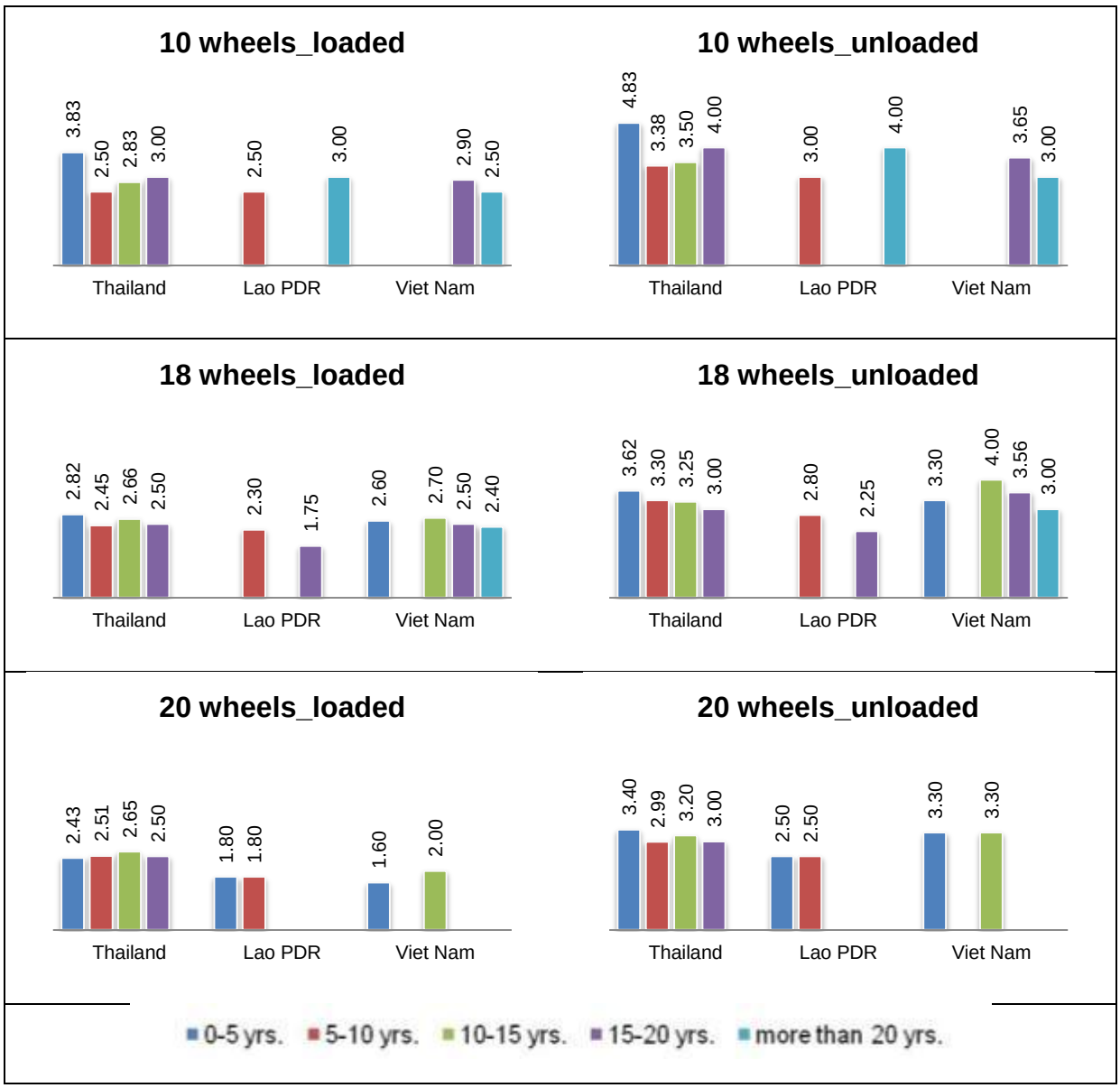


***Figure 15.*** **Fuel consumption of vehicles surveyed classified by type of vehicle and loading (km/l)**

## C. Company attitudes to energy efficiency

50. The main strategies being used by companies to manage their fuel costs include a) Incentivizing drivers to reduce fuel costs per trip; b) Regular maintenance of vehicles; c) Using GPS to better

manage trips and monitor fuel consumption; and, d) Driver training in road safety and eco-efficiency. Some companies in Thailand are also using aerodynamic equipment, though not always to its best advantage[35]. The prevalence of the above mentioned strategies are varied among different companies depending on size and capacity, and by country. The overall tendency is that company size decreases as does the use and prioritisation of fuel efficiency measures. In Viet Nam, some companies also overload their trucks on purpose as this allows them to maximize their profits despite paying the extra fuel cost as well as potential fines / tea-money along the road.

51. The willingness and attitudes to applying more effort to reduce fuel costs in companies also varied by country. In Thailand, there is much external support already available for companies (e.g. financial support, well established associations) and companies' responses showed a willingness to retrofit in-use vehicles to better manage fuel costs. In Lao PDR, the lack of entrepreneurial capacity and prevalence of very old vehicles means that reducing fuel costs are not an immediate priority, though any activity to improve overall fleet management capacity and improve the vehicle fleet would be very welcome. In Viet Nam the major issue facing companies is a lack of access to funds – to both upgrade and retrofit fleets.

52. The need for more information and capacity support is a common thread in all three countries – in Thailand, the focus is on better information on fleet best practice coupled with increased awareness among drivers; in Viet Nam, the focus is on better information on technologies to reduce fuel use in a local setting and an increase in driver and manager capacity; and in Lao PDR the focus is on increasing business management capacity.

## D. Policy environment and gaps

53. A review of national transport policies and institutional frameworks in Lao PDR, Thailand and Lao PDR was undertaken and gaps analyzed. The focus of the review was on instruments related to energy conservation and fuel efficiency targeting a) vehicles; b) fuel; c) driver behaviour; d) logistics businesses and e) infrastructure.

### 1. Lao PDR

54. Policies in Lao PDR regulate the condition of imported and modified vehicles through vehicle standards put in place by the Ministry of Public Works and Transport (physical standards) and the Ministry of Natural Resources and Environment (emission standards for air pollutant from diesel and benzene engines). Vehicle inspection standards are also in place though implementation of these is still weak with only 7 provincial inspection centres operating in 2011.

55. A recent development in the logistics sector is the development of a National Logistics Strategy that aims to stimulate the development of logistics in Lao PDR by optimizing cargo flows and stimulating businesses. The draft 2012 strategy for road transport development also mentions increasing the capacity of transport businesses and developing the logistics concept. One recent

[35] Some companies are making use of this equipment to advertise their company were unaware of how this equipment impacted their fuel usage.

program of interest is a pilot project funded by the Government of Japan to test tachographs in a few trucks in Vientiane.

56. Though there are a number of national strategies that promote energy conservation, there are no specific policies or regulations in place yet in Lao PDR targeting the fuel efficiency of vehicles. Additionally, there is a major gap in terms of driver training capacity and training in the country, particularly for freight vehicles.

## 2. Thailand

57. **Policies and regulations.** Thailand has a comprehensive policy framework in place to regulate energy efficiency and the environmental impact of vehicles. Whereas emission standards and alternative fuel policies are aimed at all types of vehicles, energy conservation measures and those promoting 'green' vehicles exclude heavy goods vehicles.

58. Major legislative instruments (e.g. the Land Transport Act, the Energy Conservation Action Plan, and the Renewable Energy Development Plan) are supported by regulations and include measures to regulate the emissions from gasoline and diesel engines (emission standards), measures to promote the use of alternative fuels (economic incentives, tax breaks for biofuel compatible vehicles, incentives for vehicles that emit less than 150 gm $CO_2$ / km) and measures to reduce fuel consumption in passenger cars (energy labelling schemes). Thailand also has in place policies to promote the use of 'Eco-cars'. One of the obvious gaps in the policy framework in Thailand is that though eco-driving and other initiatives focussing on driver behaviour are mentioned in strategic documents, there is no underlying regulation or targets for these.

59. In terms of energy conservation, Thailand has multiple economic and other instruments in place to reduce energy consumption in the country. The 20 Year Energy Efficiency Development Plan (2011-30) has a target to reduce energy intensity by 25% by 2030 and indentifies transport as a priority sector for energy conservation contributing a maximum reduction of 13,400 ktoe by 2030. Funding mechanisms like the Energy Conservation Fund, Energy Efficiency Revolving Fund and ESCO Funds engage with private sector banks to promote access to low cost funding for energy efficiency projects. Much of this funding has gone to projects in the energy sector projects and those focussing on the built environment, whereas the coverage of transport sector energy efficiency has been limited.

60. One major set of policies targeting freight vehicles in the last decade has been on alternative fuels. Thailand has promoted the use of CNG and biofuels (biodiesel and bio-ethanol), and fossil fuels are regulated to Euro 4 standards. Reconditioning of freight vehicles for the use of CNG or dual fuel (CNG / diesel) has been strongly encouraged and 3% of the overall Thai truck fleet (around 20,000 vehicles) were using CNG in 2010. Policies related to alternative fuels have faced some issues in achieving their overall outcomes due to issues with fuel pricing and fuel supply (i.e. in the case of CNG).

61. **Institutional arrangements for freight fuel efficiency**. The responsibility for freight transport and efficiency of freight vehicles is divided among different ministries and departments (see Table 5). Emissions standards are set by the Pollution Control Department (Ministry of Natural Resources and Environment) whereas the implementation of regulations is under the Department of Land Transport

(DLT) (Ministry of Transport). DLT is also responsible for regulating freight businesses, and for implementing regulations covering vehicle inspection and maintenance. Overall transport policy for the country is within the mandate of the Ministry of Transport (Office of Traffic and Transport Planning). However, energy efficiency and conservation policy and regulations are overseen by the Ministry of Energy (Department of Alternative Energy Development and Efficiency [DEDE], Energy Policy and Planning Office [EPPO]).

**Table 6: Institutional map for fuel efficiency in the Thai freight sector**

| Institutions | Areas related to freight fuel efficiency | | | | | | Responsibilities relevant to freight fuel efficiency |
|---|---|---|---|---|---|---|---|
| | Freight vehicles | Freight businesses | Driver behavior | Infrastructure | Fuel type | Energy efficiency | |
| **Ministry of Energy (MOE)** | | | | | | | |
| Energy Policy and Planning Office (EPPO) | | | ✓ | ✓ | ✓ | ✓ | Development of policies and strategies for RE and EE |
| Department of Alternative Energy Development and Efficiency (DEDE) | | | | | ✓ | ✓ | Implementation of projects and policies on RE and EE |
| Department of Energy Business | | | | | ✓ | | Development of regulations |
| **Ministry of Transport (MOT)** | | | | | | | |
| Office of Transport and Traffic Policy and Planning (OTP) | ✓ | ✓ | ✓ | ✓ | | | Development of policies and strategies for transport |
| Department of Land Transport (DLT) | ✓ | ✓ | ✓ | | | | Regulator for: freight business registration, driver registration and licensing, vehicle registration, vehicle inspection and maintenance. Development of projects on logistics management. |
| Department of Highways (DOH) | | | | ✓ | | | Development and maintenance of transport infrastructure |
| **Ministry of Natural Resources and Environment (MNRE)** | | | | | | | |
| Office of Natural Resources and Environmental Policy and Planning (ONEP) | | | | | ✓ | ✓ | Development of policies and strategies on environment, climate change |
| Pollution Control Department (PCD) | ✓ | | | | ✓ | | Development of emission standards, regulations |
| Thai Greenhouse Gas Management Organization | | | | | ✓ | ✓ | Implementation of CC mitigation projects and MRV |

62. **Government funded programs.** A number of government programs and projects have been implemented over the last five years which are relevant to the fuel efficiency of freight vehicles and companies. DLT has established the 'Thai Truck Centre' at a national level which serves as an information hub for freight businesses. In order to increase the competitiveness of freight companies in the region, DLT has also introduced a Freight Quality and Service Standard for operators, which awards a 'Q Mark' to companies that comply with these standards. Apart from business management

best practice, the Q-Mark standards also cover preventative maintenance, energy efficiency and reduction of empty haulage. Due to the comprehensiveness of the Q-Mark standards the roll-out among freight companies has been restricted somewhat to larger businesses.

63. A recent program under the aegis of the Ministry of Energy is the Transport Incentive Program for freight suppliers and operators to reduce energy consumption from freight. Implemented by the Institute of Industrial Energy (under the Federation of Thai Industries), the project increased the uptake of fuel efficiency technologies, driver training and logistics management strategies. Working with the Energy Efficiency Revolving Fund, the project also provided financial support to companies in the form of a 30% subsidy on technologies. This program was a success in terms of participation and also outlines a number of lessons learnt applicable to similar projects. In terms of uptake of technologies, a majority of the freight operators used the subsidy to procure GPS navigation systems even though a host of other fuel conservation and efficiency technologies were showcased. The eco-driving activity was considered very effective with operators reporting up to 10% reduction in fuel consumption.

### 3. Viet Nam

64. **Policies, regulations and programs.** In Viet Nam, a comprehensive framework of emission standards and regulations on vehicle reconditioning are complemented by regulations to control the age of the vehicle fleets in the country (applicable both to passenger and freight vehicles). In terms of freight vehicles, regulations banning the modification of vehicles and limiting the maximum age of trucks to 20 years aim to reduce the environmental impact of trucks as well as to reduce damage to road infrastructure. Vehicle age and physical conditions are regulated through vehicle registration requirements which are linked to vehicle inspection and maintenance. One recent regulation (introduce in 2012) relevant to freight vehicles is the requirement for all trucks to be equipped with ‘black boxes’ or digital tachographs as a way of reducing accidents. These devices could also be used to monitor fuel use, though this is not part of the current regulations. Despite multiple regulatory instruments in place, an old and inefficient in-use fleet plying the roads point to the lack of government capacity to implement and enforce regulations. One particular issue raised by stakeholders is that due to the privatisation of vehicle maintenance facilities, the quality of maintenance services varies widely which in turn has affected the quality of vehicles on the road.

65. Additionally overall transport policies highlight the importance of energy efficiency and reducing pollution, including national targets for energy efficiency and renewable energy. In terms of alternative fuels, the overall biofuels strategy has ambitious targets in place for the use of biofuels in the country over the next decade. However, an underlying regulatory framework is not yet in place as illustrated by the dependence of the overall transport fleet, and particularly freight vehicles, on fossil fuels.

66. A recent Ministry of Transport program supported by the Government of Japan tested the use of on-board fuel monitoring devices in freight vehicles in a few trucks. Future phases of the program are going to roll these out in a small selection of companies (joint-ventures with Japanese freight companies). Though these have been seen to be effective in reducing fuel use, the equipment installed may not be affordable by SMEs in Viet Nam.

67. **Institutional arrangements.** The three main ministries with responsibilities related to freight fuel efficiency include the Ministry of Transport (MoT), Ministry of Natural Resources and Environment

and Ministry of Industry and Trade (see Table 6). Within the MoT, the Directorate for Roads in Vietnam (DRVN) is responsible for regulating freight businesses (including business registration) and driver training and licensing, and Viet Nam Register is responsible for regulating freight vehicles (including inspection and maintenance, physical and emission standards).

**Table 7: Organizations with responsibilities related to fuel efficiency in the Viet Nam freight sector**

| Institutions | Areas related to freight fuel efficiency | | | | | |
|---|---|---|---|---|---|---|
| | Freight vehicles | Freight businesses | Driver behavior | Infrastructure | Fuel type | Energy efficiency |
| **Ministry of Transport (MOT)** | | | | | | |
| Department of Transport | ✓ | ✓ | ✓ | ✓ | | |
| Department of Environment | ✓ | | | | ✓ | ✓ |
| Directorate for roads of Vietnam | | ✓ | ✓ | ✓ | | |
| Vietnam Register | ✓ | | | | | |
| Institute of Strategy and Policy on Transport | | | ✓ | | | |
| The National Transport Safety Committee | | ✓ | | | | |
| **Ministry of Natural Resources and Environment (MONRE)** | | | | | | |
| Vietnam Environment Administration | | | | | | |
| Pollution Control Department | ✓ | | | | ✓ | |
| Department of waste management and environmental improvement | ✓ | | | | ✓ | |
| Institute of Strategy and Policy on Natural Resources and Environment | ✓ | | | | ✓ | |
| **Ministry of Industry and Trade** | | | | | | |
| Energy department | | | | | ✓ | ✓ |
| Institute of Energy | | | | | ✓ | ✓ |
| **Ministry of Construction of Socialist Republic of Vietnam** | | | | | | |
| Department of Science, Technology and Environment | | | | ✓ | | |
| Department of Construction Management | | | | ✓ | | |

## E. Low carbon freight interventions for the EWEC

68. Holistic interventions to manage the environmental impact of transport are normally categorized around an 'Avoid, Shift, Improve' framework[36]. Applied to fuel efficiency in the freight sector such strategies could focus on: a) *Avoiding freight activity* i.e. reducing transport demand through increased efficiency in the way freight fleets are managed; b) *Shifting to more efficient modes* of freight transport such as rail; and c) *Improving current freight transport* vehicles i.e. replacing / retrofitting vehicles, improving maintenance regimes and driver behavior. Taking into account the context of the freight

[36] UNCRD and CAI-Asia, 2011. Best Practices in Green Freight for an Environmentally Sustainable Road Freight Sector in Asia.‖ Pasig City, Philippines.

sector in the three countries a selection of measures at a policy level, company level and vehicle level are evaluated below. Due to the road based nature of the East-West Economic Corridor measures that focus on increasing the efficiency of road freight movements are considered here.

69. Five main sets of interventions have been evaluated in terms of the carbon savings they would result in if implemented across the corridor. These include: a) Implementation of fuel standards; b) Upgrade of national fleets due to replacement of older vehicles; c) Deployment of cleaner fuels at a national level in the three countries; d) Retrofitting vehicles with green technologies; e) Improving driver behaviour with eco-driving capacity building; and, f) Improving freight efficiency by enhancing logistics management capacity.

### 1. Implementation of fuel standards

70. At a national level, implementation of fuel economy standards (e.g. Corporate Average Fuel Economy (CAFE) standards in the United States.) and associated policies have been seen to increase regulatory certainty for manufacturers faced with long investment cycles, enabling them to bring new technologies to market. Fuel economy standards focus on reducing the fuel consumption of new vehicles at the time of manufacturing, and are therefore a measure to improve fuel efficiency 'upstream'. Analyses of the CAFE standards have shown that the average fuel economy of the light trucks fleet in the US was reduced significantly over time (3% annual increase between 1975 and 1999)[37], for both domestic and imported vehicles which implies a spillover impact of these standards on vehicles manufactured in other countries. In addition, research shows that fuel economy mandatory standards enable greater greenhouse gas emission reductions (on average 2-3% per year) than voluntary systems (on average 0-1% reductions per year).

71. Currently there are no fuel efficiency standards in place in Thailand, Lao PDR or Thailand. In Thailand, fuel standards for passenger vehicles have been drafted as part of commitments under the suite of energy conservation policies at a national level, however, discussions with manufacturers are still ongoing. In Viet Nam, discussions with manufacturers have been initiated to establish baselines for fuel standards. The situation is complicated by the fact that freight vehicles are assembled in Viet Nam and there is a prevalence of second hand vehicles being used for freight.

### 2. Upgrading national fleets

72. Interventions to increase the overall fuel efficiency of new vehicles entering the market are often complemented by national programs to upgrade fleets through vehicle age regulations as well as incentive packages such as scrappage schemes, buy-back programs etc. This is an important issue for companies in Lao PDR and Viet Nam due to the prevalence of older vehicles, and the impact this has on the quality of service these companies are able to provide. The survey of trucks along the EWEC showed that the difference in the fuel consumption of a 5 year old and 20 year old vehicle could be as much as 20%. The main issue facing companies is a lack of access to funds – in this situation potential interventions could include low cost financing or provision of guarantees for companies to enable them to access newer vehicle technologies. Instituting a national level scrappage scheme in support of well

[37] National Research Council, 2002. Effectiveness and Impact of Corporate Average Fuel Economy (CAFE) Standards.

enforced age limits on vehicles could be one potential way to upgrade the fleet in Lao PDR and Viet Nam.

### 3. Alternative and renewable fuels for transport

73. Deployment of cleaner fuels such as biofuels or CNG is another national level intervention that can be employed to reduce the impact of transport. As seen in Chapter 4, efforts are already underway in Thailand and Viet Nam to increase the share of alternative fuels in the national transport fuel mix, though (in the case of Viet Nam) the implementation of these will need to be ramped up in order for national targets to be achieved. While the use of biofuels and CNG will increase the carbon efficiency of transport activity, they do not necessarily increase fuel efficiency. Additionally, there is increasing debate about the sustainability of biofuels supply. Recently, questions have been raised about the impacts of biofuels on food security in the face of dwindling land availability in the GMS.

### 4. Deployment of cleaner technologies

74. There are many vehicle technologies available to improve the fuel efficiency of the in-use fleet, including:

- Tire technologies and aerodynamic equipment that *reduce the resistance of the vehicle* to either the road or wind which results in fuel savings.
- Technologies to *reduce vehicle idling* which help vehicle owners reduce fuel use while idling (e.g. at a border crossing or within city traffic) either by switching off engines or switching to an alternate power source.
- Technologies to *reduce air pollutant emissions* from vehicle exhaust – these do not reduce fuel use and are normally deployed as a supplement to emissions regulations
- Newer or alternative vehicle technologies (e.g. hybrid vehicles)[38] that *reduce losses* from internal combustion engines and make use of alternative fuels.

75. Potential fuel savings vary depending on the physical condition of the vehicle, environment within which the technology is used (i.e. vehicle speed, quality of roads) and driver behaviour. A selection of different technologies and applicability to companies along the EWEC (based on the local context) is given in Table 6 below. All of these have been tested in a local setting in different parts of the world, but not all savings estimates are applicable to a GMS case. Pilot projects conducted in Guanzhou, China serves as an example of the range of savings expected from the use of technologies[39]. Tests of low rolling resistance tires along with tire pressure monitoring showed savings of 18% - part of this savings was attributed to better quality tire being used which in itself reduced the fuel use of the vehicle. In another test, aerodynamic nosecones and side fairing coupled with low rolling resistance tires showed savings of 6.7%. The study found that aerodynamic equipment is more effective on longer trips at higher speeds due to the overall increase in vehicle weight.

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[38] UNCRD and CAI-Asia, 2011. Best Practices in Green Freight for an Environmentally Sustainable Road Freight Sector in Asia.‖ Pasig City, Philippines.

[39] CAI-Asia, 2010. Guangzhou Green Trucks Pilot Project: Final Report for the World Bank - Truck GHG Emission Reduction Pilot Project.

**Table 8: Vehicle technologies and their applicability to companies along the EWEC**

| Technology | Description | Applicability to EWEC |
|---|---|---|
| **Tire technologies** | | |
| Better quality tires | | Yes |
| Low rolling resistance tires | Reduces rolling resistance or the friction between the tires and the road | Yes |
| Single wide-based tires | Reduces rolling resistance by replacing two tires with one wide tire | Yes |
| Automatic tire inflation systems | Maintains tire pressure at optimum levels | Yes |
| Tire pressure monitoring systems | Signals when tire pressures are too low | Yes |
| Nitrogen-filled tires | Nitrogen is used as an alternative to air inside tires which maintains optimum tire pressure for long periods due to tire rubber being less permeable to nitrogen than air. | Yes |
| Aluminum wheels | Reduces the weight of the tire | Yes |
| **Aerodynamic equipment** | | |
| Truck tractor aerodynamics | These could include a) Roof fairings (integrated air deflector mounted on the top of the cab) b) Cab extenders (known as gap fairings or gap seals, which reduce the gap between the tractor and the trailer) c) Side fairings and d) Air dam on front bumper (reduce air flow beneath the truck) | Yes |
| Trailer aerodynamics | These could include: a) Nose cones (installed on the front of the trailer) b) Side skirts (panels that hang down from the bottom of a trailer to enclose the open space between the wheels) and c) Trailer tails (panels installed at the back of the trailer | Yes (a); No (b,c) |
| **Idling reduction technologies** | | |
| Advanced truck stop electrification | Electrification units provided at rest areas for trucks which provide a source of power for heating / cooling | No |
| Auxiliary power units | Small diesel engine that provides power for an HVAC system and electrical outlets that service the sleeper cab | No |
| Satellite tracking | Using satellite data to monitor speed and driving behaviour of truck drivers | No |
| Vehicle telemetry units | Analyzing in-vehicle data on movement and performance - this can be combined with GIS information to provide information for fuel consumption monitoring | Yes |
| Automatic shut-down / start up systems | These are in-built integrated starter/generator systems that help reduce fuel use by automatically turning the engine off when the vehicle comes to a stop and restarting it instantaneously when the accelerator is pressed. These are more applicable in an urban context. | Yes |
| **Engine technologies** | | |
| Newer vehicle technologies | Improvements to fuel economy of a vehicle that is concentrated on the internal combustion engine. These could include variable valve timing and lift, turbo charging, direct fuel injection, and cylinder deactivation can be used to reduce engines losses. | Yes |
| Alternative fuel technologies | Hybrid, electric and fuel cell trucks | No |

## 5. Improving driver behavior and maintenance

76. Fuel use can also be reduced by focusing on how the vehicle is used and maintained. Fuel efficient driving (i.e. eco-driving) focuses on optimizing the speed at which a vehicle is driven, acceleration practice, and idling-related practice to reduce the fuel consumption of the vehicle. Eco-driving training for freight vehicles is normally offered by vehicle manufacturers (e.g. Hino, Isuzu) and

under government programs and has been seen to result in savings in the range of 5-10%. Thailand has a national strategy in place to promote eco-driving (though the implementation of this is yet to be rolled out), and in both Thailand and Viet Nam eco-driving training has been tested at a city-level as part of projects to reduce the environmental impact of transport. One of the gaps so far has been that eco-driving is often conducted as a one-off campaign, with little follow up monitoring to show whether fuel savings are maintained over time. Additionally, there are limited driver training schools / courses catering to freight companies and driver training is often not seen as a high priority for SME companies.

77. Improving preventative maintenance practices in companies can also help increase the fuel efficiency of the vehicle (for example, by improving tire pressure monitoring) as well as increase the life of the vehicle. Currently, maintenance practice varies widely among companies. As part of the Q-mark quality standard in Thailand, companies are required to maintain a schedule of maintenance activities carried out – however, this standard has so far catered to bigger companies.

### 6. Increasing logistics efficiency

78. Logistics management strategies to reduce empty backhaul and increase the overall efficiency of trips made include managing loads better (i.e. to match the capacity of vehicles and optimize deliveries / pick-ups), optimizing the routes travelled to avoid delays and monitoring vehicles and driver behavior. Some of these can be implemented in house by enhancing the fleet management and monitoring capacity of staff, whereas (particularly for SMEs) the optimization of loads requires inter-company arrangements facilitated by a network of contacts. Owner drivers often manage this issue by joining a trucking association (e.g. Savannakhet Trucking Association) which would help to optimize loads. Strengthening this capacity in national or provincial associations could facilitate better networking between companies. The system of a freight loads ‘virtual clearing house’ or platform where information on loads and clients can be exchanged could also be a potential way of optimizing deliveries / pick-ups. As part of the Transport Incentive Program in Thailand, advisory services were provided to companies to improve load management and warehousing solutions on a case by case basis, with average efficiency gains of 10% reported from participating companies.

# V. FORESTRY INTERVENTIONS IN LAO PDR

## A. Forestry Issues in Lao PDR

### 1. Trends in forest cover and quality

80. Until about fifty years ago, Lao PDR was a densely forested country with biodiversity richness among the highest in the world. The general sparseness of the human population contributed to sustaining the density of the forest and its species richness. In the second half of the twentieth century, a combination of wars, population expansion, especially in neighbouring countries, and economic development has placed increasing pressure on Lao PDR's forest resources. As a result the proportion of the land area that is forest covered declined from around 70% to about 40% over that period. This represents a loss of around 7 million ha of forest or about 140,000 ha annually.

81. However, forest area does not show the whole picture as the quality of the forest that has remained, as measured by the stocking density of trees has also declined sharply. Between 1992 and 2002 the area of forest classed as having a crown density of more that 70%, declined from over 3 million ha to around 800,000 ha or only about 3.3% of the land area. Most of the remaining forest has been heavily disturbed by logging and other human activities. There are no records of forest cover before and after the Indo-china wars, but it is almost certain that bombing, logging and road building for military purposes contributed greatly to the loss in forest.

82. According to the data in the forest land cover assessment for 1982, 1992 and 2002 and an additional survey in 2010, published by the Forest Department, which is post the war period, the number of trees in the forest with more that 20% crown cover declined from 6.04 billion to 5.15 billion over the 28 year period. The overall average growing stock in all forest types declined from 50.4 $m^3$/ha to 41.1 $m^3$/ha and the densest forest, that has more than 70% crown closure declined from an average of 137 $m^3$/ha to 127$m^3$/ha over the same period. Thus about three quarters of the decline in tree numbers and total volume was due to deforestation and about a quarter to degradation of the rest of the forest. The total volume lost from 1982 to 2010 was about 148 million $m^3$, which compares with a reported harvest of about 12 million $m^3$ during the same period.

83. It is not clear where the volumes of timber that appear to have been lost have gone, but a high proportion must be due to illegal or unrecorded logging and associated collateral damage to the remaining trees that results in their death and decay. The large decline in the number of trees and the data tend to confirm this as there were substantial declines in trees of all diameter classes and only about 60% of the volume lost was in trees of commercial size and species.

### 2. Government responses

84. Over the past decade or more the government has designated about 16 million ha of forest to be managed by the state as production forest (3.1 million ha), protection forest (8.2 million ha) and conservation forest (4.7 million ha), but of this area only about 40% is currently forested. There are a further 3.3 million ha of forested land not yet designated, much of which is expected to be managed by local communities eventually.

85. With water resources being of major economic importance to Lao PDR, especially for hydro-power generation, protection of watersheds is very important, and this, combined with the fact that around 70% of the land area of the country is on slopes steeper than 20% is why such a high proportion of the forest has been designated as Protection forest, which has the primary function of watershed protection. Detailed information on the proportion of the designated protection forest that is seriously degraded or devoid of forest cover is not available, but it is likely to be high and hence this forest category is the primary target for restoration for soil and water conservation, and carbon sequestration. Much of the land adjoining the EWEC transport corridor in Lao PDR, especially in the mountainous area on the Lao side of the border with Vietnam is designated as protection forest and therefore is a prime target for restoration and carbon sequestration.

### 3. Investments to reduce greenhouse gas emissions from forestry

86. In 2009, following the UNFCCC COP 13 in Bali, the government recognised the importance of the need to reduce emissions of GHG from deforestation and forest degradation and during 2010 prepared a REDD Readiness Preparation Proposal (R-PP) which was submitted to the Forest Carbon Partnership Facility. This was approved and the government given a grant of about US$3.4 million to implement the proposal. Following this the Forest Investment Program, under the Climate Change Fund administered by the World Bank selected Lao PDR as one of eight countries to pilot investments in measures to reduce GHG emissions under the REDD+ concept. An FIP Investment Plan was prepared during 2011 and approved in early 2012, which sets out the concept for three investment projects worth in total US$30 million that will aim to implement relatively large scale measures designed to make measurable reductions in GHG emissions. These projects are currently under preparation.

## B. Offsetting through forestry

87. There are two routes by which forests can contribute to offsetting emissions from other sectors such as transport. The first is through measures to reduce emissions from deforestation and forest degradation that may be exacerbated by the presence of a road that allows access to existing forest areas, which may then be more easily cleared or partially harvested for timber in an uncontrolled and unmanaged manner. The second is through the restoration of forest by tree planting on land that has already been cleared of forest, but is not being fully or effectively utilized for agriculture or other productive purpose.

### 1. Conservation of existing carbon stocks

88. The estimated current forest carbon stock in Savannakhet Province in Lao PDR is in the range 50-70 million tonnes (see Chapter VII for more details) and the current average annual loss in carbon stock in the province is estimated at around 200,000 tonnes, which if converted to $CO_2$ will yield around 750,000 tonnes annually. A study carried out by the SUFORD project covering about 470.000 ha surrounding the Dong Sithuane Production Forest Area (about 22% of the provincial area) found that during the 3 years 2006-9 a total of about 700,000 tonnes of carbon stocks were lost or more than 230,000 tonnes annually. About 50% of this loss was from Mixed Deciduous Forest and about 45% from Dry Dipterocarp forest. There is thus considerable scope for applying measures to ensure better protection of the current forest areas.

89. Investment in forest protection and management in the province could make a significant contribution to overall reduction in $CO_2$ emissions. This approach has the further advantage that forest that would have been disturbed, but is protected from encroachment and uncontrolled tree felling, will then grow and begin to sequester additional carbon. A reduction of about 10% in the annual loss of carbon stocks in Savannakhet province alone would reduce emissions by an amount comparable with one of the interventions in the transport sector. If similar conditions apply in Thailand and Vietnam, forest protection could make as big a contribution as all the transport interventions combined.

90. This would be a relatively cost-effective way to offset transport emissions, since little investment is required and the main cost involved is the provision of financial incentives to local communities and the transaction costs associated with establishing a baseline level of emissions and monitoring the carbon stocks to confirm the reductions in emissions.

### 2. Increasing sequestration of $CO_2$ through tree plantations

91. Further reductions in net emissions could be achieved by tree planting, as discussed above, but it will take far longer to achieve results because of the need to negotiate the land, train those involved and implement the work and the time taken for trees to grow and sequester measurable amounts of carbon.

92. A spatial multi-criteria analysis (SMCA) was configured to estimate location and amount of land potentially suitable for reforestation within the EWEC buffer zone in Savannakhet. Together with stakeholders, 18 restrictions and feasibility criteria were identified and considered in the assessment, among them concessions, production forest, high value forest and protected areas, hydropower catchments and reservoirs, terrain features, forest fragmentation, ecotourism tourism assets and socio-demographic indicators. The results suggest that there is a substantial area (196,313 ha) that conforms with 50% or more of the suitability criteria (see Figures 16 and 17). Of this area, about 50 patches are larger than 250 ha, while the vast majority of patches – 984 or ~95% – are smaller than 250 ha. The balance is in larger patches and therefore the areas are likely to be more suitable for some form of commercial private enterprise, rather than smallholders. If the suitability range is drawn more conservatively, i.e. an area must show 70% aggregated suitability rather than 50%, only about 3,000 ha could be identified, of which only one out of 84 patches is larger than 250 ha (318ha), likely making it feasible only for smallholder undertakings. This situation presents a number of possibilities for carbon sequestration that could offset some or all of the expected emissions from traffic in the coming years.

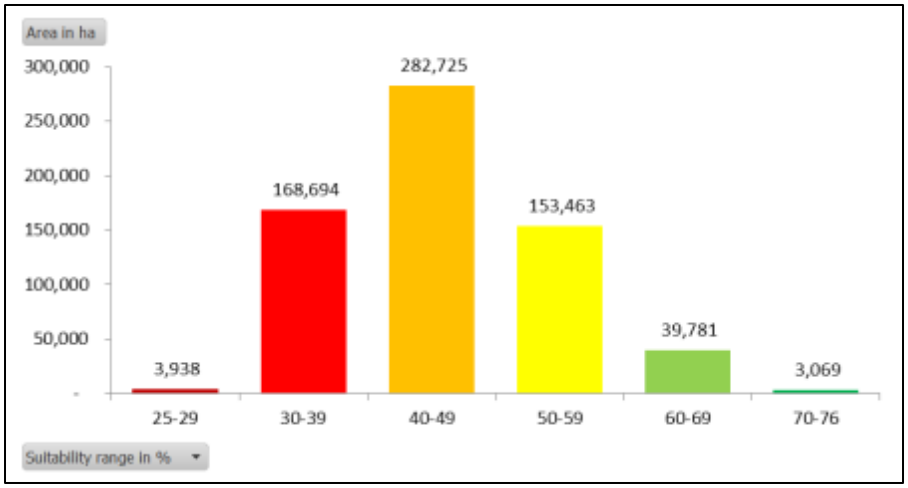


**Figure 16. Area suitable for carbon sequestration in Savannakhet province by suitability range**

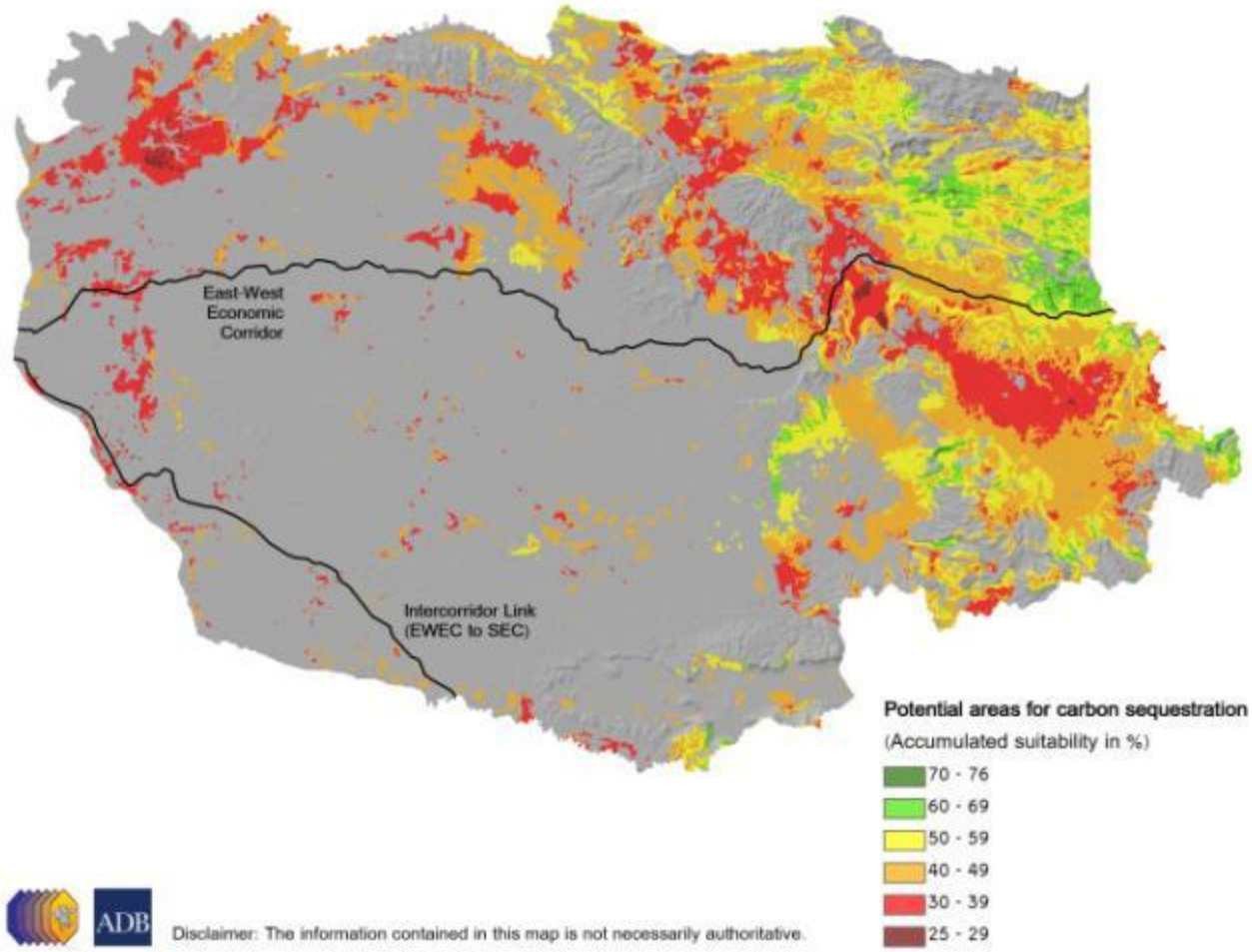


**Figure 17. Distribution of areas suitable for carbon sequestration in Savannakhet province by suitability range**

93. Trees sequester substantial amounts of carbon, most of which remains locked-up as long as the tree is growing, and may remain locked up in the woody part of the tree for many years beyond that if the wood is utilized. Provided it is not burnt, the release of $CO_2$ from the natural decomposition of the wood is quite slow. However, tree species vary in their growth patterns, and there are some species that naturally pioneer bare land, growing rapidly to compete with other vegetation and have a short life cycle while there are others that normally appear when tree cover has been established and grow slowly to form a diverse high forest, but have a very long life cycle. For carbon sequestration therefore there are a number of options: use pioneering-species that will rapidly sequester $CO_2$ and hope that nature will take over and that longer living forest species will appear after some years; use pioneer species and replant with forest species after 5-10 years; or plant slow growing forest species from the outset. Each of these options will have slightly different financial and cash flow implications.

94. Most of the fast-growing tree species that are used in commercial plantations are chosen primarily for their timber production potential and are exotic species within GMS. There are a large number of indigenous pioneering species within GMS, many of which come from the *Fabaceae* and *Euphorbiaceae* families that have very valuable attributes such as nitrogen fixation and the production of important bio-chemicals, and for restoration of degraded land and $CO_2$ sequestration such species should be used, although experience with their silviculture (seed collection, nursery and planting practice etc.) is limited at present. To this end a review of the current knowledge in the region on such indigenous species would be very valuable.

95. Most of the land that has been classed as suitable for carbon sequestering plantations is on slopes between 15 and 30% and so should be managed primarily for soil protection, water conservation and biodiversity, to provide economic benefits in addition to those from the $CO_2$ sequestration. They are also most likely to be on land that was formerly Mixed Deciduous Forest, since Dry Dipterocarp Forest is confined to the flatter areas and the Evergreen Forest is at higher elevations. This will have a bearing on the choice of species to use.

96. Areas planted by smallholders can also provide further benefits by using species that provide valuable Non-Timber-Forest Products (NTFPs) and create opportunities for additional cash income for the smallholders without affecting the sequestration potential. Some of the areas that have been identified as potentially suitable may have secondary forest that has established on land formerly used for shifting cultivation, and participatory land-use planning (PLUP) will be needed to ensure that the community are willing and able to refrain from using the land again. In such situations the natural regrowth of the forest could provide a very low cost means for $CO_2$ sequestration, with the main payments being to the community to protect the forest, rather than planting trees.

# VI. RECOMMENDATIONS

97. **Carbon neutral vs. Low carbon transport corridors.** It can be argued that any of the large scale carbon neutral developments currently in existence globally (e.g. Masdar City in Abu Dhabi, Logrono-Montecorve in Spain) are not carbon neutral in practice. However, setting a high, ambitious goal like 'Carbon Neutral' signals policy resolution to ultimately reach that goal. As established in the previous section, achieving a carbon neutral GMS corridor is unlikely in the short term – however, an overall vision of carbon neutral with 'Low carbon' as an intermediate, more realistic objective towards that goal may be more pragmatic. In terms of implementation, a phased approach separating out transport and forestry interventions would provide more opportunities for development (including for investment). For example, developing public-private models could pay for fuel efficiency uptake and national government funding could be sought for reforestation and forest protection either through a levy on capital infrastructure or through national forestry programs (such as REDD+).

98. **Low carbon transport interventions should focus on efficiency and co-benefits.** Fuel makes up as much as 40-60% of operating costs for transport companies operating along the EWEC, and with escalating fuel prices fuel efficiency interventions are becoming more of a priority. Fuel efficiency, rather than reducing overall fuel use in absolute terms, enhances the resilience of development and investments in the corridors. Focussing on Small-and Medium Enterprises (SMEs) would help increase the competitiveness of these companies (and in turn the corridor as a whole) and support the achievement of national targets towards poverty reduction. Additionally, promoting fuel efficiency has further co-benefits - increasing fuel efficiency by improving the way vehicles are driven also increases road safety (e.g. by bundling eco-driving and safety training) and investing in cleaner technologies helps to reduce air pollutants.

99. **Development of a mechanism to take into account the forestry related impacts of transport.** The analysis in this paper has served to show that forestry has significant potential – both as a source of greenhouse gases and as a potential intervention to combat climate change. Particularly, the difference in the scale of impact between transport and forestry in Savannakhet illustrates how important it is for transport projects to take GHG emissions from forestry into account. Currently, under safeguards requirements for transport projects, some compensation for land directly deforested as a result of road construction is normally included in project costs, however, the indirect impact of transport infrastructure is rarely acknowledged. The situation is complicated by the fact that emissions from land use change are not attributable to the transport sector alone, but rather these are a result of wider development where transport infrastructure acts as a catalyst. With increasing global movements towards accounting for and reducing GHGs from transport, there is a need to develop innovative examples from the GMS which channel funding from development sectors like transport (e.g. in the form of a carbon levy on infrastructure projects) to the forestry sector either as a compensation for forest loss or as a way of offsetting emissions from traffic.

100. **Develop and test mechanisms to increase the fuel efficiency of freight companies.** One of the recurring messages from freight companies and stakeholders is the need for more information on the savings from fuel efficiency interventions such as low carbon technologies or eco-driving in a local

setting. Also, learning from other regional programs on low-carbon / green freight[40], it is important to design and test a mechanism to provide access to fuel efficiency interventions to private companies which incorporates some degree of co-financing by companies (i.e. soft loans or subsidizing the cost of interventions). Based on the sector assessment, there is a need to develop institutional mechanisms to deploy interventions at a company level while driving the development of policy interventions at a national level. Pilot projects should be developed in each country which bundle capacity building and awareness of technologies with a financing mechanism at a local level. It is proposed that these projects cater to SME freight companies in EWEC provinces, and that institutional arrangements bring together government partners, local associations and academic experts. The main focus of the projects will be:

- Low carbon technologies: The pilot should include two parts: first, enabling access to energy efficient technologies for trucks[41] which have been tested in a local setting; and second, developing a revolving fund mechanism to enable SME freight operators to access funds to purchase retrofit equipment as required. In time this funding mechanism could be extended to vehicle upgrades as well.
- Eco-driving training for freight companies: This project would build the capacity of existing institutions / service providers in the countries so as to provide access to regular eco-driving training for freight. It will include identifying and developing training materials, testing on a small sample, facilitating the development of existing institutions to provide and monitor eco-driving training for freight operators.
- Logistics management: This project would build capacity of transport associations in the region to facilitate access to relevant management techniques and skills, networking and information on logistics by freight operators. This would enable freight companies to reduce empty running and increase fuel efficiency per unit load carried.

101. **Natural regeneration of forest for poverty reduction and carbon sequestration.** Most of the land that has been classed as suitable for carbon sequestering plantations is on slopes between 15 and 30% and so should be managed primarily for soil protection, water conservation and biodiversity, to provide economic benefits in addition to those from the $CO_2$ sequestration. Some of the areas that have been identified as potentially suitable may have secondary forest that has established on land formerly used for shifting cultivation, and participatory land-use planning (PLUP) will be needed to ensure that the community are willing and able to refrain from using the land again. In such situations the natural re-growth of the forest could provide a very low cost means for $CO_2$ sequestration, with the main payments being to the community to protect the forest, rather than planting trees. Possible interventions should include:

- Participatory land-use planning (PLUP) with communities within the buffer zone of the transport corridor to determine the precise location and extent of land where forest restoration will bring

[40] The China Green Freight Program which has grown from an initial pilot project in Guangzhou in Guangdong province.

[41] I.e. those that have been tested successfully in the region (e.g. China) - optimum sizing of tires, equipment to monitor tire pressure regularly and aerodynamic equipment to decrease the air resistance of the vehicle

economic benefits both in terms of improved livelihoods for the communities and a combination of soil, water and carbon conservation and restoration.

- As an outcome of the PLUP, negotiated agreements with the communities to manage and protect areas of forest that can be assigned to them. This will need funding and the negotiations should include identification of Payments for Environmental Services (PES) including $CO_2$ emission reductions that will provide sustainable long-term finance.
- Within the buffer zone of the corridor private sector concession holders for land development should be engaged, especially for commercial tree and rubber plantations, to develop plans for conservation and protection of specific areas within their concessions including buffer zones along rivers, streams and roads, residual patches of natural forest such as those found on many small hilltops and around important cultural sites and any areas of special importance as habitats for rare or threatened species to include birds, insects and small mammals.
- Both local offices of relevant government agencies for forest protection, conservation and production and local communities need capacity building for forest management and monitoring of the forests for which they are given responsibility. This should include training in forest inventory and carbon stock assessment and identification of species of plants and animals in order that changes in populations of important species can be monitored.