GREEN FREIGHT INDIA

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Fuel and Emission Saving Methodology

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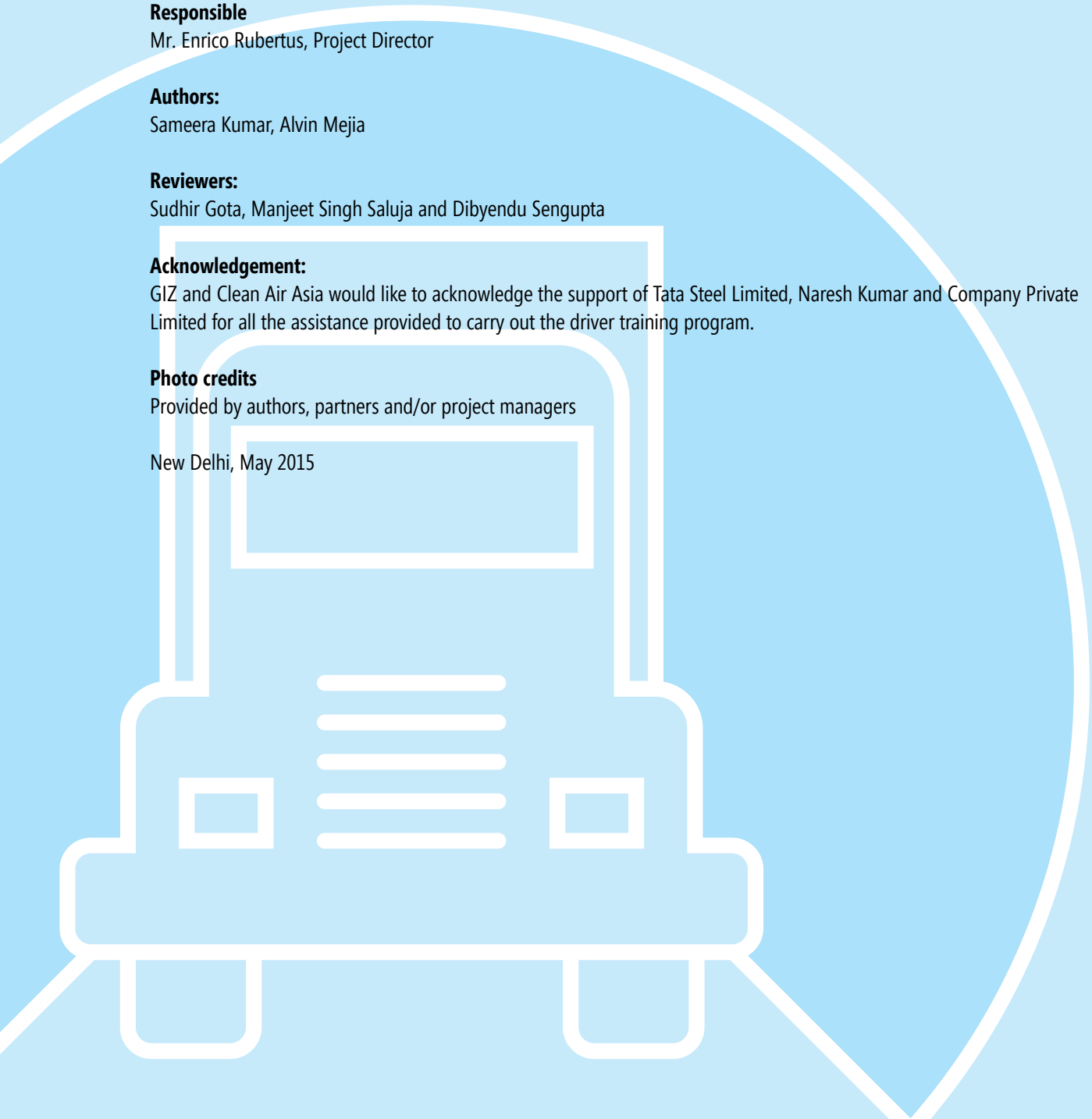

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EXECUTIVE SUMMARY

Between 1950 and 2012, India's GDP grew at the rate of 7.4 percent CAGR[1]. But during the same period the road freight volume grew by 9 percent. With India gearing up for further economic growth, it is time to evaluate the status quo of freight in the country.

Currently, road and rail carry 99 percent of India's freight in the ratio 70:30. While freight vehicles constitute less than 10 percent of the vehicle fleet on Indian roads, they consume a disproportionate amount of fuel and are the primary polluters. Presently, fuel costs constitute about 40 to 50 percent of the transportation cost of goods.

It is estimated that in 2011-12, trucks consumed 38 percent of the country's diesel [PCRA] and emitted about 63 percent of the CO_2 [Clean Air Asia]. Thanks to India's continued focus on road development and growing freight needs, the number of trucks is likely to increase. In fact, PCRA (2013) projects that the truck fleet will grow at an average of 8.9 percent every year up to circa 2025.

It is therefore in the interest of both business and society to seek a sustainable freight system that reduces transport cost as well as emissions. The world over, countries are adopting Green Freight as the means to this end. Fundamentally, Green Freight refers to an ecosystem that makes freight transport less polluting, more people-friendly and considerably more efficient and economical. The government, civil society and businesses need to collaborate in order to develop and implement strategies that can lead to the creation of such a system.

In 2012, a dialogue among stakeholders led to the formation of the Green Freight India initiative (GFI). The GFI is an informal group comprising of civil society organizations, industry-associations, academics, experts and bureaucrats who recognize the importance of Green Freight in India. Helmed by civil society (GIZ, CAA and EBTC), GFI uses a market-based collaborative approach to provide freight shippers, carriers, and logistics companies with tools to benchmark fuel efficiency, strategies to improve it and ways to measure their progress.

Clean Air Asia has developed a Green Truck Toolkit (GTT) to help businesses in Asian countries calculate the baseline fuel consumption and emissions of the trucks in their fleet and provide insights on the potential impacts of several interventions. GFI has modified the toolkit for India. It ran a pilot to test the reliability and robustness of the refined methodology. The GTT was tested on Tata Steel's outsourced fleet of trucks at Jamshedpur, operated by Naresh Kumar and Company Private Limited (NKCPL).

This document details the toolkit components, the baseline findings of the fleet, the process of identifying, designing and implementing the right intervention to increase fuel efficiency of the fleet and finally, the outcome of the intervention. What may especially interest the readers is, the intervention identified to increase fuel efficiency – eco driving. Training to drivers in eco-driving resulted in more than 45% improvement in fuel efficiency.

The document is meant to act as a crisp and clear reckoner for those who want to understand or adopt green freight strategies and practices. The GFI also hope that it makes a strong business case for green freight and contributes to its scale up by encouraging businesses to adopt green freight practices and interventions.

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1 TCI, 2010]

ABBREVIATIONS

ADB	Asian Development bank
ASEAN	Association of Southeast Asian Nations
ASIF	Activity, Structure, Intensity, Fuel
BAQ	Better Air Quality
B t-km	Billion tonne kilometres
CAGR	Compound Annual Growth Rate
CO	Carbon Monoxide
CO_2	Carbon Dioxide
EBTC	European Business and Technology Centre
GEF	Global Environment Facility
GDP	Gross Domestic Product
GFI	Green Freight India
GFIWG	Green Freight India Working Group
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GTT	Green Trucks Toolkit
GVW	Gross Vehicle Weight
HP	Hewlett Packard
ICLEI	International Council for Local Environmental Initiatives
IIM	Indian Institute of Management
INR	Indian Rupee
ITC	Indian Tobacco Company
Kmph	Kilometre per hour
Kmpl	Kilometre per litre
LRR	Low Rolling Resistance
MoUD	Ministry of Urban Development Government
NKCPL	Naresh Kumar and Company Private Limited
NOx	Oxides of Nitrogen
OEM	Original Equipment Manufacturer
Pb	Lead
PCRA	Petroleum Conservation and Research Association
PM	Particulate Matter
RPM	Revolutions per Minute
SD	Standard Deviation
SIAM	Society of Indian Automobile Manufacturers
SOx	Oxides of Sulphur
TCI	Transport Corporation of India
t-km	Tonne-kilometre
TNT	Thomas Nationwide Transport
UMI	Urban Mobility India
UNCRD	United Nations Centre for Regional Development

UNEP	United Nations Environment Programme
UPS	United Parcel Service
USD	United States Dollar
USEPA	United States Environment Protection Agency
VKT	Vehicle Kilometre Travel
VOC	Volatile Organic Compounds
WB-GEF	World Bank Global Environment Facility
WHO	World Health Organization
3PL	Third Party Logistics

1. BACKGROUND

The demand for freight movement in India is expected to increase as the country gears up for further economic growth. Historically, the road freight sector has dominated freight movement, with almost 70% share of the total ton-kms movement in 2012. The trends show that road freight transport in India is projected to reach 3450 billion ton-km (b t-km) by the year 2020 from 1325 b t-km in 2007, a 2.5-fold increase[1] [McKinsey]. While road freight vehicles only constitute less than 10% of the vehicle fleet, they have been estimated to contribute significantly to the energy consumption (e.g. diesel consumption from trucks in 2011-12 was 38% of the national total[2] [PCRA, 2013] as well as externalities such as local air pollutant and greenhouse gas emissions. It is estimated that 63% of CO_2 have been emitted by the road freight sector [Clean Air Asia].

The relative significance of the road freight sector is expected to be maintained, as the truck population is expected to grow strongly. The Petroleum Conservation Research Association (2013) estimates that the truck fleet will grow at an average of 8.9% per annum leading up to 2025. Given these considerations, strategies for making the sector more sustainable must be put in place. Generating evidence-based bottom-up success stories on improving efficiencies and generating cost savings while minimizing negative impacts is much needed for scaling up green freight practices in the sector.

In India, rail and roads carry 99% of the total freight traffic (ton-km). From the 1990's, when road capacity increase was taken up in a large scale with private sector involvement, road became the dominant mode, while the railways for many reasons could not install capacity. The ratio of road vs rail as of 2011-12 is about 70:30[3].

A study conducted by Transport Corporation of India (TCI) and the Indian Institute of Management (IIM), Calcutta in 2012, estimated that inefficiency in the Indian roads sector costs the Indian economy INR 27,000 crores annually. In addition, the impact of additional fuel consumption due to delays and slow speeds of vehicle on the Indian economy are to the order of INR 60,000 crores per annum.

Hence there is a need to improve efficiency and reduce emissions from the Indian road freight sector to make it greener. Though the concept of "Green Freight" has gained considerable attention around the world there has been a general lack of knowledge and human capacity towards achieving it in India.

1.1 Concept of Green Freight

The "Green Freight" concept is prevalent in Asian countries such as China, Japan, and South Korea, through national level programs, while many nations such as India, Indonesia, Philippines, Vietnam, Laos, Thailand, are taking steps to develop one.

Green Freight can be defined as [UNCRD, 2014[4]]

a. A set of strategies, policies, practices and standards;

b. or measures targeted at the movement of goods via road, rail, marine, inland waterways and air;

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1 Mckinsey, Building India: Transforming the nation's logistics infrastructure

2 http://www.pcra.org/English/latest/Report%20%96%20Market%20Survey%20for%20Fuel%20Consumption%20norms%20for%20Diesel%20Trucks%20&%20Buses%20in%20India.pdf

3 http://planningcommission.nic.in/sectors/NTDPC/volume2_p1/trends_v2_p1.pdf

4 Position Paper for promotion of Green Freight in Asia

c. Aim to:

   i. Reduce the environmental, climate and public health impacts through reduced air pollution and greenhouse gas emission intensity;

   ii. Improve social conditions, including road safety, and health and working conditions of people involved in freight movement; and

   iii. Enhance economic development through improved energy efficiency, fuel security, and efficiency and competitiveness of the freight and logistics sector overall;

d. Developed and implemented by government, private sector and other stakeholder groups jointly or individually.

The concept of green freight has increasingly become more relevant in global, regional and local discussions due to several underlying factors including the increasing demand for greener products and services, the continued pursuit to gain competitive advantage through more efficient operations and lowered costs, and even the globalization of supply chains.

The United States Environmental Protection Agency's, (USEPA) SmartWay[5] is a voluntary public private initiative that helps businesses to improve their supply chain efficiencies through technologies, certification, knowledge sharing etc. Since 2004, the program has helped save 120 million barrels of fuel and 51 million metric tons of CO_2. [SmartWay statistics, June 2015]

The Green Freight Europe[6] aims to be recognized as the leading independent voluntary program for improving environmental performance of road freight transport in Europe. Initiated in 2009 it now comprises of more than 110 multinational carriers, shippers and logistics service providers. The initiative aims to generate strong market incentives to engage companies across the supply chains in green procurement of transportation services in order to stimulate long-term improvements. Therefore, a central database to calculate, validate and benchmark the environmental performance of transportation companies was built and is hosted by a neutral and independent body. Therefore, logistics managers are able to measure and reduce the carbon footprint of their products through green procurement of transportation services. [Green Freight Europe website[7], June 2015]

An initiative of the private sector was the Green Freight Asia[8]. A private sector declaration was announced during the joint Urban Mobility India Conference and the Environmentally Sustainable Transport in December 2011 organized by the Ministry of Urban Development, Government of India and United Nations Centre for Regional Development (UNCRD) respectively[9]. The declaration brought together leading shippers and carriers such as TNT, DHL, UPS, IKEA, Schneider Electric and Diageo among others to reduce the carbon footprints and costs from supply chains.

One of the recent developments in Asia in that of the Green Freight China Program[10], which is now a Government led initiative. The origin of this program was through the coming together of the civil society with the support of development agencies and cooperation of the local governments. A pilot project was undertaken in the city of Guangzhou, which showed the potential of improving fuel efficiency through technology interventions. This caught the interest of various stakeholders and was scaled up to the province of Guangdong to a $14million, three year program targeting almost 1500 trucks. Institutional development and policy support were developed in parallel with the demonstration projects to conceptualize a national program, adopted by the government to replicate throughout the country.

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5 http://www.epa.gov/smartway/
6 http://www.greenfreighteurope.eu/
7 http://www.greenfreighteurope.eu/
8 http://greenfreightasia.org/
9 http://cleanairasia.org/portal/node/7865
10 http://cleanairasia.org/portal/projects/GreenFreightChinaProgram

1.2. Efforts to make freight sector greener in India

The first Green Freight India workshop was held to have in-depth discussion with stakeholders on 9 January 2012 in New Delhi along the side lines of the 11thAuto Expo. It was jointly organized by Clean Air Asia (then Clean Air Initiative for Asian Cities) and the Society of Indian Automotive Manufacturers (SIAM) with the support of Ashok Leyland, towards conceptualizing the scope and potential benefits of making the freight sector green. The seminar received strong interest from the truck manufacturers and other private sector companies with willingness to collaborate on green freight and logistics in India. Stakeholders of the freight industry such as goods manufacturers, experts, Original Equipment Manufacturers (OEMs), truck operators, and academics among others participated in this event.

Later, GIZ and Deutsche Post DHL held stakeholder consultation workshops during May and July 2012 with private and public stakeholders respectively. The former workshop was intended to provide an outline of similar Green Freight programs initiated in the Americas, Europe and Asia. It gauged the general interest and specific requirements for a similar initiative in India. The second workshop contributed to defining the vision and objectives by disseminating key inputs arrived by interviewing people within the freight sector. It also mapped the stakeholders for green freight and discussed upon the key focus areas along with an organizational setup that the Green Freight India initiative should follow.

Green freight initiative in India, was catalysed by the civil society but private sector played an important role in consultations and pilot; and the government will also play a vital role to bring the necessary policy revisions to boost the freight industry.

Following several internal discussions and consultations with a variety of stakeholders, the structure of "Green Freight India Initiative" formed was unique. The rationale behind the approach was to address the intricacies of the sector; and a neutral initiative considers and balances the priorities of both the government and the private sector. This approach helps to create a level playing field and develop consensus leading to the successful implementation of policies and adoption of technological intervention. The main advantage of this model is that stakeholders concerns are addressed through active consultations and consensus building.

To ensure that both government and the private sector and others get a platform to address their concerns the GFI Working Group (GFIWG) has been set up. During a stakeholder consultation in October 2014, it was discussed that to develop policy initiatives this informal working group can play a vital role. The GFIWG comprises of members from various backgrounds - private sector, government, research, academe, industry associations and its role is to deliberate on the policy issues pertaining to road-freight and make suitable representations to the relevant ministry.

1.3. The Green Freight India (GFI) Initiative

The GFI Initiative attempts to use a market-based, civil society-led collaboration framework to provide freight shippers, carriers, and logistics companies with tools to benchmark and improve fuel-efficiency, save money, and track progress for their achievements. Its principal elements include:

- **Partnership program** – through the GFI, attempts are made to assess, benchmark, and track emissions of private sector organizations like carriers, shippers, or logistics companies. Further, the data will be used to identify the most economical intervention and strategies that could be utilized in order to increase fuel efficiency and thus reduce carbon footprint of the partnering association. The program will assist in providing benchmarking and reporting tools to further optimize their road fleet.

- **Technology interventions** - the information provided in this element focuses towards providing technology assessment and suggesting the suitable technology intervention, which could allow their road fleet achieve desired performance, in terms of fuel savings and emission reduction.
- **Recognition, marketing and out-reach** – through this the partners and their "greener" measures and practices will be disseminated in the form of information and education (e.g. workshops, fact sheets, newsletters, website, workshops), and used as basis for future marketing (media campaigns, events).

The various steps in the development of the toolkit and the estimations methodology is detailed in the next chapter.

2. PROJECT PLAN

The current project supported by GIZ aims to contribute towards the proliferation of green freight practices by creating awareness among carriers and shippers about the various possibilities to reduce fuel consumption and emission from the movement of goods. It generates an evidence based case study on fuel efficiency improvement as a proof-of-concept, as well as tools and guidance for entities that would like to explore appropriate green freight options.

Though the targeted users of the methodology are the shippers and carriers, the outcomes of the trials would be targeted at multiple stakeholders, including researchers and government officials, since insights on the freight sector is usually scarce.

The entire project can be divided into three phases, namely:

- **Phase 1: Methodology Development –** This phase focuses on identifying the key areas for fuel efficiency improvements. It also involves identifying the necessary process for calculating carbon emissions and developing a protocol that can be followed by freight companies in India and is in sync with international standards.
- **Phase 2: Conducting Pilot Test –** This phase focuses on testing the developed methodology in collaboration with a volunteer organization. It includes collecting baseline data, analysis of data, recommending or testing interventions to reduce fuel consumption and emissions.
- **Phase 3: Dissemination of the case study –** This phase focuses on disseminating the outputs from Phase 2 and promoting the findings to the relevant stakeholders.

The ultimate objective is to scale up the initial efforts to ensure that the methodology and the fuel saving interventions are widely adopted by the private sector fleets. The entire process is depicted in Figure 1 below.

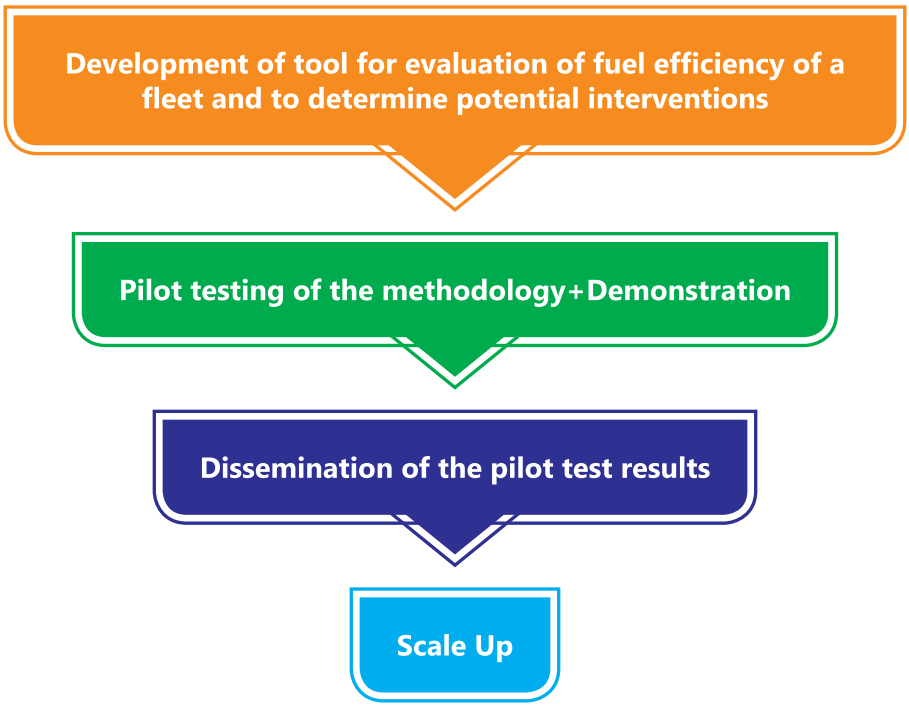


Figure 1: Process of the Program

On 15 October 2014, a stakeholder consultation was held in New Delhi as part of the project. The objective was to showcase the methodology being developed (for assessing the baseline fuel consumption and emissions profiles of truck fleets and assessing potential interventions) and to gauge the interest of the stakeholders in carrying out pilots in emissions and fuel savings. This workshop hosted by GIZ, EBTC and Clean Air Asia, was attended by more than 50 diverse stakeholders such as World Bank, SIAM, Mahindra Logistics, HP India, Petroleum Conservation and Research Organization, Steinbeis India, KPMG, ICLEI, Embarq. The methodology was shared with the stakeholders.

Discussions were also held with companies such as Gati, ITC Paper Boards and Specialty Papers, TCI, Tata Steel, Coca Cola India among others. The interest levels were high as fuel savings was high on the agenda of many companies, while some of the global shippers had an interest to be seen as a green company with low carbon footprint.

The methodology and its features are described in the subsequent section.

3. METHODOLOGY

With the context of fast rising emissions from the transport sector that is detailed in the previous sections, there is a need to estimate the current emissions and forecast so that relevant actions can be taken now. It is important to sensitize relevant entities and enable them to choose and implement appropriate actions that can benefit their operations.

In the fragmented freight sector, it will be ideal to work with large organizations to carry out fleet level interventions to bring about an impact, due to an organizational structure and control over the fleet. It is necessary for a fleet manager to understand the baseline and the various fuel saving options that are available and suitable for a particular fleet. Various tools are available for this purpose and the Green Trucks Toolkit developed by Clean Air Asia is simple in its approach and provides robust estimates with minimum data requirement and helps in quick analysis.

The Green Trucks Toolkit (GTT) is a Microsoft excel based tool built for the Asian Development Bank under the Greater Mekong Subregion Core Environment Program Biodiversity Conservation Corridors Initiative (GMS CEP-BCI) for ASEAN region. The model was designed as a capacity building tool for truck operators and managers, to understand the impacts of various fuel savings options. The tool adopts the globally accepted ASIF methodology (Activity, Structure, Intensity and Fuel) to estimate emissions. It allows for the calculation of the baseline fuel consumption and emissions of the trucks in a fleet as well as provides insights on the potential impacts of several interventions.

The toolkit provides the cost-benefit analysis for following interventions:

1. Eco-driving
2. Improved maintenance
3. Aerodynamic styling
4. Tyres and wheels
5. Idling reduction
6. Reduction of sulphur in diesel and petrol
7. Reduction/elimination of lead in petrol
8. Emission control devices
9. Replacement of diesel and petrol trucks with LPG/CNG trucks

The emissions that are estimated are,

1. Particulate Matter (PM)
2. Carbon Dioxide CO_2
3. Carbon Monoxide CO
4. Nitrogen Oxides (NOx)
5. Sulphur Oxides (SOx)
6. Volatile Organic Compounds (VOC)
7. Lead (Pb)

The ASIF[11] methodology is a simple and straightforward methodology and was developed by the late Dr Lee Schipper.

Total Carbon Emissions (G) = Total Activity, represented by vkt
(vehicle kilometres travelled) or ton-km (A) x
Modal Structure (in this case truck type,
for ex. LCV, HDV) (S) x
Modal Intensity (I) x
Carbon Content of Fuel, in this case diesel (F)

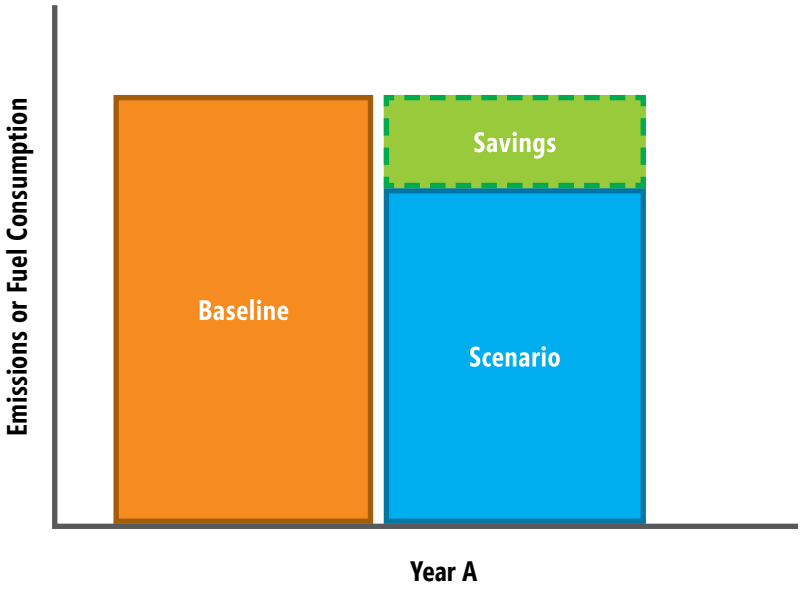


Figure 2: Concept of baseline and savings

The tool provides the baseline or current status of the fleet with respect to fuel consumption and various emission impacts. Through the application of various interventions that are available in the tool, the savings impact is estimated with respect to the baseline. This is the underlying philosophy of the tool.

The input parameters that are required for analysis in the tool are the following:

1. Truck plate number or ID number
2. Number of wheels
3. Fuel type
4. Kilometres per year
5. Fuel consumption per year
6. Average payload/loaded trip (tons)
7. Average distance per trip (km per trip)
8. Year of manufacture

11. http://www.adb.org/sites/default/files/publication/28537/adb-wp09-transport-co2-emissions.pdf

9. Kerb weight (tons)
10. Gross Vehicle Weight rating (tons)
11. Percentage of total trips that are empty (%)
12. Average speed (kmph)
13. Average idling time (minutes per day)

3.1 Indianisation of the GTT

Considering the need for a methodology for emissions estimation and reduction in India, which was lacking for the freight sector, the GTT India was proposed to be developed, by refining the existing Green Truck Toolkit built for the ADB. The approach was to customize the Green Trucks Toolkit to suit the Indian requirement and to consider the local conditions and parameters.

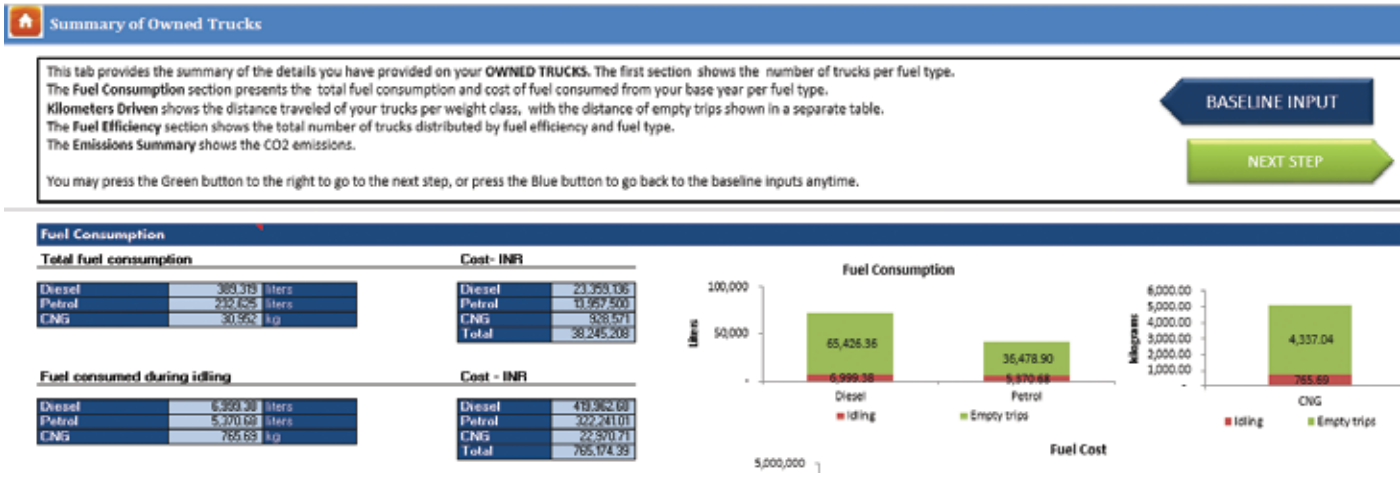
The GTT-India has adopted emission factors relevant to India. To add further relevance for Indian users, the GTT-India incorporates the Indian vehicle emission standards (Bharat Stage, BS) and vehicle types. Based on gross vehicle weight (GVW) the trucks are categorized into light, medium and heavy trucks. SIAM vehicle classifications were adopted, which the industry follows. A discussion was also held with former Director of the Automobile Research Association of India (ARAI) which is responsible for all the type approval of the vehicles that hit the Indian roads.

Interventions such as reduction of lead in petrol was removed since India uses only unleaded petrol throughout the country.

In terms of pollutants, the focus has been on CO_2 estimation than other pollutants, since more emphasis is on carbon savings in the global markets and there is a greater incentive to reduce them.

Further changes such as currency, language were also incorporated to provide an Indian feel.

Various summary tables and charts have been added to make the outputs easy to visualize. Easy navigation through click buttons on each tab allows for an easy step by step use of the tool.



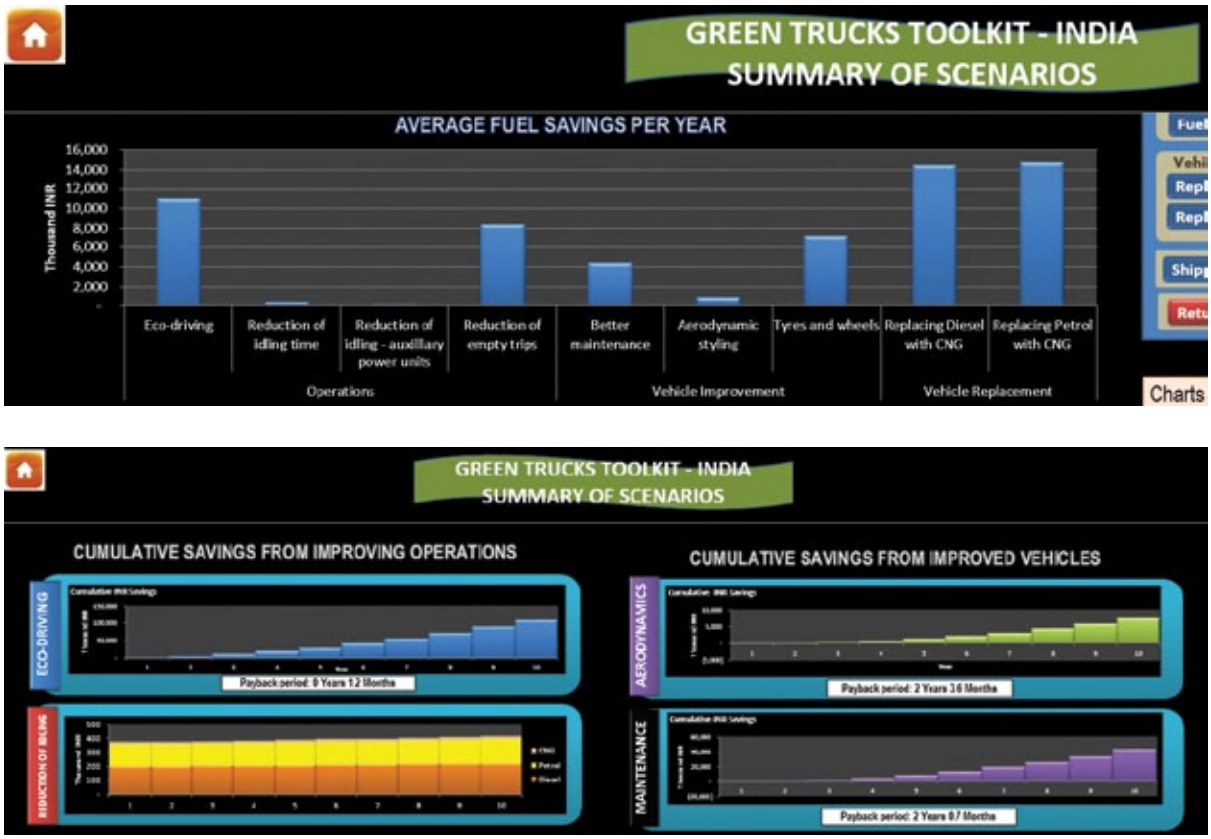


Figure 3: Summary of various interventions

Tables and charts at each step helps in quick understanding of the baseline as well as the interventions impact in terms of emissions and finances. The cost versus returns summary helps in deciding the most suitable interventions that provides high rate of return.

Apart from the changes to suit the Indian conditions, one of the objectives was to make the tool useful for shippers. A 'Shipper's Module' has been developed, which helps shippers to choose a more efficient set of outsourced trucks or a more efficient transport company to carry a given load by comparing fleets. This is a unique feature added in the GTT, which would assist the Shippers (or even the fleet owners) to identify the most or the least efficient trucks. A pilot demonstration on the use of the toolkit was carried out to test the reliability and robustness of the tool.

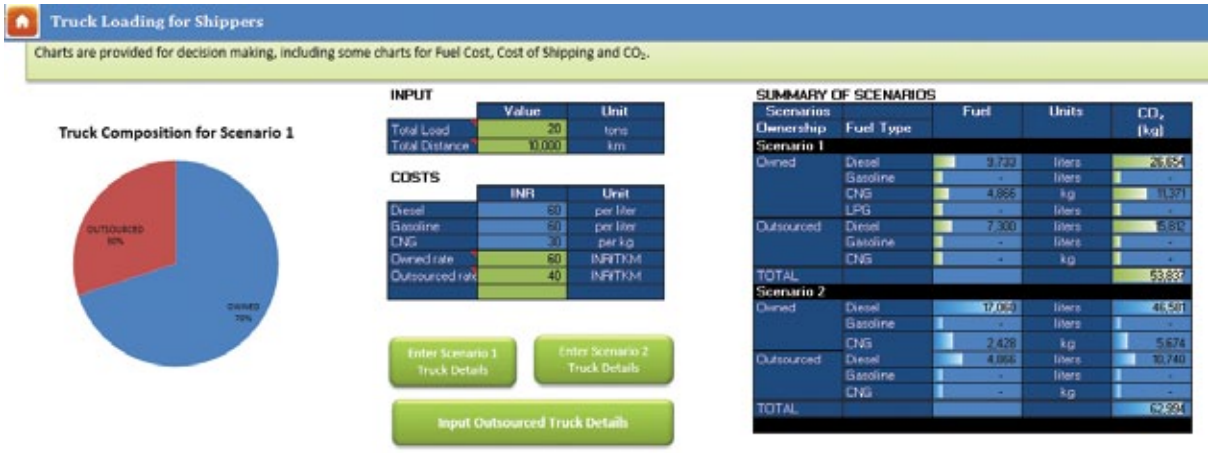


Figure 4: Shipper's module

3.2 Application of GTT India

Tata Steel Limited, the flagship company of the multibillion dollar Tata Group of companies, is one of the largest steel makers in the world and established its first plant in Jamshedpur in eastern India in 1907. Over the decades the Tata Group is acknowledged as a pioneer in diverse sectors (e.g. automotive, aviation, power, household goods, industrial products and software services).Tata Steel endeavours to be a green organization with many sustainability measures and was keen to be part of the Green Freight Initiative

Naresh Kumar and Company Private Limited or NKCPL, handles steel and coal for Tata Steel at various stages of production. It has been associated with Tata Steel since 1964 and handles more than 1 million metric tons annually. NKCPL also works with leading corporate houses such as ACC, Aditya Birla, Lafarge, Ultratech, Sesa Group, Jaypee and Vedanta etc. [NKCPL website[12], June 2015]

The operations data from NKCPL for the year 2014 consisted of details of 75 trucks from two operating locations, the Tata steel plant and a railway siding at Birarajpur on the outskirts of Jamshedpur. Both the locations involved short haul and almost all trucks were heavy duty truck trailers and dumpers except for 4 medium duty trucks.

Though the trip lengths were short, (10 to 20km) the time taken is usually long due to the long queue lengths at the factories and the loading and unloading time.

The vehicles were of two types, trailers of 22 and 14 wheels dumpers of 14 and 8cubic meters.

The average fuel efficiency was 1.46kmpl and all the 75 trucks were in the range of 1.1 to 2 kmpl. The baseline CO_2 was 2.7 kg per km and 0.33kg per ton-km. The fleet CO_2 emission was 4,100 tons per year.

Table 1: Data Summary

	Vehicle Type	Number of vehicles	GVW (tons)	Avg age (years)	Annual vkt (km)	Fuel Avg (kmpl)	Days used per year	Avg distance pertrip (km)
1	Trailer 22 Wheels	15	49	4.7	10,368	1.3	336	20
2	Trailer 14 wheels	17	40	6	6,595	1.5	336	12
3	Dumper 14 cubic meters	39	25	6.7	30,191	1.5	336	10
4	Dumper 8 cubic meters	4	16	7.5	15,420	1.9	336	10

The interventions were analysed using the tool and the indicators derived, as shown in Table 1.

The average age of the fleet is 6 years and 73% of the fleet are in the range of 5 to 8 years. 13% trucks are 9 to 10 years old and 13% are 1 to 4 years old. Tata Steel has a policy that does not permit trucks older than 10 years, which is enforced through contracts with the transport operators.

The impact of age on fuel efficiency is evident. For example, a 25 ton dumper 5 years or less does an average of 23,000 km per year at 1.55kmpl, while a vehicle that is 5 to 10 years does 19,000km at 1.46kmpl.

Considering the nature of operations, (within the plant or for last mile transport from railhead to nearby factories), the return trip is empty, making empty trips 50% of the total trips.

12. http://www.nkcpl.com/

All trucks run on diesel and the annual consumption for the fleet is 10.1 lakh litres costing about INR 5 crores. The average per truck per year is 13,500 litres costing INR 6.75 lakhs.

The estimated idling time was 8 to 10 hours. While, these figures were based on certain estimates, discussions with the drivers revealed a value of 4 to 8 hours depending on the location; indicating that actual measurements are not carried out and stoppage delays maybe construed as idling. [Though the vehicle is stationary in both cases, the difference is that in idle condition the engine is on while in a stop delay the engine is switched off]

Since the average fuel efficiency falls in the range of 1.1 to 2 kmpl for all the trucks, it can be assumed that the fuel consumption and the vehicle kilometre travelled values are accurate. Analysis of the data revealed that the idling data was unrealistically high and has been reduced to 120 minutes for all trucks, which led to reasonable values while estimating the savings from the various interventions.

The trucks usually operate for about 20 hours a day and therefore idling time constitutes a significant proportion of the total working hours and has equivalent impact on the fuel consumption. One-fourth of the total fuel is consumed in idling, while the loaded trips and empty trips consume 41% and 34% respectively.

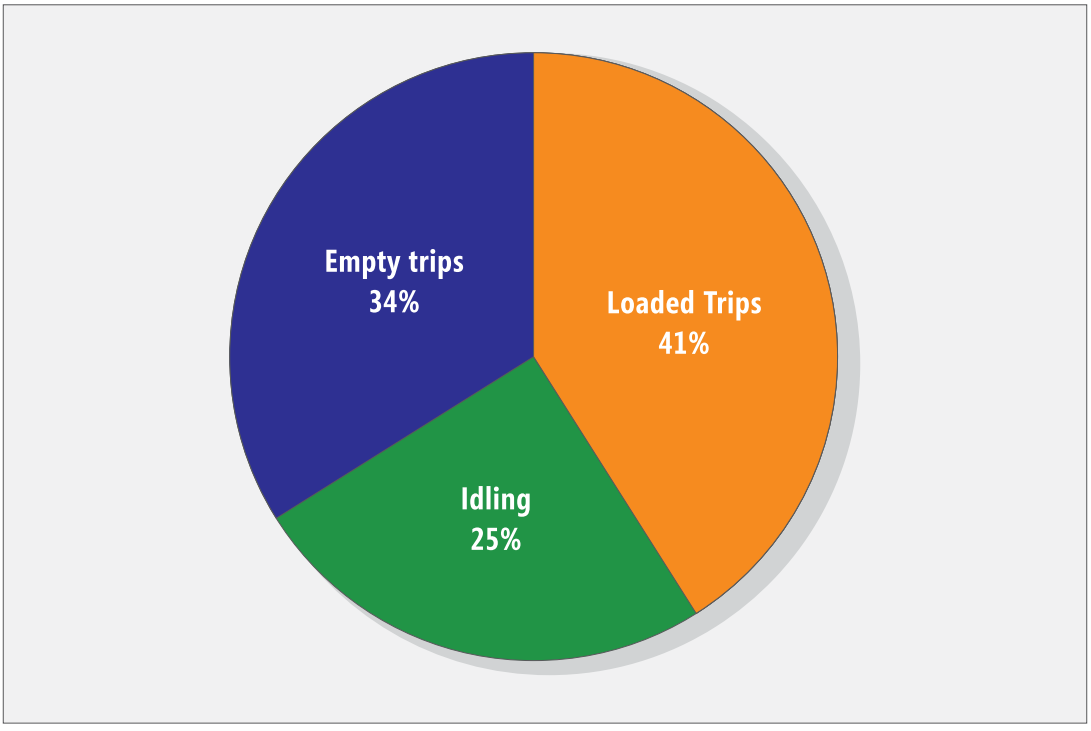


Figure 5: Breakup of fuel costs

The high idling time and the fuel consumed due to idling is definitely an area that can be tackled both manually (by turning off the engine during long waiting times) or by using Idling stop devices that automatically shut down or start a vehicle based on pre-set conditions. Analysis reveals that the use of start stop technologies is not profitable, as the expected return on investment does not compensate for the initial cost of the technology.

Whereas, switching off the ignition at long waiting time provides significant gains, both in fuel and emissions savings when just 10%, or about 12 minutes of idling time can be reduced per truck per day. It would lead to an average saving of INR 17,000 and 1.5 tons of CO_2 in per truck annually.

The financial savings can be invested into better and larger carrying capacity trucks that can reduce the overall number of trips. Manufacturers or Third Party Logistics (3PL) companies aiming to be seen as a green company can use the CO_2 saved. To incentivize reduced idling by the drivers, a reward program can be instituted, which can provide financial incentives for drivers who manage to achieve the most reduction in idling.

The use of low rolling resistance (LRR) tyre technologies does not appear to be a profitable intervention. The high initial costs of the tyres of approximately INR 420,000 per truck provide a saving of about 500 litres of diesel truck a year. LRR tyres is a relatively new technology in India, which needs to be trialled extensively to determine the extent of savings and can be piloted when subsidies or other financing mechanisms are available. Considering that the trucks are overloaded, the life of the tyres gets reduced and currently the bias ply tyres that are used are replaced approximately every 2 to 2.5 years.

Interventions of aerodynamic technologies were not investigated due to low speeds with poor road conditions, stop and go movement and short trip distances.

Eco driving, which involves training the drivers on techniques that help improve the performance of the vehicle, is estimated to have the largest saving of more than 2000 litres of diesel per truck annually. Considering that the drivers have not been trained before, a higher saving percentage of 20% has been assumed. The payback period is 6 months due to the high savings potential and also with a caveat that the learning is sustained. An average savings of INR 3 lakhs can be achieved every year for a period of 5 years. The initial expenditure is higher as more time is required to train the untrained drivers and later refresher courses of shorter duration can be delivered twice a year to ensure the drivers' consistent behaviour. The other advantages are that, it can be piloted quickly, compared to technologies which require procurement, testing etc. Eco driving will also involve training the drivers to reduce idling by switching off the engine when waiting for long durations.

Table 2: Summary of Interventions

	Intervention	Initial cost (per truck or driver in INR)	Annual recurring cost (per truck in INR)	Duration (years)	Fuel Saved per truck (litres per year)	Average Savings per truck per year (INR)	CO_2 Saved (tons per year)	Payback period (years)
1	Eco driving	30,000	10,000	5	2,020	3,09,700	8.9	0.5
2	Reduction in idling a) Manual[13]	NA	NA	5	342	17,100	1.5	-
	b) Reduction in idling using technology	72,000	5000	5	171	(57,970)	0.71	11
3	Improved maintenance practices	35,000	35,000	5	1010	31,358	4.4	3.6
4	Low Resistance tyres	420,000	-	5	515	(14,82,950)	2.3	12

13 *Manual means of reducing idling is to train the driver to switch off the engine when the truck has to be stationary for long periods of time.*

Trip reduction as an intervention is possible through replacement of existing trucks with higher capacity ones. For example, a 100 ton capacity truck can replace three 30 ton trucks. Given the nature of operations, empty return trips cannot be avoided.

The value proposition of low investment, high return and short payback period, eco driving appears the most suited intervention to pilot.

4. CASE STUDY: DRIVER TRAINING

4.1 Introduction

Eco driving, the chosen intervention has multiple benefits of emission reduction, extended vehicle life, reduced maintenance costs, improved road safety and reduced driving stress. A specialized driver-training module was developed and piloted on Tata Steel's (outsourced) fleet at Jamshedpur.

Though a high percentage of Tata Steel's goods are transported by road, active plans and trials are underway to shift to low carbon transport modes such as rail and water. Among the numerous transporters contracted by Tata Steel to move their goods at various stages of production, the training was carried out on the drivers of Naresh Kumar and Company Private Limited (NKCPL) whose data was shared for analysis.

Figure 6: Flow of the process

4.2 Training Process

The training was carried out in Jamshedpur in Jharkhand state, where NKCPL operates for Tata Steel. Similar to most cities in India, Jamshedpur too has restrictions on the movement of heavy vehicles in the city limits at various times of the day, which necessitated a training location beyond the city. NKCPL's operations besides the steel plant (within the city)was also in the city outskirts, at Birarajpur, where goods from the plant sent by trains are unloaded, stocked and sent to nearby factories for further processes.

It was therefore ideal to carry out the hands-on training at Birarajpur. The theory modules was imparted at NKCPL office located in the city about 14 km from Birarajpur. To avoid commuting every day and to make the best use of time, the theory and practical classes were held on separate days.

A. Route Selection

Reconnaissance trips were carried out and a route of 22.9km was chosen, see Figure 7. The route comprised of mixed road conditions of potholes, under construction road as well as a well maintained 4 lane divided highway. The traffic condition also varied from very low traffic density to slow moving local traffic and busy intersections, which was ideal to train and test the skills of the driver. The selected route did not have truck movement restrictions and was therefore convenient to carry out the trials.

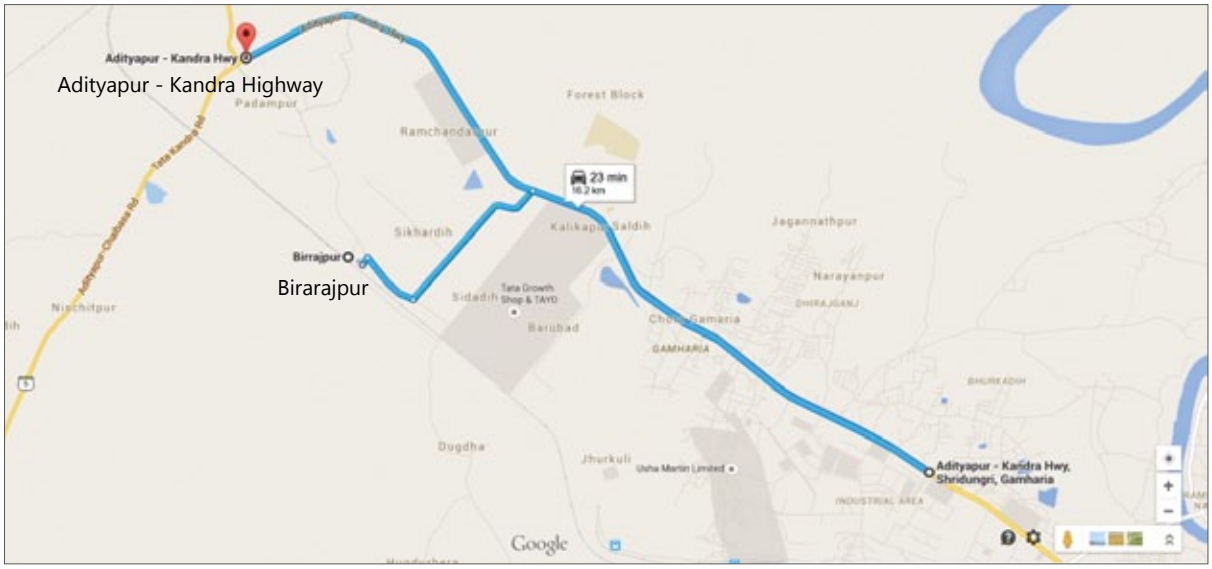


Figure 7: Map of the route (Highlighted line)

B. Test Procedure

Since all the drivers had a background of operating trailers, the same vehicle type was used for training and a single vehicle with registration number WB33A 7203, a 2008 model of Tata 3516 was used for the entire duration. Fixed vehicle on a fixed route helped eliminate the variables of route and vehicle and made possible the comparison of driver performance.

The fuel efficiency was measured manually by filling the fuel tank completely before the trip and refilling after the trip is completed. The amount of refuel indicates the fuel consumed during the trip and the same process is applied to all the drivers. Through measuring cans of various volumes the quantity of fuel is measured accurately. The trip meter reading, start and end time and fuel consumed is recorded for each trip of a driver.

Figure 8: The training vehicle at the site

4.3 Training Module

The course content was tailored to emphasize hands on training than classroom knowledge, since the drivers were not trained in eco driving before and it was essential that the course be completed in quick time without affecting the operations schedule of the organization.

The spirit of competitiveness and eagerness to learn led the drivers to better themselves each day of the training. As an incentive, chocolates or cookies were given to the top 3 drivers of each day; the names were displayed on the notice board at the training location. The details of the modules are provided in Annex A.

The results are provided in the findings and outcome section.

Table 3: Schedule of the activities

Step	Day	Activity
1	Initial discussions + Day 1	Reconnaissance surveys and finalization of route with Tata and NKCPL officials
2	Day 2-3	Baseline data collection
3	Day 4-5	Classroom sessions
4	Day 6-9	Hands on training
5	Day 10-11	Mid-course assessment
6	Day 12	Classroom sessions
7	Day 13-16	Hands on Training and tests
8	Day 17-18	Post training assessment

Figure 9: Demonstration of engine oil check

At the beginning, the drivers were imparted classroom modules. Some of the basics covered were: holding the steering at 10:15 position, implications of using the pressure horn, right of way, proper parking practices, importance of inspection of vehicle before the trip, road signs and their meaning. Drivers were explained about the various causes of accidents and solutions to avoid them.

In the next session, emphasis on maintaining the ideal revolutions per minute (RPM) of the engine per gear to obtain maximum fuel efficiency and power were illustrated. General maintenance checks such as inspection of oil gauge, engine oil, steering oil, gear oil, air filter, tyres etc. were demonstrated on an available vehicle. Various components of the vehicle and its role in fuel efficiency were thoroughly discussed.

The base line fuel efficiency data was recorded on days 2 and 3. Apart from the fuel efficiency, the driving skills especially with respect to use of clutch, brake, gearshift, rpm, speed, and lane driving was noted using a standard format by the trainer. See Annex B for format. Importantly, the drivers were not informed that the exercise was to test their driving skills so that they drive in their usual fashion.

For the next four days, the drivers were provided hands on training. To ensure greater utilization of time and to have better engagement with the drivers, 3 drivers were taken on each trip along with the trainer. Each of the drivers took turns to drive for a certain distance while the trainer provided feedback to all of them. Obtaining the sweet spot of RPM, speed, use of clutch, gear change, lane discipline, use of signals were imparted practically.

Post this phase of training, individual assessment of the drivers were carried out for mid-course assessment. Apart from fuel efficiency, the drivers were assessed on driving style and then ranked for this phase of training. Learning so far and the areas of improvement were also discussed in an informal session, mid course.

The post training assessment was carried out on day 17 and 18, which included a theory test apart from the fuel efficiency driving test.

4.4 Findings and Outcome

The baseline average fuel efficiency was 4.4 kmpl. The range was from 3.3 to 5.0kmpl, with a standard deviation of 0.5. Though 3.3 was an outlier, the rest had a range of 4.1 to 5kmpl, 10% to 15% from the mean value showing consistency in driving behaviour.

In the mid-course assessment, the average efficiency had increased to 5.9kmpl i.e. an increase of almost 35%, (compared to baseline data).

Some of the drivers were trialled again since they had obtained high values initially. This move was to override any kind of errors that may have crept in during the 1st trial. See box 1 for details.

The average efficiency when supervised and unsupervised was 6.4 and 5.9kmpl respectively. A vehicle followed the truck to record traffic conditions and to ensure that there were no variances.

The last part of the training, the drivers were again assessed independently. The average fuel efficiency in this phase was observed to be between 6.3 to 6.5 kmpl.

Table 4: Fuel Efficiency and Speed Data

	Baseline 9, 10 April '15		Mid Training 17, 18 April '15		End Training 22, 23 April '15		Post Training 24, 25 April '15	
Driver Name	**Kmpl**	**Avg speed**	**Kmpl**	**Avg speed**	**Kmpl**	**Avg speed**	**Kmpl**	**Avg speed**
Driver 1	4.6	27.5	9.4	22.2	7.7	22.3	5.2	29.6
Driver 2	5.0	27.5	5.5	22.2	6.7	26.6	6.7	26.6
Driver 3	4.8	25.0	6.7	20.5	7.4	29.6	6.6	24.2
Driver 4	4.8	29.2	5.0	24.2	6.3	29.6	7.2	30.3
Driver 5	4.5	29.2	5.2	22.2	5.4	29.6	6.3	22.2
Driver 6	3.3	31.4	5.3	22.1	6.3	22.2	6.3	26.6
Driver 7	4.7	32.6	5.8	22.2	5.8	24.2	8.9	24.2
Driver 8	4.2	32.0	5.6	24.3	8.5	25.6	6.3	26.6
Driver 9	-	-	7.4	24.3	8.9	26.6	6.3	27.7
Mean	4.5	29.3	6.2	22.7	7.0	26.3	6.7	26.5
Standard Deviation	0.5		1.4		1.2		1	

Figure 10: The trained drivers receiving certificates and gifts from Tata Steel officials

Post training results indicated that the average fuel efficiency had increased to 6.7kmpl, an improvement of 48% compared to the baseline 4.5kmpl. The range was from 5.2 to 8.9kmpl; These two values were outliers, and the rest were in the range of 6.3 to 7.2 in a 10% range from the mean, but the standard deviation was high at 1.

The high standard deviation during and after training reflects the inconsistencies in the behaviour of the drivers, when compared to the baseline. This could be due to the learning and adaption of each driver to the new set of skills being taught. Except for one driver with 13% improvement, the rest improved from 35% to 90%. The highest percentage improvement was seen in the driver with the lowest kmpl in the baseline. The best driver in the baseline stage achieved a 35% improvement.

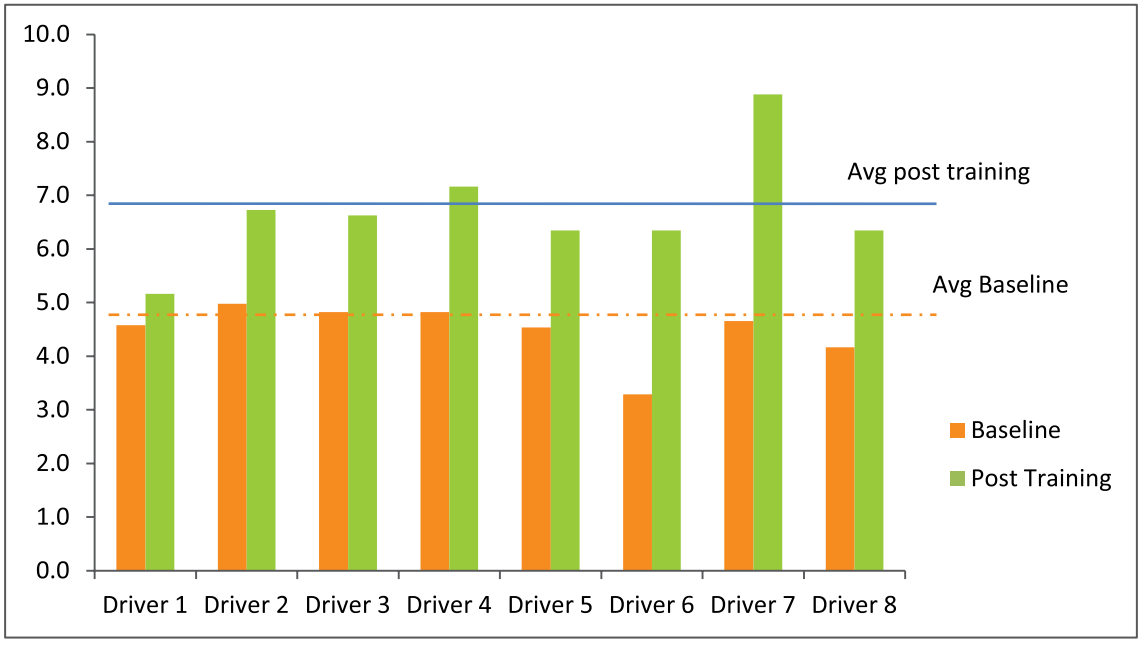


Figure 11: Comparison of Pre and post training of fuel efficiency in kmpl of each driver

Instances of High kmpl values

A system of double checking of odometer readings and refuel measurements was put in place to ensure accuracy; but certain mechanical possibilities in the vehicle such as, bulge in tank, vacuum in the flow pipes and change in the fuel density, (which were not measured), may have caused the spikes in the fuel efficiency. Such changes in a vehicle can occur at random.

But the spikes do not appear as random occurrences. Considering 6.5 kmpl the average obtained in the post training assessment, there have been 12 instances (out of total of 30) when the value has been 6.5 kmpl and above, the highest being 9.4 kmpl. It was again not restricted to any day or particular time of the day and was observed during the training period too.

It is possible that such mechanical anomalies may not have occurred and the drivers could have driven the vehicles perfectly at the right RPM, anticipating the traffic and slowing the vehicle, not applying the brakes, accelerating gradually etc. This is a drawback in the manual system of measurement which can be overcome by the use of sensors such as CarbonPod[14] that can capture details such as fuel flow, rpm, gear shift, location and other details of the vehicles at few seconds interval and store it in a database.

4.5 Inferences and Recommendations

Inferences and recommendations upon analysis of the data and training are,

1. The average fuel economy increased by almost 48% from 4.5kmpl baseline to 6.7 kmpl post training.
2. For an individual driver, the maximum increase was 93% from 3.3kmpl to 6.6 kmpl.
3. Least increase was 13%, from 4.6kmpl to 5.2kmpl. But during the training, the same driver achieved figures of 9.4, 7.7 and 5 kmpl.
4. Previously untrained drivers were able to improve their performance more than the two trained drivers.
5. Among all the trials, the variance in the baseline was the least, 0.3 and average of 4.4kmpl and range from 3.3 to 5kmpl respectively.
6. The first assessment during the training had the maximum SD of 1.4 and a range from 5 to 9.4kmpl and an average of 6 kmpl; This progressively narrowed down during the training and post training, with a SD of 1.2 and 1 respectively with ranges from the range was 5.2 to 8.9 kmpl
7. Though all drivers showed an improvement in performance, some performed better in the trials during the training than the post training assessment.
8. Fuel efficiency improvement translates to savings of 70ml per km per truck or about INR 3.5 per km.
9. While only data such as vkt and fuel consumed are captured, it is essential that other parameters such as idling time, which have a large impact on the fuel efficiency in this case, are also captured.
10. A system of data capture and analysis, ideally automated, should be in place that would help the management with better knowledge and control of the fleet.

14 www.carbonpod.com

11. Considering the large fleet size, the system should help keep track of the preventive maintenance and alert the maintenance team on the requirement for each truck and plan the activities in advance.
12. A dedicated team should be in place that looks into fuel efficiency in the entirety of operations and interventions
13. Targets should be based on route and vehicles and create incentive programs that rewards mechanics and drivers for achieving better fuel efficiency

5. WAY FORWARD

The Green Truck Toolkit (GTT) pilot has demonstrated that a technically sound, bespoke approach can considerably improve a fleet's efficiency and environmental performance. But pilot projects can be like ships passing silently in the night unless there is concerted effort to use them as stepping-stones for scale up.

The GTT project can be used in two ways: (i) as a ready reckoner for fleet owners who want to test the waters as they decide on their green strategies (ii) as an advocacy tool to strengthen the case for green freight.

The project partners are keen to work with interested groups – particularly shippers and road freight carriers - to help them roll out the tool. The basic framework already exists and can be adapted to the individual needs of the organisation. All that is needed is the willingness on the part of the businesses to try it in order to experience the business and environmental gains.

With each green intervention, the toolkit will throw up richer learning. This will not just help in refining the methodology but also contribute to building a stronger case for Green Freight. Going further, all stakeholders will have to effectively communicate the evidences of such interventions. There is need to build and strengthen the perception that Green Freight is an intelligent business decision and not just a social responsibility.

Green Freight India has an informal working group called Green Freight India Working Group (GFIWG). It consists of members of the civil society, industry associations, academia and businesses. The project partners hope that GFIWG will play a leadership role in integrating these green interventions in the larger conversation on Green Freight in India.

With the economy poised to grow, now is the time to lay the foundation of Green Freight. In times of climate change and depleting resources, if India has to grow it must be on the bedrock of sustainability. In the final analysis, Green Freight is that bedrock for businesses.

ANNEXES

Annex A: Module Content

Topic	Sub Topics/Description	Method
Introduction	Introduction to the Company, Course content, Objectives of eco driving, informal discussion with drivers on their history	Power point presentation, Video Aided
Safety Precautions of Automobile Workshop	Safety measures and Guidelines of Workshops and Vehicles to be followed for safety	Safety Equipments
Introduction to Different types of Tools	Description and specifications of tools daily used and its uses at different situations	Hands-on use of tools on a vehicle
Introduction to Indian traffic scenario	Road accidents in India, typical causes of accidents, prevention measures, defensive driving	Power point presentation, Video Aided
Vehicle dynamics	Shape and design of vehicle, gravitational pull, road grip, load and axle capacities, application of brakes in different weather conditions.	Power point presentation, Video Aided
Hazard perception	Types of hazards on Indian roads and carrying loads and handling of such hazardous situations.	Power point presentation, Video Aided
Driving in difficult conditions	Precautionary and safe driving in rain, desert, fog and snow conditions etc., and importance of hill driving	Power point presentation, Video Aided
Soft Skill Module	Behaviour of driver with pedestrians, elderly, women and handicapped people and other road users and co-workers. Alertness, discipline, adherence to road rules, safety rules etc	Power point presentation, Video Aided
Clutch Lining and Clutch Troubles	Types of Clutch, properties of clutch lining and clutch troubles. Effective use of clutch in various conditions including on hill roads and slopes	Power point presentation and Demo
Gear Box	Types of gear boxes, lubrication, common troubles and solutions, correct gear shift process	Hands on training
Differential lubrication	Differential working, lubrication and troubleshooting and initial checks	Hands on training
Rear and Front Axle	Axle functions, types, lubrication and troubleshooting, basic maintenance	Hands on training
Wheel Balance and Wheel Alignment	Wheel balance importance and alignment technique, basic checks of alignment	Hands on training
Health Module	Effect of alcohol on driving, Legal limit of alcohol in blood, effects of various addictive drugs during driving, Effects of BP, diabetes, importance of rest and sleep, awareness of AIDS etc,	Power point presentation and Demo
Breakdown, Towing	Different types of Breakdown, Towing and managing of breakdown and accident vehicles.	Power point presentation and Demo

Traffic control devices	Clear understanding importance and application of Police Traffic Control, Signal Traffic Control, Road and Line, Road Furniture and Road Signs.	Models, Track and hands on training
Rules of the road & defensive driving	Brief description of road rules, different types of road users and different types of hand signals	Power point presentation and hands on training
Indicators and safety systems	Use of indicators, Braking distance at different speeds, Right of Way monitoring, Use of Helmets and Belts	Power point presentation and hands on training
The responsible driver	Importance of cleanliness in the vehicle, Good knowledge of the vehicle functioning, Precautionary and safe driving, Right use of mobile phones, Tools and accessories requirement, emergency kit, regulatory documents of the vehicle, Empathy for other drivers and road users.	Power point presentation and videos

Annex B: Assessment Parameters

SL No	Parameters
1	Inspection of brake and clutch pedal
2	Inspection of tyres
3	Engine starting pattern
4	Engine shutting down pattern
5	Inspection of fuel leakages
6	Is the driver using clutch when not changing gears?
7	Is the gear changed properly?
8	Is brake being applied properly?
9	What is the speeding pattern?
10	Is appropriate RPM maintained?
11	Inspection of other meters on dashboard
12	Steering holding pattern (10:15)
14	What is driving pattern on non-maintained road?
	Inspection before starting
A	Inspection of Steering
B	Clutch oil
C	Air filter indicator
D	Silencer
E	Fuel injection and calibration
F	Oil & water
G	Lubrication

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