

Module B: ECO DRIVE



Report B4: Implementation Eco Drive

TA-7987 (REG)

**Core Environment Program and Biodiversity Conservation Corridors Initiative in the
Greater Mekong Subregion, Phase 2 – Green Freight Project Implementation – Lao and
Viet Nam**

Report realized on behalf of ADB

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20/07/2016

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MODULES

The reports within the ADB Green Freight Project are divided into four modules being Green Freight Technologies (GFTs), Eco Drive, Logistics Measures and Monitoring of implemented options. Within each module reports include an upfront technology assessment, a report on the pilot implementation as well as a report on the full implementation level.



Abbreviations

ADB	Asian Development Bank
CAI	Clean Air Asia
GFP	Green Freight Project
GFT	Green Freight Technology
GHG	Greenhouse Gas
GVW	Gross Vehicle Weight
HDV	Heavy Duty Vehicle
ICT	Intelligent Communication Technology
IEA	International Energy Agency
MOT	Ministry of Transport
UNEP	United Nations Environment Programme

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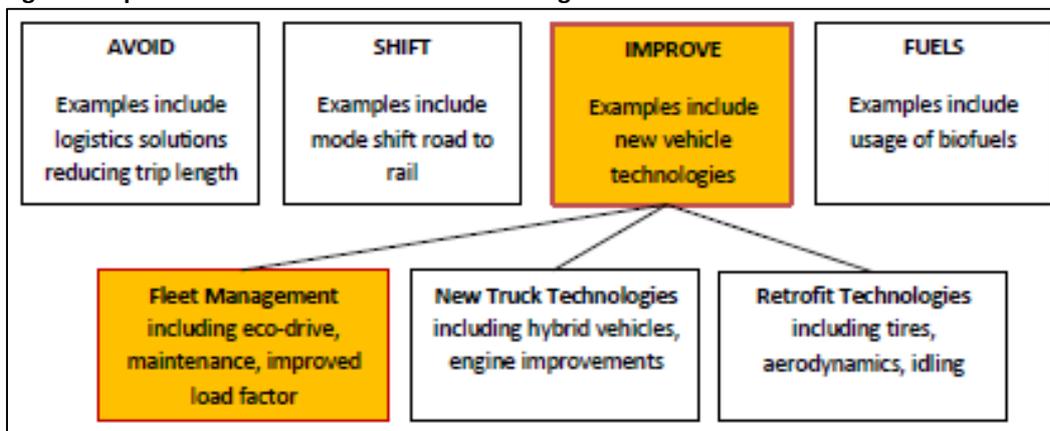
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1. Introduction

This report summarizes and assesses the experience with Eco Drive to reduce fuel consumption and GHG emissions of Heavy Duty Vehicles (HDVs, focus on trucks) in Viet Nam and Lao PDR. The report also summarizes international experience, the curricula developed for Viet Nam and Lao PDR and potential future steps. Eco Drive was implemented with a focus on long haul truck drivers within the scope of a Green Freight Program (GFP) of ADB realized 2015-2016 in Viet Nam and Lao PDR¹.

This report focuses on Eco Drive for HDVs. Within the framework of ASIF (Avoid – Shift – Improve – Fuel) there is a wide range of options available to reduce GHG emissions from freight transport. The figure below shows the focus for this report.

Figure 1: Options to Reduce GHG Emissions in Freight



Source: Grütter, 2015

Within the strategy of greening freight transport, the focus is on reducing emissions per distance driven of trucks by promoting Eco Drive i.e. the performance of the existing truck fleet shall be improved through a fleet management measure.

The structure of this report is:

- Chapter 2: Summary of the concept of Eco Drive including international experience;
- Chapter 3: Previous experience with Eco Drive in Viet Nam and Lao PDR;
- Chapter 4: Summary Eco Drive curricula for Viet Nam and Lao PDR;
- Chapter 5: Activities and trainings realized;
- Chapter 6: Eco Drive results.

2. Concept of Eco Drive

Eco Drive refers to a smarter and more fuel-efficient driving style adopting driving techniques that get the most out of modern vehicles and engines. Eco Drive tactics include accelerating slowly, cruising at more moderate speeds, avoiding sudden braking, idling less, as well as selecting routes that allow more of this sort of driving. Eco Drive is not only an easy and cost-efficient way to reduce fuel consumption but is also an attitude and respect for society as a whole. Eco Drive has been promoted since various

¹ The program is also being implemented in Thailand but not through Grütter Consulting

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decades in many countries worldwide with the goal of reducing fuel consumption with a safe driving style. Eco Drive as a government policy is in place in various countries of Europe, the US, Japan and Korea. International organizations such as the International Energy Agency (IEA) or The United Nations Environmental Program (UNEP) today also promote Eco Drive which has become a global effort.

The major **benefits** identified for applying Eco Drive are:

- Environmental impact (reduced GHG emissions and local pollutants);
- Economic benefits due to reduced fuel consumption and lower maintenance costs;
- Lower accident rate and less stressful driving;
- Eco Drive as an instrument to demonstrate the social and environmental responsibility of a company.

Important factors to ensure a sustainable impact of Eco Drive include fuel consumption monitoring, regular repetition of core messages and updating of information (e.g. for new vehicle technologies).

Major **obstacles** identified for widespread application of Eco Drive include:

- Eco Drive has the image of driving slowly;
- The benefits of Eco Drive are not recognized by all stakeholders i.e. low awareness as well as low motivation and interest resulting in low demand for training courses;
- Influencing drive-styles and habits is difficult;

Despite its popularity, there is poor and inconsistent research evidence regarding the effects of Eco Drive on both fuel consumption and emissions. Wahlberg states for example: *“The claims regarding the Eco-drive benefits were mainly made by educators and bureaucrats, and lack scientific backing”*. Eco Drive is difficult to turn into a driving habit as it is dependent on the driving situation such as traffic, environment and personal motivations. The impact of Eco Drive is potentially dependent on the driving circumstance (urban, highway), driver background (professional or amateur drivers) and on the vehicle category (bus, truck, taxi, passenger cars, motorcycles). Mostly data has been reported for passenger cars.

3. Previous Experience with Eco Drive in Viet Nam and Lao PDR

Viet Nam

Various and regular trainings for Eco Drive in passenger cars, taxis and light duty vehicles have been realized e.g. through the University of Transport Technology of the Ministry of Transport (MOT). Swisscontact in cooperation with Clean Air Asia (CAI) organized some years ago Eco Drive trainings for around 100 garbage truck drivers in Hanoi measuring the impact however only during the training course itself. Nippon Japan as well as Hino have also realized Eco Drive training with a focus on light duty truck drivers without ex-post impact measurement.

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Lao PDR

Some companies have been trained on Eco Drive e.g. the Vientiane Capital State Bus Enterprise trained drivers on Eco Drive under a Japanese program and Phu Bia mining has realized training internally for their truck drivers with an Australian instructor. Phu Bia has a truck simulator for trainings. No reports are available on monitoring of impacts of driver training.

4. Eco Drive Curriculum

Based on experience with an initial Eco Drive course for truck drivers a Curriculum for Eco Drive was developed² and discussed in workshops in Viet Nam and Lao PDR. Thereafter, the curriculum was applied in various training courses in both countries with around 100 truck (and in Lao PDR also bus) drivers being trained in Eco Drive). The curriculum includes a theoretical and a practical part:

- **Theoretical part:** This includes motivating the driver, explaining reasons why Eco Drive is good, explaining what needs to be done and why, and demonstrating the results of changing the driving style.
- **Practical experience:** This includes test-driving either on a simulator or with actual trucks. The instructor thereby gives the driver tips on how to improve his Eco Drive skills. Ideal is if a first test-drive can be realized prior the theoretical course and another test-drive after the course.

The 4 golden rules of Eco Drive are promoted:

1. Check your vehicle prior driving; The most relevant checks for low fuel consumption prior driving are tire pressure, cargo and aerodynamics;
2. Up-shift as early as you can and use high gears;
3. Drive defensively running at constant speed;
4. Effectively utilize the engine brake and retarders.

5. Activities and Trainings Realized

Basically two types of trainings were realized:

- Capacity building of trainers of driving schools on Eco Drive on the curriculum developed. This was realized in 2015 through a half-day workshop realized with around 15 trainers in each country.
- Training of 100 truck drivers in Viet Nam and 100 truck and bus drivers in Lao PDR in various courses during 2015 and 2016 using the developed curriculum. In all trainings all drivers performed trips on a standardized route prior course with precise fuel consumption measurement and just after the course measuring again the performance. The run after the course included feedback and recommendations of the instructor whilst the run prior course the driver had to drive as usual without assistance.

² See for details Report 3

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Photo 1: Training Courses Lao PDR and Vietnam



Source: Grütter Consulting

6. Eco Drive Results

6.1. Monitoring Method

To measure the impact of Eco Drive the following monitoring methods were used:

1. Measurement of fuel savings during the training course: each driver performed a trip on a pre-defined standard route with a truck. During this run no instructions were given. After the training course the driver performed the same run with the same truck and together with the instructor which also gave him feedback and tips during the drive. Fuel consumption was measured on both runs and compared. This monitoring approach gives an indication of the maximum potential fuel savings of Eco Drive.

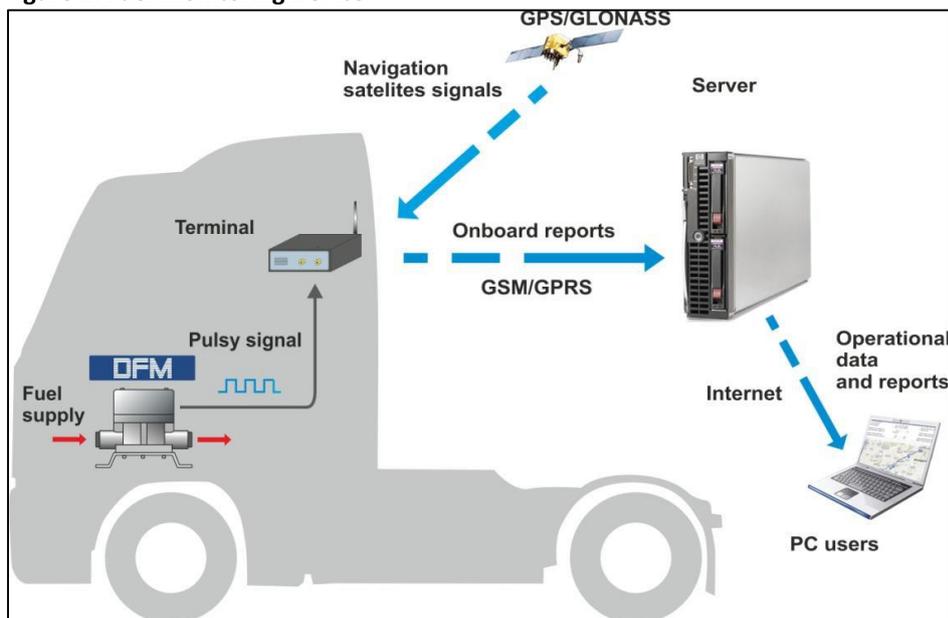
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- Fuel consumption of drivers was monitored one month prior and one month after the training course and then compared. Drivers used the same truck prior and after the training course but on differing routes. This monitoring approach indicates the short-term impact of training³.
- Monitoring of fuel consumption of drivers one month prior and up to 6 months after training. Drivers used the same truck prior and after the training course but on differing routes. This monitoring approach indicates the short-term impact of training.

Important is the fact that fuel savings are based on litres per ton-kilometre and not on litres per km. This takes into account that the average weight of tons due to differing loads and differing empty backhaul are not constant and therefore differences in weight need to be factored out when calculating efficiency gains.

Fuel consumption was measured during the training with fuel-flow measurement equipment. Measurement of fuel consumption of trucks during a longer period is based on GPS for distance driven, fuel consumption (based on drive computer of the truck or records) and on freight tonnage (based on loading papers). Some trucks were also equipped with telematics including direct volumetric measurement with Technoton equipment and GPS with data transmission (see figure below).

Figure 2: Fuel Monitoring Device



6.2. Results Viet Nam

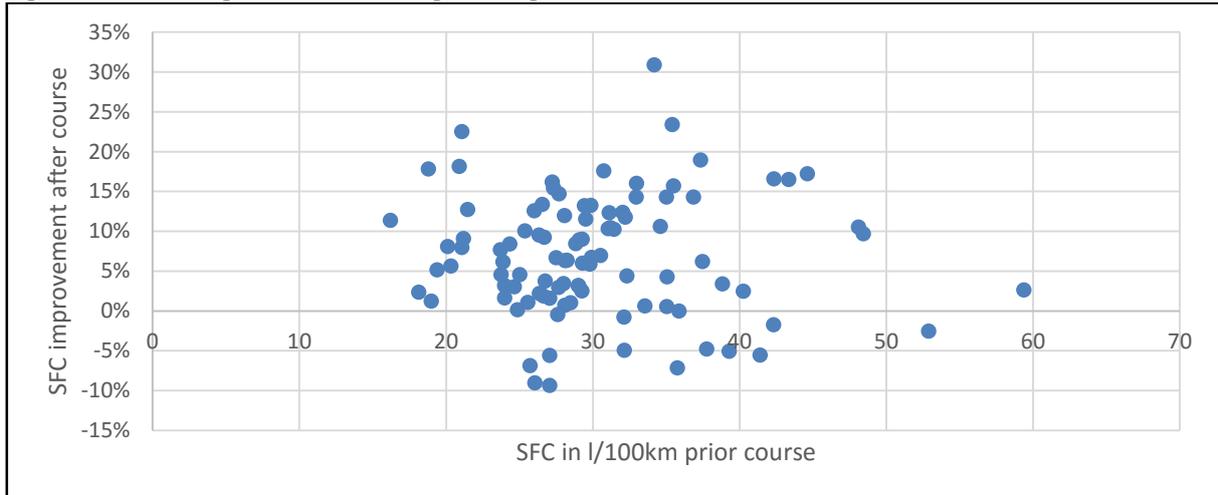
Training Results

The results during the trainings with valid data from 98 drivers indicates an average improvement rate of 7% of fuel consumption with a maximum of 31% and a minimum of -9% (median value also 7%; see figure below). 10% of drivers worsened their fuel consumption which is an indication also of variations of fuel consumption depending on driving circumstances. The 95% confidence level of fuel efficiency improvement is thereby between 5.5% and 8.5% improvement.

³ This monitoring was only realized in Vietnam

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Figure 3: Fuel Savings Measured During Training Viet Nam



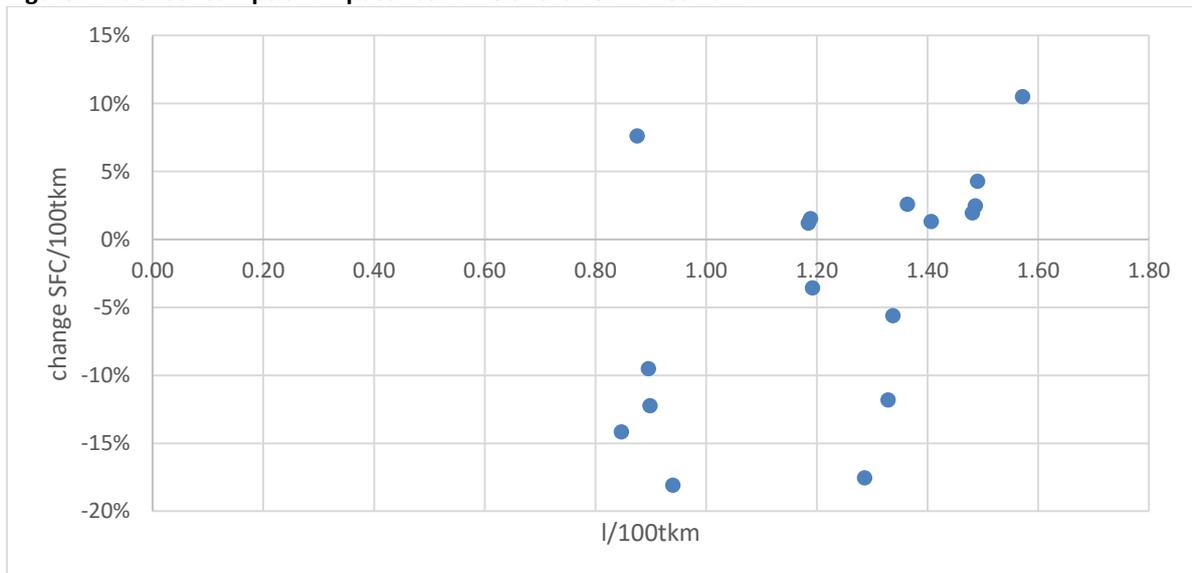
Source: Grütter Consulting (positive values indicate fuel savings and negative values an increase in SFC)

Average speed driven was around 40 km/h. Comparing the average speed prior and after the course latter was on average 8% higher i.e. Eco Drive did not result in lower but higher average speeds (which also explains at least partially the fuel savings). Absolute fuel consumption levels were on average 30 l/100km. The average GVW of trucks during training was 18t corresponding to the empty weight of large container trucks.

Impact after 1 Month

As trucks were driven with different weights the fuel efficiency was measured relative to ton-kilometre. On average fuel efficiency improvement was 3% in terms of tkm. Using a 95% confidence interval the range of fuel efficiency improvement is between -8% and +1.1%. This means that statistically we cannot exclude the possibility that Eco Drive does not improve fuel efficiency. The following figure shows the results for Viet Nam. The average speed of trucks thereby improved by on average 8%.

Figure 4: Fuel Consumption Impact Eco Drive Short-Term Viet Nam



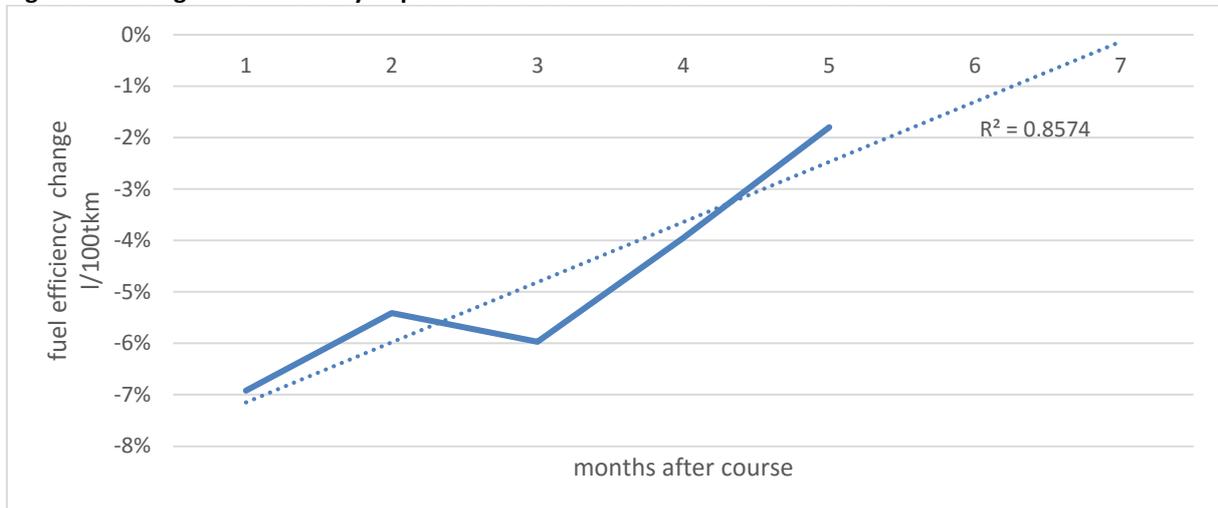
Source: Grütter Consulting based on data 1 month prior and 1 month after course (positive values indicate an increase in the specific fuel consumption and negative values a decrease)

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Impact after ½ year

Average fuel efficiency gains for litres per km dropped from initially 10% in month 1 to 6% in month 5 whilst the same trend can be observed in fuel savings relative to tkm where savings dropped from 7% to 2% (see following figure).

Figure 5: Average Fuel Efficiency Improvement Eco Drive Medium-Term Viet Nam

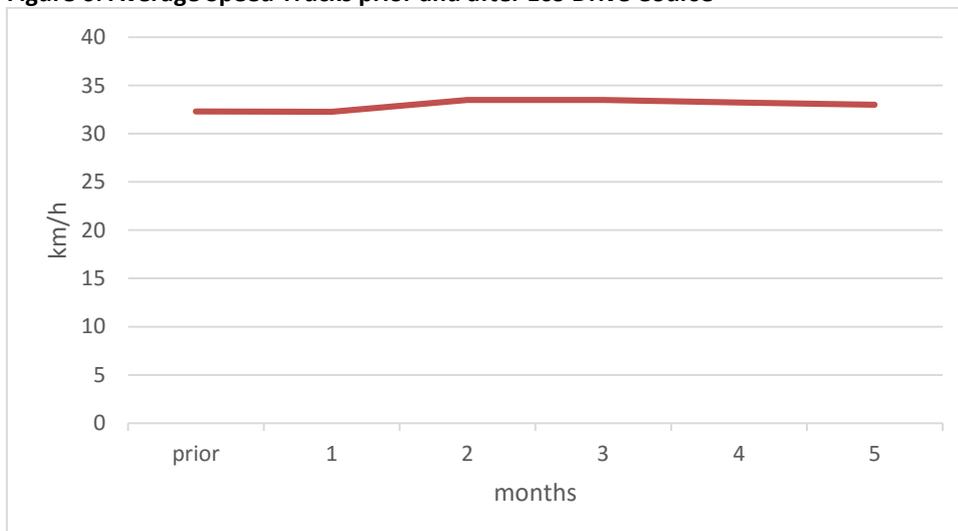


Source: Grütter Consulting based on data 1 month prior and 5 month after course

From above it can be clearly seen that the impact of Eco Drive diminishes over time. After around ½ year the average impact is around 2% and would reach 0% after 7 months if the current trend is forecasted. Using a 90% confidence interval the range of fuel efficiency improvement is between -7% and +3% for the month 5 and -8% and +1% for the month 4. This means that statistically we cannot exclude the possibility that Eco Drive does not improve fuel efficiency. Either training courses need to be repeated every semester to maintain a certain impact level or truck drivers need feedback on fuel usage and supervision of their companies e.g. through advanced telematics.

The following figure shows the median vehicle speed prior course and the 5 months after course. It shows no significant change meaning Eco Drive will not affect negatively or positively the speed.

Figure 6: Average Speed Trucks prior and after Eco Drive Course



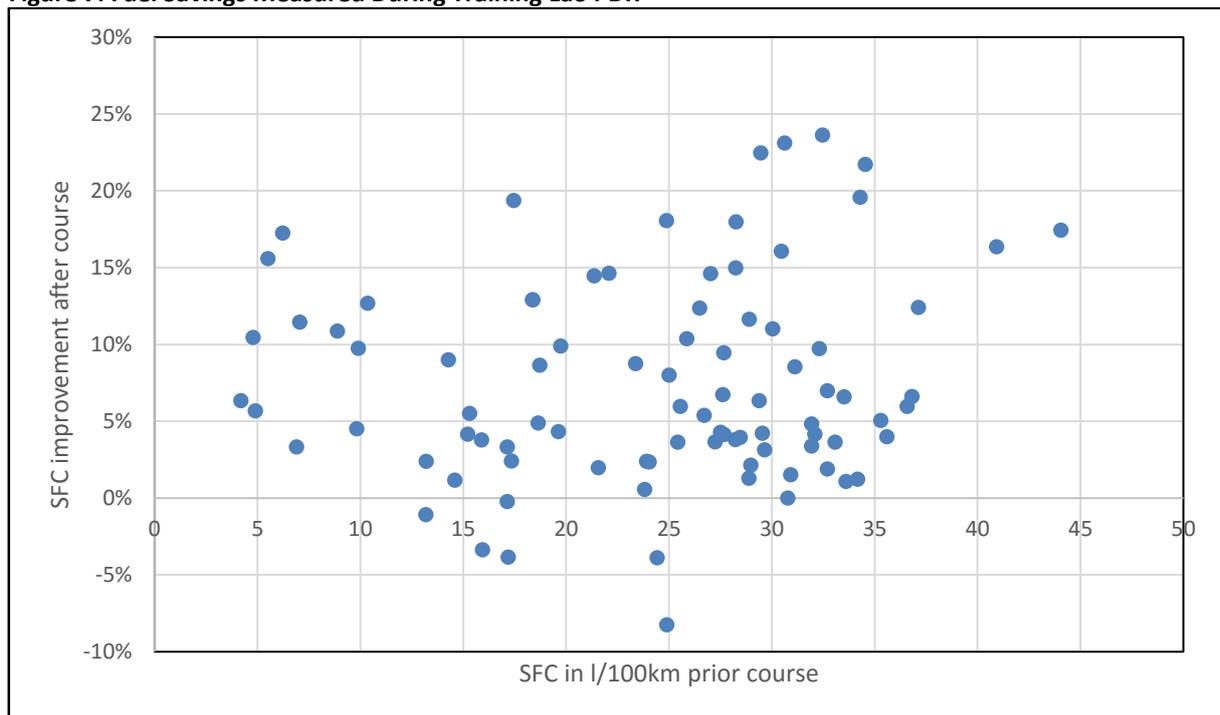
Source: Grütter Consulting based on GPS data 1 month prior and 5 month after course

6.3. Results Lao PDR

Training Results

The results during the trainings with valid data from 89 drivers indicates an average improvement rate of 8% of fuel consumption with a maximum of 24% and a minimum of -8% (median value 6%; see figure below). 5% of drivers worsened their fuel consumption. However, this is probably due to differing driving circumstances. The 95% confidence level of fuel efficiency improvement is thereby between 6.2% and 8.9% improvement.

Figure 7: Fuel Savings Measured During Training Lao PDR



Source: Grütter Consulting

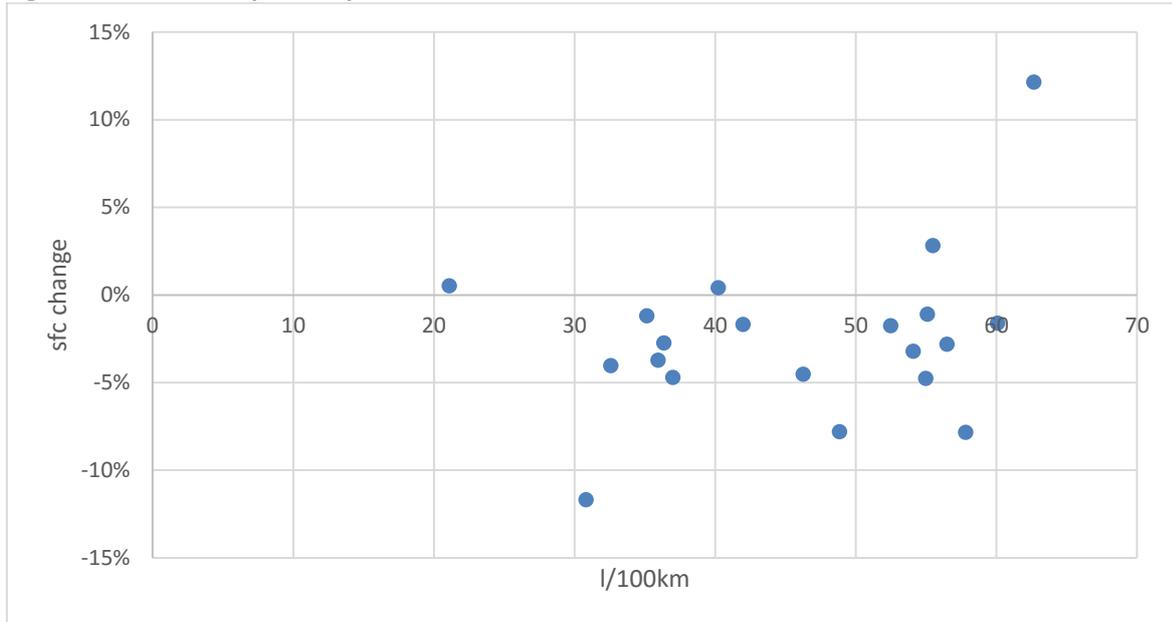
Average speed driven was around 50 km/h. Comparing the average speed prior and after the course latter was on average 6% higher i.e. Eco Drive did not result in lower but higher average speeds (which also explains at least partially the fuel savings). Absolute fuel consumption levels were on average 25 l/100km. The average GVW of trucks during training was 15t using to a large extent trucks of 18t and to a smaller part buses with an empty weight of 12t and smaller units of 3.5 tons.

Impact after 1 Month

As trucks were driven with different weights the fuel efficiency was measured relative to ton-kilometre. On average fuel efficiency improvement was 3% (median value also 3% saving). However, the median value showed no improvement of fuel efficiency reflected also in the fact that fuel efficiency had improved in 85% of drivers and had worsened in 15%. Using a 95% confidence interval the range of fuel efficiency improvement is between -5% and -0.3%. This means that statistically Eco Drive improves fuel efficiency with a 95% probability. The following figure shows the results for Lao PDR.

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Figure 8: Fuel Consumption Impact Eco Drive Short-Term Lao PDR



Source: Grütter Consulting based on data 1 month prior and 1 month after course (positive values indicate an increase in the specific fuel consumption and negative values a decrease)

6.4. Conclusions Concerning Eco Drive Potential

The impact of Eco Drive during the course is 7-8% fuel savings. However, under actual driving circumstances the improvement is reduced to 2-3% after 4-6 months and, without further training tends to 0% within 8 months.

The GHG impact of implementing Eco Drive, if sustained, would be around 3-4 tCO_{2e} reduced per annum per truck for Viet Nam or Lao PDR with a positive cost-benefit⁴. These savings might however not be sustained if there are no incentives for the driver. In the medium term no statistically discernible impact can be registered of Eco Drive if no follow-up is realized. To be successful and achieve sustainable savings of around 2-3% trucks need to be equipped with ICT equipment to allow drivers as well as trucking companies to keep track of fuel consumption and of performance of drivers.

Literature

J. Barkenbus, Eco-driving: An overlooked climate change initiative, *Energy Policy* 38 (2010), 762-769

Beusen, B. et. al., Using on-board logging devices to study the longer-term impact of an eco-driving course. *Transportation Research Part D: Transport and Environment*, 14, 514-520, 2009

CAI, Driver Training Course Guangzhou, China 2009

CAI-Asia, Guangdong Green Freight Demonstration Project Phase I Technology Demonstration Evaluation, presentation by Lu Fu, 06/2014

⁴ Based on the average SFC and mileage of trucks; higher value based on WTW incl. BC

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H. Chaari et.al., Fuel Consumption Assessment in Delivery Trucks to Develop Eco Driving Behaviour, Association for European Transport and Contributors, 2012

Ecowill, Identification of potential benefits for relevant target groups and recommendations how to influence target groups behavioural change in order to enhance ecodriving activity, 2010

Ecowill, Guidelines for delivering Short-Duration Ecodriving Training courses, 2011

Ecowill, Quality Control and Certification, 2011

Ecowill, Harmonised Ecodriving Curriculum for Driving School Education and Driver License Testing, 2012

Ecowill, Short Duration Training Handbook for Trainers, 2012

Ecowill, Ecodriving in Learner Driver Education Handbook for Driving Instructors, 2012

D. Van Hiep et.al, Towards Sustainable Transportation through Introduction of Eco-Drive Management System for Vehicle Fuel Efficiency, Proceedings of the Eastern Asia Society for Transportation Studies, Vol. 9, 2013

D. Hornung, et.al: Evaluation of the Eco-Drive, courses; in response to a commission from the Swiss Federal Office of Energy, 2000

J. James, Maintaining the Habit when Training is Over, Freight Best Practice, Department for Transport, UK, 2007

K. Lovejoy et.al, Policy Brief on the Impacts of Eco-driving Based on a Review of Empirical Literature, 2013

C. Mantero et.al., Eco Drive in Large Fleet: City: Funchal; Project: CIVITA-MIMOSA; CIVITAS (Cleaner and better transport in cities; an initiative co-financed by the EU), 2013

Ministry of Transport of Viet Nam, Circular on Driver Training, Driving Tests, and Issuance of Driving Licenses, 07/11/2012

QAED, Summary: Evaluation of Eco-Drive Training Courses, Zürich, 2004

A. Rakotonirainy et.al., Research issues in Eco-driving, <http://www-esv.nhtsa.dot.gov/Proceedings/22/files/22ESV-000146.pdf>

H. Strömberg et.al., Comparative effects of eco-driving initiatives aimed at urban bus drivers - Results from a field study, Transportation Research Part D, vol. 22, pp. 28-33, 2013

Wahlberg, Long-term effects of training in economical driving: Fuel consumption, accidents, driver acceleration behavior and technical feedback, International Journal of Industrial Ergonomics 37 (2007), 333–343