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Stakeholder perception on Heavy Duty Vehicle (HDV) fuel efficiency

Survey report

An initiative supported by

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FOUNDATION

Suggested format for citation

T E R I.2015
Stakeholder perception on HDV fuel efficiency : Survey Report
New Delhi: The Energy and Resources Institute. 46pp.
[Project Report No.2014EE08]

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Table of contents

List of Figures

1 Introduction

India has shown tremendous economic growth in the last two decades. Growth in population, urbanization, and industrialization has led to increased demand for raw materials and manufactured goods. Correspondingly, the demand for passenger and freight movement has increased significantly, as has the consumption of petroleum products in the road transport sector. Following the industrial sector, transportation is the next largest consumer of energy in India. The transport sector presently accounts for 17 per cent (72 million tonnes of oil equivalent) of the total energy consumed in the country (MoSPI, 2015).

Figure 1 shows the sales of heavy-duty vehicles (HDVs) in India from fiscal year (FY) 2008–09 to 2014–15. Whereas, figure 2 shows the annual registration of buses and goods vehicles in India from the year 2003 to 2013.

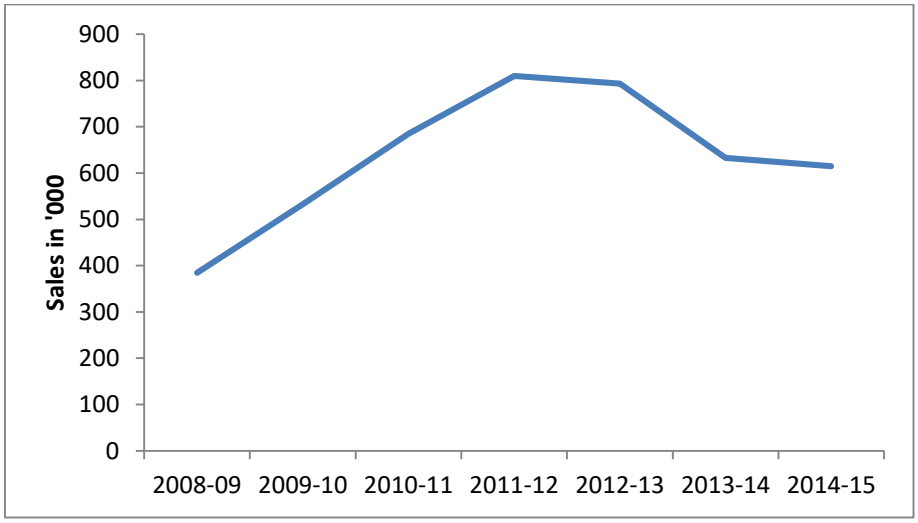

Figure 1: Historical commercial vehicles (light and heavy commercial vehicles) sales in India

Source: SIAM, 2015

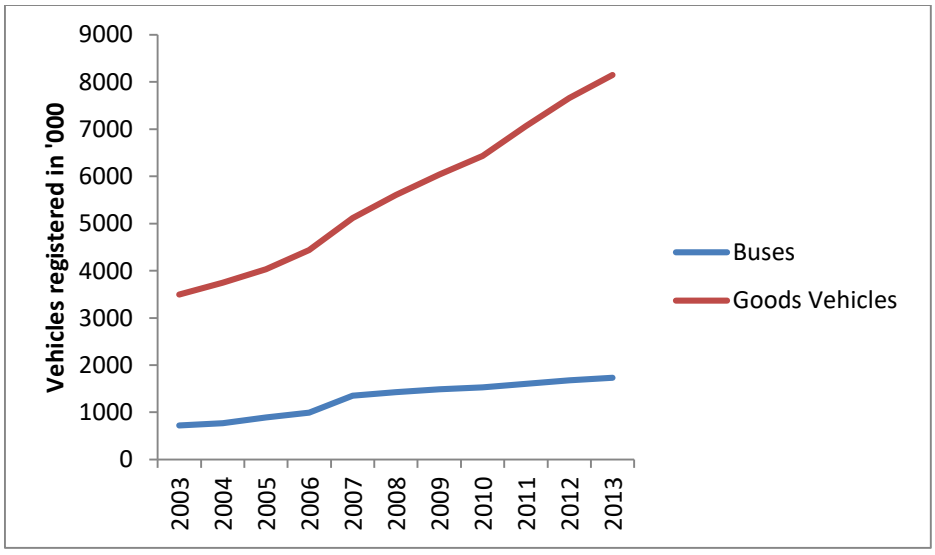

Figure 2: Annual registration of buses and goods vehicles in India from 2003 to 2013.

Source: (MoRTH, 2015)

The share of heavy duty commercial vehicles in India is just 3 per cent of the total number of registered vehicles (Figure 3). However, HDVs consume almost 38 per cent of the fuel used in the transport sector (MoPNG, 2014). This clearly highlights the need to reduce fuel consumption and carbon emissions from HDVs.

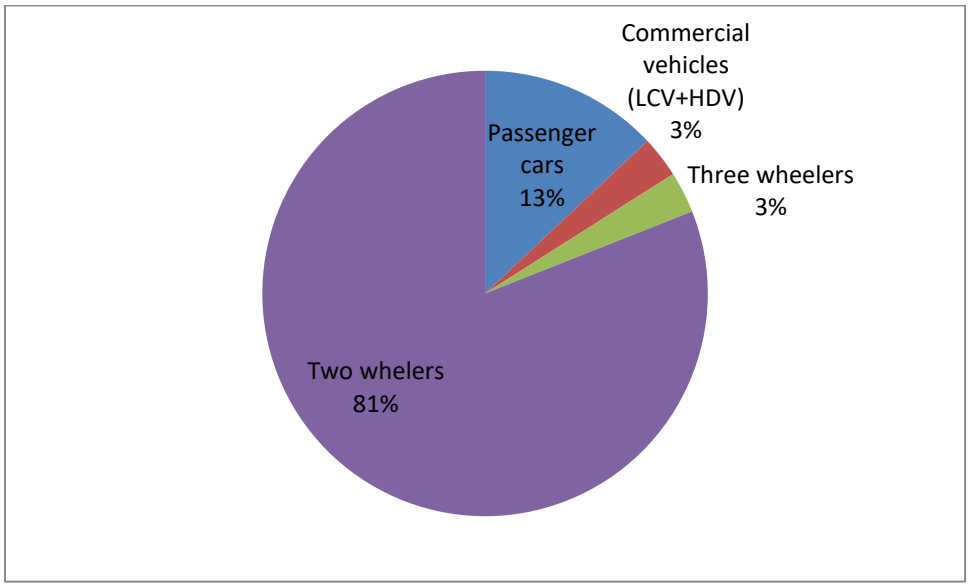

Figure 3: Vehicle sales in India in FY 2014–15

Source: SIAM, 2015

TERI analysis projects a steep increase in fuel consumption in the HDV sector. Figure 4 shows energy consumption in India by vehicle type from 2001 to 2011 and projections out to 2051. Over the 40-year period from 2011 to 2051, these projections estimate a 10-fold increase in total on-road vehicle fuel consumption and a similar level of increase in HDVs as well.

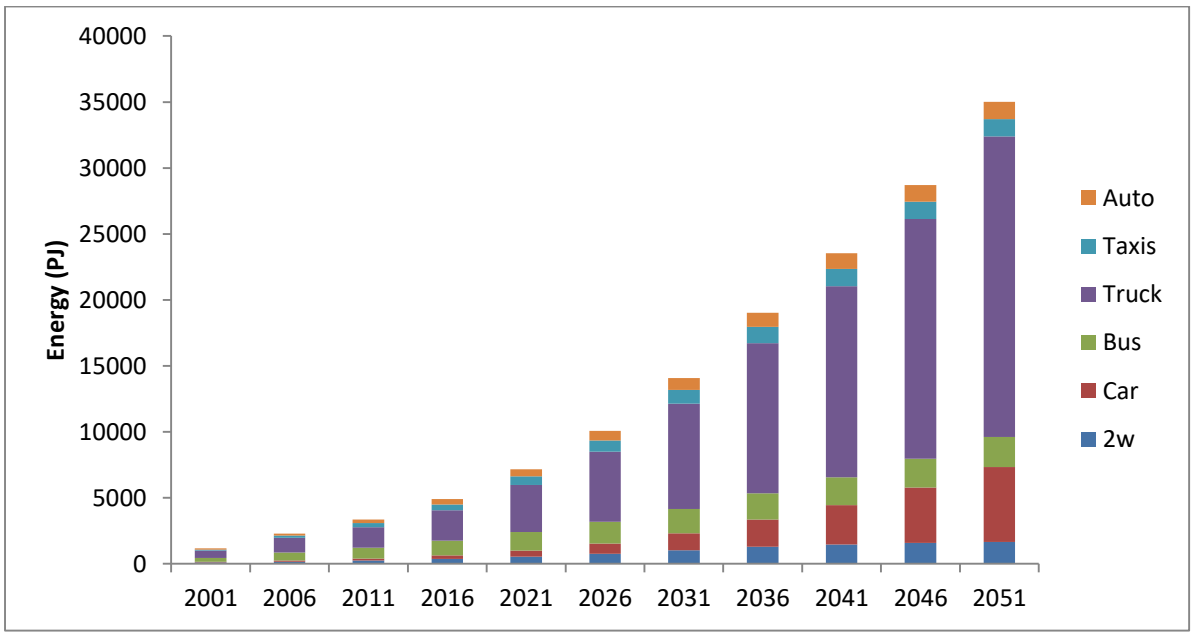

Figure 4: Vehicle-wise share of energy consumption in India during 2001–51

Source: TERI-MARKAL model results

With such massive growth projected for the HDV sector, improving the fuel efficiency of the fleet is of critical importance. The primary objective of this study was to survey a diverse cross section of stakeholders with the HDV industry to better understand the attitudes, experiences, and expectations of these various actors with respect to efficiency technologies and operational strategies. This paper presents the results of interviews conducted with various manufacturers, HDV fleet owners, component manufacturers, and research institutes to assess their views on the current situation in India and opportunities for fuel efficiency improvements in the future.

2 Methods

Between April and October 2015, TERI staff conducted telephone and in-person interviews of different stakeholders on various topics related to efficiency and to better understand their respective businesses. The participants in this study can be segmented into three main stakeholder groups:

- End-users: Bus fleet and truck fleet owners who purchase the HDVs and use it on the roads for transportation of passenger and goods
- Manufacturers: Original equipment manufacturers (OEMs) and tier-1 suppliers (e.g., engine manufacturers, tire manufacturers)
- Research institutes: One of the leading automobile testing and research entities in India

Figure 5 lists different set of stakeholders in the HDV industry.

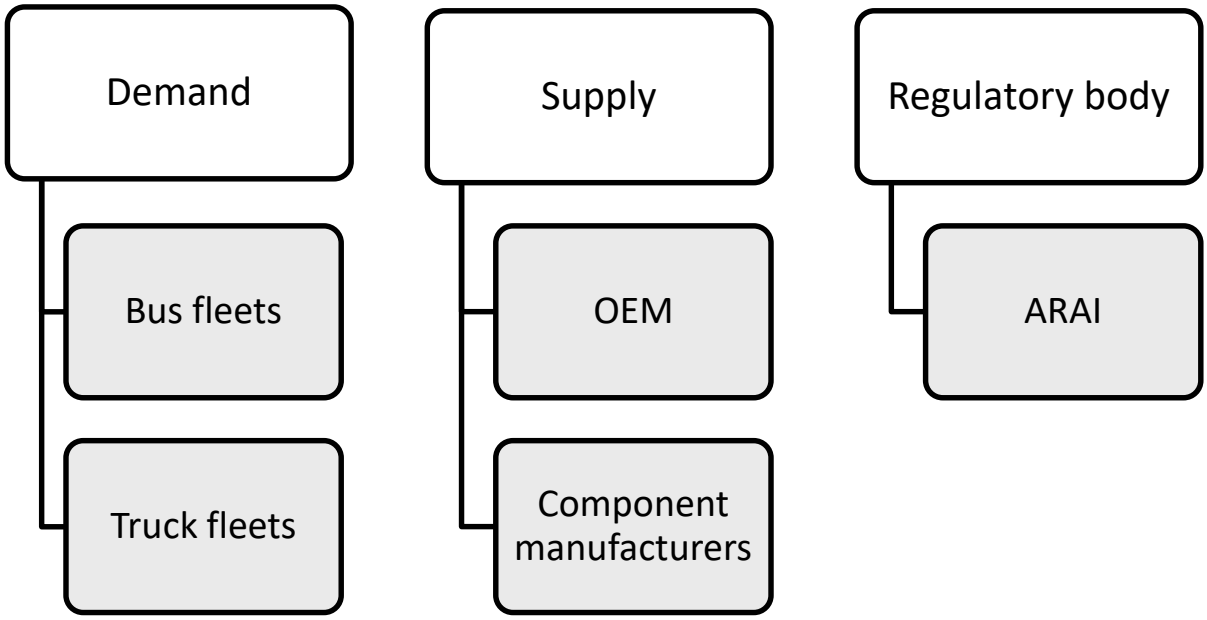

Figure 5: Stakeholders in the HDV industry interviewed for the perception survey

TERI prepared questionnaire templates for vehicle manufacturers and component manufacturers after several rounds of discussions with internal experts as well as consultations with the International Council on Clean Transportation. The objective of the vehicle and component manufacturer interviews was to understand how important fuel efficiency is in the overall design and planning process; what they feel about fuel efficiency policy measures; information about future technology deployment (see Annexure 1 and 2). In addition, the survey team asked questions regarding the marketing strategies of each company and the regulations that influence their businesses the most. TERI also interviewed experts from the Automotive Research Association of India (ARAI) to acquire a better understanding of the testing procedures in place for HDVs. The discussion with ARAI revealed how testing is currently done in India and the path that India should follow in developing test procedures to support fuel efficiency regulation.

For end users, questionnaires were developed for both truck fleets and bus fleet operators. The main objective was to better understand the emphasis placed on fuel efficiency while purchasing and operating trucks and buses (Annexures 3 and 4). Moreover, the survey team wanted to gain knowledge about various aspects of operating a HDV fleet in India, including typical vehicle purchasing dynamics, driving and payload conditions, contracting issues, and logistical considerations.

Altogether, 11 interviews were conducted with truck and bus fleets. Seven manufacturers (OEMs and component manufacturers) were interviewed, as were two experts from ARAI. Other experts in the industry who had been associated with ARAI or the manufacturing community were also interviewed.

Once the interviews were completed, the survey team analyzed the responses to identify the common themes as well as disparate views across the various topic areas. The subsequent sections summarize the survey's major findings.

Box : Inerviewees

- Secretary General of All India Confederation of Goods and Vehicles Associations
- Two small truck fleets in Delhi – Uttaranchal transport service and Jaiswal transport service.
- Large truck fleets like TCI and VRL logistics.
- Transport authorities from Uttar Pradesh, Gujarat, Navi Mumbai and North east Karnataka
- VRL bus services and small bus fleet in Delhi – Singh tours and travels.
- Research and Development department of Daimler
- Marketing Department of Mahindra & Mahindra
- Research and Development department of TATA motors
- Society of Indian Automobile Manufactures (SIAM).
- Current and former employees of ARAI

3 Survey findings

Fleet owners

The fleet owners were asked about the types of vehicles purchased, ownership patterns, mission profiles, typical routes, and fuel consumption rates. They were also asked what factors influence the procurement process for HDVs and the importance of fuel efficiency in this process. Figure 6 represents the themes under which under which discussions were carried out with fleet owners, fuel efficiency being the central theme. Operational costs of the fleets were also discussed. Expenses on fuel and the use of any operational practices for reducing fuel consumption were also explored. Finally, they were also interviewed for their opinion on maintenance of fleets and technological considerations for fuel efficiency improvements.

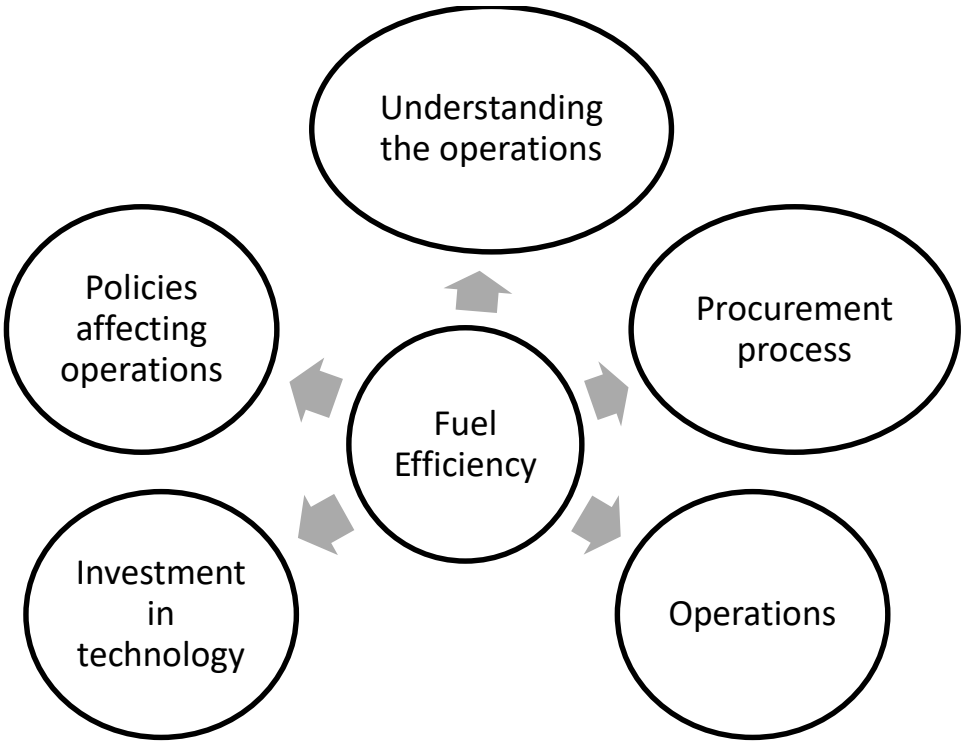

Figure 6: Major themes of discussion with fleet owners.

Truck fleets

About 80 per cent of the trucks in India are owned by fleets that own less than 10 trucks. Only 10 per cent of fleets own more than 25 trucks, and less than 2 per cent of fleets own trucks between 200 to 1,000 trucks (KPMG, 2011).

A variety of different types of truck fleets were selected. The interviewees ranged from small fleet operators with less than 10 trucks and regional operations to some of the largest logistics companies in India with more than 3,500 trucks and nationwide coverage.

Fuel efficiency considerations in the procurement process

The survey revealed that for the small truck fleets, the most important point of consideration is the purchase price of the vehicle. Small fleet owners are generally constrained by capital; hence, they are typically unable or reluctant to invest beyond the basic trucks that can successfully perform their operations. Getting loans from banks and other financing institutes is often a challenge. Small fleet owners usually have limited formal education; this makes it difficult for them to be informed about new technologies in the market and models of vehicles that might reduce their fuel consumption. For these small fleets, the main source of information is word-of-mouth. Thus, a very limited number of truck models are popular amongst the small fleet owners. The popularity of these truck models is based on:

- Low acquisition cost
- Low maintenance – there are certain models of trucks that are very popular in India, hence, it is possible to find spare parts very easily. Moreover, small fleet owners prefer 'non-OEM' workshops over OEM-authorized facilities because of lower service cost.
- Better fuel efficiency – one of the reasons for popularity of such models is good fuel efficiency. Therefore, even though the fleet owner might not verify the fuel efficiency of the truck while purchasing it, high fuel efficiency is in fact one of the implicit reasons for the choice of the truck. Typically, they themselves or other fleet owners in their peer network have achieved good fuel efficiency with these truck models in the past.

Large truck fleet owners are much more willing and able to invest in newer technologies provided they have proven benefits. Thus, such fleets are the motivation for OEMs to invest in new technologies. In large fleets, fuel efficiency is closely monitored during the operations, and thus, it is one of the most important factors while purchasing trucks. Of course, the application of the truck is the most important factor in the selection while purchasing. For example, choice of truck for operations in mines would be very different from a choice for dry bulk transport.

Operation costs for truck fleets

From the fleet responses, the operating costs of trucks breakdown in the following major categories:

- Fuel costs
- Driver salaries
- Maintenance costs
- Toll charges paid while crossing interstate borders

From the discussions with fleet owners the team found that fuel cost is the dominant contributor to overall operational costs. Fuel costs are followed by driver salaries. Toll charges are paid at state borders for using certain roads. Even though maintenance costs are not incurred on every trip, these expenses still constitute a sizeable percentage of operational costs.

Designing of contracts for shipping goods

The fleets were asked about how their contracts for shipping of goods are structured. The fleet owners stated that shipping contracts are designed according to the type of service required. For large companies, especially those in the public sector, tenders are issued and any fleet meeting the requirements can bid on the contract. Usually, the fleet proposing the lowest cost is given the contract. As such, this business is highly competitive. Therefore, fleets try to minimize operating costs as much as they can. If the contract is not acquired via competitive bid, large fleets usually have a fixed rate for transporting goods based on criteria such as the route, weight of the goods, distance, terrain, and road conditions.

For smaller fleets, trucking contracts are obtained with the help of brokers that do not have any trucks of their own. Shippers approach the brokers, and then small fleets are hired by these middlemen, based on competitive bid. As with the contracts for larger fleets, these smaller contracts are also highly competitive, and the trucking companies keep their operating costs as low as possible. In many cases, transport agents help small fleet operators to get contracts for a modest fee.

It should be noted that truck operators have to ensure that they have another shipping contract at the place of delivery after they drop-off the first load. Therefore, the contract amounts are dependent on the destination. If the destination is a place or town where shipping contracts are easy to find, then the cost of delivery is low. Otherwise, the cost of delivery is high as an empty back-haul is the only option left for the truck operator.

As revealed from surveys, fuel costs are a major percentage of the overall operation cost, and the on-road freight business is highly competitive. Consequently, fleet operators need to be very conscious about the fuel efficiency of the vehicles. However, the approach with which small and large fleets handle this is very different. Large fleets reported that they maintain logs of fuel consumption, by vehicle, after every trip. The fuel efficiency is recorded in kilometer per liter, and other points like route, payload, and driver for each trip are also noted. This information is later analysed to optimize the fuel efficiency of the fleet. On the other hand, it is rather uncommon for small fleet owners to keep logs of the fuel spent per kilometer run, and other factors. Small fleet owners usually operate their trucks over the same set of routes and transport similar types of goods. The fleet owners also try to supervise drivers closely using frequent communication so that they are aware of their day-to-day operations and driving habits. Such fleet managers usually have an estimate of the amount of money neededfor fuel to transport goods to a given distance.

Factors which influence fuel efficiency of the vehicle

When asked about the operating factors that might influence the fuel efficiency of trucks, both large and small fleet owners had almost the same opinion. During the discussions, the fleets stated that driving habits have a very important role in the fuel efficiency of the vehicles. Fleets believe that a skilled driver with efficient driving habits saves more fuel as compared to an unskilled driver in comparison to other interventions such as preventive maintenance or fuel-saving technologies. It was also unanimous amongst the fleets that road conditions and terrain also have an important role in fuel efficiency. The fuel consumed by the vehicle, per kilometer travelled, increases as the payload increases. However, the way fleets perceive this dynamic was varied. Some fleet owners expressed that overall freight efficiency (i.e., the amount of goods transported per unit of fuel) of the vehicle increases with overloading, as more goods

can be transported in a single trip. Despite that physical reality, it was clear that some of the fleets were less comfortable with overloading, as these conditions tend to compromise safety.

Relationships between drivers and truck fleet owners

As discussed in the previous section, drivers are one of the key governing factors behind fuel efficiency of the vehicle. Therefore, this makes it important to understand how drivers are compensated and the kind of relationship they share with fleet owners. Fleet owners have different methods for paying drivers. Of the different fleets interviewed, two payment systems seemed to emerge as the most popular in Indian truck fleets. In the first type of payment structure, which is more popular among the small fleets, drivers are paid a monthly salary and given a certain additional amount of money for each trip. This extra money is given to drivers so that they can cover charges like toll fees, fines for overloading, food, etc. An important point is that drivers are not given this money for fuel costs. The fleet managers have an idea of the amount of fuel the vehicle will consume during the trip and then fill the vehicle fuel tank accordingly. In a way, this arrangement takes away the incentive of truck drivers to conserve fuel. In the alternative driver payment system, which is typically used by large fleets, the drivers are given the vehicle and certain amount of money at the beginning of each trip. With the money, the driver has to cover the trip expenses, and the remaining balance is the take-home pay. In this arrangement, the payment rate is per kilometer of distance travelled rather than monthly salary. The fleet owners have designated stations where drivers can refuel their trucks. In addition, large fleets have special monetary incentives for the drivers for completing the job early or for using less fuel than the benchmark level.

Vehicle maintenance procedures

Upon selling vehicles to customers, the OEMs provide information about the maintenance procedures. The buyers are given information regarding the maintenance and inspection intervals, lifetimes of different components of the vehicle, and other relevant information. Moreover, state governments also have mandatory fitness tests for vehicles. Typically, new vehicles are given a fitness certificate for a certain period of time, and then after that initial period, the certificate has to be renewed annually. The certification procedures are in place to help confirm the proper functioning of the emissions control system and also ensure that the overall vehicle is in a good condition for safety purposes.

During the surveys the small fleets revealed that they are overly strict about the maintenance schedules and generally take the vehicles to the workshops only when they are experiencing issues. Also, small truck fleets do not prefer workshops that are authorized by the OEMs, as they are more expensive as compared to local, 'non-OEM' service stations. One drawback is that the local service personnel may not have the proper knowledge of the vehicle or component in question. This is one of the biggest reasons why small fleets tend to prefer well-known, popular truck brands and models.

From the interviews, it seems that large truck fleets are much more likely to follow the maintenance schedules as suggested by the OEMs. Most of these fleets are more sophisticated in their asset management approach and tend to have the requisite software to assist them in managing maintenance and inspection schedules.

Fuel efficiency technology investments

From the interview responses, it seems that small fleet owners generally do not invest in technology after purchasing the vehicles. Managing day-to-day operations, meeting loan repayment obligations for existing equipment (most trucks are financed through loans), paying drivers, and searching for new businesses dominates small fleets' administrative resources, and there is typically no time to research new fuel-saving technologies. As such, these fleets are almost never in a position to spend the time or money investing in efficiency technologies (e.g., radial tires, improved engine oil), which might reap fuel savings benefits.

On the other hand, large fleets have more administrative resources at their disposal and are thus in a much better position to investigate fuel-saving technologies and strategies and make investments that have an attractive return. To date, some of the most popular vehicle fuel efficiency investments have been higher-grade engine oil and radial tires. These fleet owners also expect that technologies like lower rolling resistance tires, more efficient engines, and hybrid technologies might be available commercially in the next 3–5 years. These respondents also believe that technologies like air suspension and detached trailers, which are available in more developed countries, would be beneficial to their business.

Both large and small fleets believe that if maintained properly, the vehicle life can be extended. However, the age at which a truck is retired from the fleet is influenced a lot by the regulations of the state. For example, small fleet owners from Delhi stated that they retire the vehicle from their fleet even if the vehicle performance is acceptable. The primary reason for retiring trucks from fleets is the 10-year age limit restriction imposed by the Delhi Transport Authority. Whereas, fleet managers from other states responded that a truck is retired only when the maintenance and fuel costs exceed the revenue earned from the truck. There were instances cited when trucks were used in the fleet for up to 20 years. The usage of trucks retired from inter-state transportations is generally limited to applications within the city, like construction activities, etc.

Discussions with fleets, industry experts, and OEMs revealed that most large fleets are keen on investing in technologies that help them monitor their trucks more closely. These larger fleets have been investing in software that catalogs information like vehicle characteristics, operating conditions, and fuel costs so that they can more quickly identify areas that require intervention and help them improve their business.

For example, the Green Trucks Toolkit (GTT) is a Microsoft Excel-based programme developed for the Asian Development Bank. The main purpose of the GTT is to guide the fleet owners or shippers in selecting the technologies and/or operational strategies that would reap the maximum benefits. The required input parameters include the truck model year, number of wheels, fuel type, annual kilometers, annual fuel consumption, average trip length, curb weight, gross vehicle weight, number of empty trips, average speed, and idling time. After taking in these inputs, the toolkit suggests the percentage benefits in different areas with respect to the required investment. Examples of areas of intervention include:

- Eco driving
- Improved maintenance
- Aerodynamic styling
- Tires

- Idling reduction
- Alternative fuels

By using this tool (and other similar types of software) the fleet owners claim to be able to make better-informed decisions about ways to improve fuel efficiency. In addition, the GTT can also be applied for other purposes like criteria pollutant emissions control.

Buses

While trucks are used for freight movement, heavy-duty buses are the primary mode of public transportation in India. Both public and private bus fleets of varying sizes were interviewed as part of this study. The fleet size of the STUs interviewed in this study range from a few hundred buses to almost 8,000. Four of the bus fleet interviewees represented state transport units (STUs) from different regions of the country. STUs are managed by the state governments. The primary function of the STUs is to provide public transport services for the citizens of its particular region. Generally, the STU buses run on the same route daily. The routes of the buses in the STUs are both inter-city and intra-city. The fleets interviewed comprise buses both with and without air conditioning. The average distance covered by each bus everyday varies is roughly 250 to 500 km.

Other than the four STUs, two small bus fleets were also interviewed. The first fleet operates 10 buses and is privately owned. The buses run daily operations from Delhi to popular tourist destinations around Delhi on set routes. All the buses in this fleet are air conditioned. Each bus covers 800 to 1,000 km per trip and has 3 to 4 such trips on a weekly basis.

Finally, another private bus fleet was interviewed that mainly operates in the western and southern parts of the country. This fleet has 372 buses and roughly half of them are air conditioned. The buses in this fleet run on a contract carriage—i.e., the route driven by a particular bus is defined according to customer demand.

The six bus fleet managers were asked about the vehicle procurement process, operational aspects of their business, vehicle maintenance, and their attention to fuel efficiency.

Procurement of buses and the relevance of fuel efficiency in this process

The STUs do not exercise complete autonomy in selecting buses for their fleets. The Union Ministry of Urban Development issues guidelines and specifications to STUs for the procurement of buses. These guidelines take into account critical parameters such as the type of operation (i.e., inter- vs. intra-city), road conditions, and seating capacity needs. Apart from these set guidelines, other factors like the purchase price, ease of maintenance, and fuel efficiency play an important role in the STUs selection of the bus. In addition, government and quasi-government agencies such as ARAI, the Petroleum Conservation Research Association, and the Association of State Road Transport Undertakings, provide information to STUs about bus parameters and test results and therefore, influence the procurement process.

Private fleets have the ability to select buses for themselves. In case of smaller fleets, the most important factor is the purchase price of the bus. Just as with small truck fleets, small bus fleets owners are highly influenced by their peers (i.e. or small- or medium-sized bus fleets). It was clear from all six of the interviews that good fuel efficiency performance and low maintenance are factors that are always important when acquiring new buses.

Operation of buses

The operation costs of buses can be broadly classified into three areas—driver salaries, fuel costs, and maintenance costs. Figure 7 shows an approximation of the distribution of operation costs in STUs. Unlike truck fleets where fuel costs are always a larger percentage of operating costs other than driver salaries, STUs spend roughly the same amount on fuel and driver costs. A possible reason for this could be that drivers in STUs are government employees, which forces the fleet owners to pay them according to the rates set by the government.

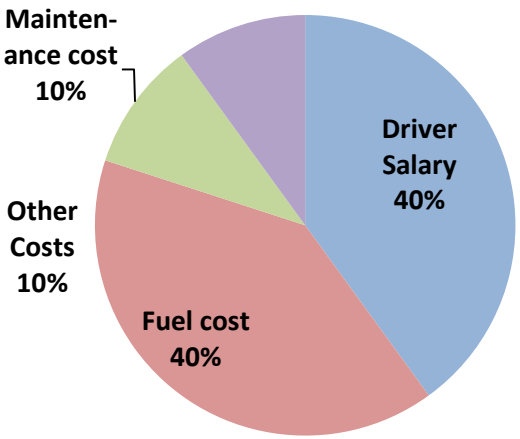

Figure 7: Estimated distribution of operating costs for state transport unit (STU) bus fleets

Source: Interviews with STU fleet manufacturers

STU bus fleets face a unique challenge with respect to fuel costs. If fuel prices increase, the private bus fleets can increase passenger fares for service, but STUs do not have the liberty to increase the tariffs, since the primary function of STUs is to provide affordable public transportation. Hence, STUs are highly motivated to minimize their fuel expenditures as much as possible. As such, the interviews revealed that STU operators are very conscious about the fuel efficiency of their buses.

STUs regularly monitor and report the fuel efficiencies of their vehicles in kilometers per liter (km/l). Since the vehicles travel on the same route every day, fuel efficiency is relatively easy to monitor. In addition to STUs, large private bus fleet owners are also conscious about fuel efficiency and have the administrative resources necessary to make investments based on their findings.

When asked about the operating factors that influence the fuel efficiency of the vehicles, all of the interviewees had similar responses. All of the respondents agreed that driving patterns and the skill level of the drivers have a significant influence on the fuel efficiency of the buses. Road conditions and terrain also impact the fuel consumption rates. Buses running on good quality roads—like most of the national highways—tend to have better fuel efficiency compared to buses operated over poor roads. Moreover, as with all vehicles, congestion also negatively affects the fuel efficiency of buses. Some fleets also responded that the number of

passengers on the bus affects the fuel efficiency. In India, due to very high demand for public transportation, it is fairly common that the number of passengers on a bus far exceeds the recommended maximum seated and standing capacity.

Relationships between drivers and bus fleet owners

Driving behavior is one of the most significant variables that has an effect on the fuel efficiency of a vehicle. This makes it important to study the relationship of the driver with the fleet owner.

STUs are in the public sector, and hence, the drivers are paid according to the wage scales set by the government. Since fuel efficiency is a significant concern for STUs, incentives such as special recognition and cash rewards are given to drivers who deliver the best fuel efficiency on the buses. Almost all the STUs have in-house driving training programmes or send their drivers for off-site coaching and education courses. The private bus fleet interviewed also has its own driver training center.

In addition to a fixed salary, large private bus fleets also pay their driver on a per-kilometer basis. With smaller bus fleets, the drivers are paid per trip, and these funds must cover their salary as well as operations expenses such as tolls and parking fees. The private bus fleet owners responded that certain OEMs offer to train a driver after the purchase of a vehicle. For the private bus fleets interviewed, the responses indicate that special incentives are not given to drivers to save fuel.

Vehicle maintenance procedures in place

The STUs and large bus fleets keep detailed records of their vehicles and maintenance charts as recommended by the OEMs. Some fleets have software to keep track of the maintenance schedules. However, small fleets do not generally have any elaborate systems. The small fleets reported that bus components are only replaced when they start malfunctioning. Typically, engine oil and frequently replaced parts such as air filters are installed periodically by local mechanics after a set number of kilometers.

Fuel efficiency technology investments

The small bus fleets indicated that they do not invest much into the vehicle to increase the fuel efficiency. The main reasons for this decision are as follows:

- Fuel expenses are not as critical as they for STUs, since private fleets can easily raise the cost of service for customers.
- Most fleet owners lack the technical knowledge and awareness regarding technologies that can offer a return on investment.
- Small fleets do not maintain records of fuel consumption.
- The average life of a bus in small fleet is five years. This is another reason why fleet owners do not make investments with longer pay back periods.

STUs and large private fleets do make investments to improve fuel efficiency from their buses. The most important interventions are high-grade engine oil and radial tires. The STUs that have made these changes stated that these technologies have provided an acceptable return on investment. Some STUs have also used hybrid buses in their fleets at a pilot scale. Buses

in larger fleets are retired after 8 to 10 years or after they have logged 800,000 km or more. Government regulations are the primary reason behind retiring buses.

Manufacturers

Manufacturers were interviewed with an intention to understand the importance of fuel efficiency in their overall design process and marketing strategies. As shown in figure 8, the manufacturers were also asked questions regarding the preferred testing procedures for the upcoming fuel efficiency standards and policies which influence their decision making the most.

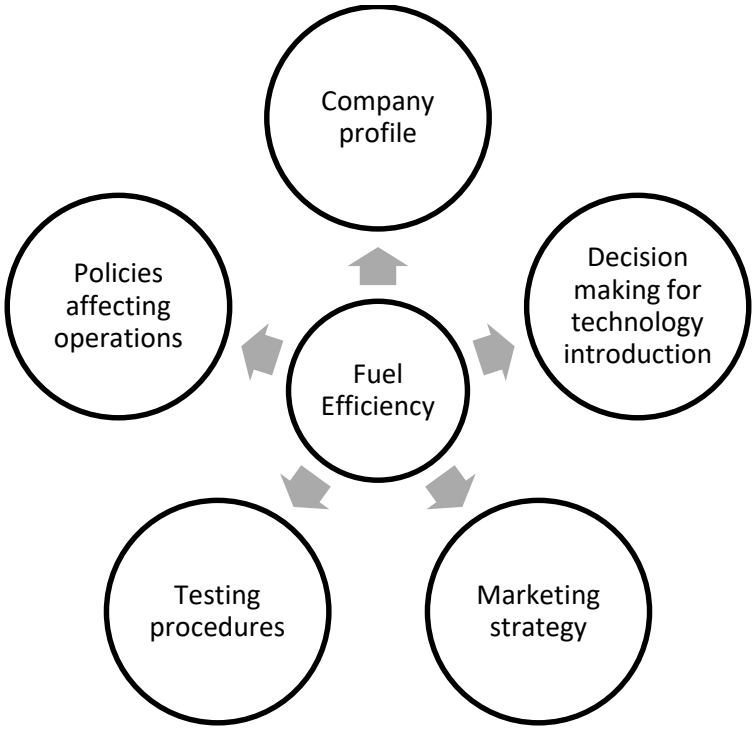

Figure 8: Major themes of discussion with manufacturers.

Original Equipment Manufacturers

There are three leading commercial vehicle manufacturers in India—TATA Motors, Ashok Leyland, and Volvo-Eicher—that have double-digit percentages in market share in India. Daimler Benz, AMW, Mahindra, VWCV, and SML Isuzu each control less than 5 per cent of the market. TATA Motors holds roughly half of the market share for both trucks and buses, and the second largest OEM, Ashok Leyland, accounts for about one-fifth of total sales. Figures 9 and 10 show the manufacturer market shares for domestic truck and bus sales, respectively.

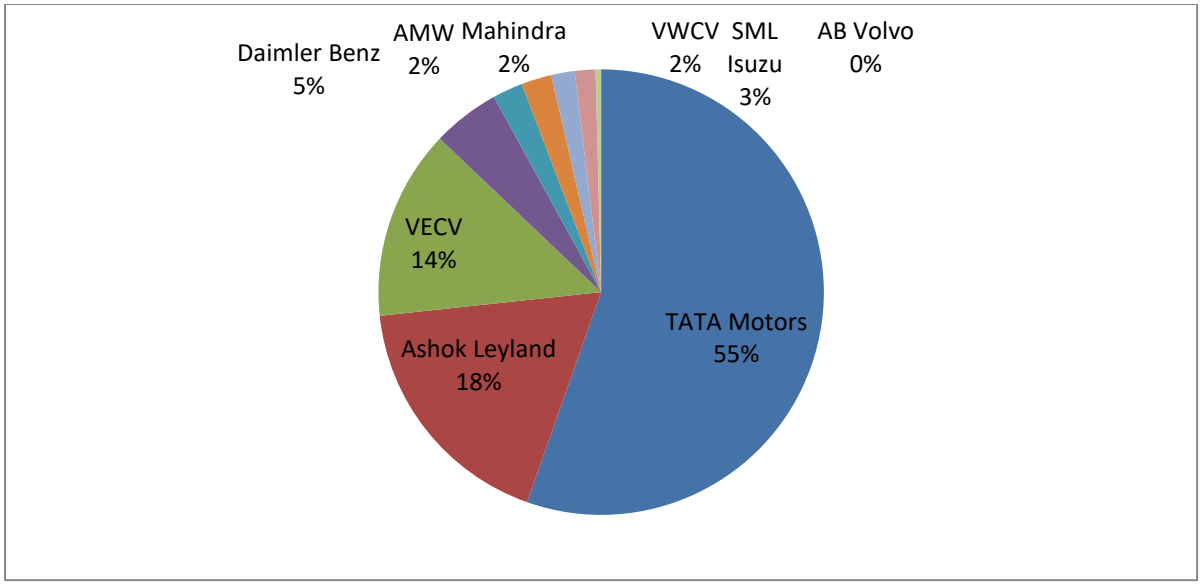

Figure 9: Manufacturer market shares for truck sales in India

Source: ICCT, 2015

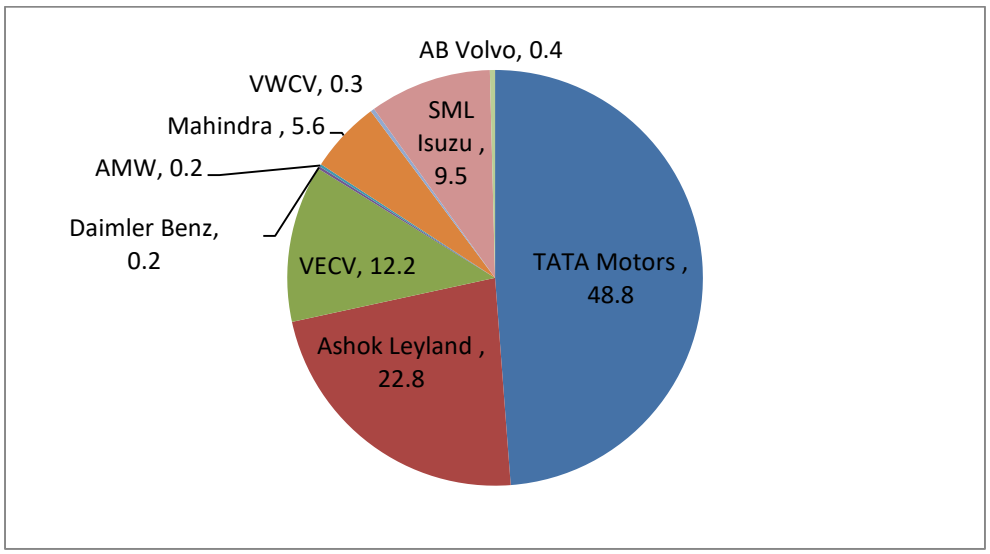

Figure 10: Manufacturer market shares for bus sales in India

Source: Sharpe, 2015

Relationships between OEMs and fleets and the relevance of fuel efficiency

The way OEMs view their customers is very critical to understanding their perception on fuel efficiency. Interviews were conducted with the marketing heads of only a subset of OEMs, since many of the companies were unwilling to openly share their marketing strategies related to fuel efficiency. The following section is based on the discussions with these select OEMs, and it is possible that the other manufacturers may have different opinions based on differences in target customers, company policies, etc. However, the opinions that are summarized below are a good starting point to better recognizing how well customers are understood by truck and bus manufacturers in India.

Customers—i.e., the fleet owners (truck fleets in particular)—can be broadly classified into two categories:

- **Revenue generating:** Customers that have other businesses and truck fleets are owned to serve those businesses. For example, these include truck fleets owned by mines, processing industries, and oil companies. The main priority of these customers is to efficiently use trucks to enhance profits in their primary business. Thus, the purchasing decision is largely influenced by the kind of application in use and more importance is given to the durability of the vehicles. Even though fuel efficiency might be of some importance, it certainly is lower in the list of priorities. Also, such customers are more willing to invest in technologies and will accept the higher acquisition cost of the vehicle as long as there is a reasonable return on investment.
- **Cost Savings:** Bus or truck fleet service is the primary business for these kinds of customers. The best example is logistic companies and STUs. Around 70–80 per cent of the customers fall into this category. Low purchase costs and high fuel efficiency of the vehicles are very crucial factors for these fleets. This category can be further sub-divided based on the number of trucks in the fleet.

Based on the number of vehicles, truck fleets can be divided into four categories—large fleets with more than100 vehicles; medium fleets that have between 50 and 100 trucks; small fleets between 5 and 50 trucks; and owner-operators with up to 5 trucks. The manufacturers interviewed claimed that around 60–70 per cent of their customers are in the large and medium categories. Thus, the major research and development in the company is done with an eye towards these key customers. For the latter two categories, OEMs generally sell off-the-shelf vehicles.

With large and medium fleets, OEMs tend to be more engaged in the sales process, since these typically comprise orders of many trucks at a time. Manufacturers revealed that they conduct a significant amount of research for customers who place large orders. In the initial stages of the process, information regarding the fleet operations, geographical area of work and fleet preferences is gathered from sources like vehicle body builders, financial institutes, insurance agencies, etc. Then, in one-on-one conversations with fleets, the manufacturers try to understand their specific needs. The OEMs revealed that in most cases the fleets often consult with the manufacturers before applying for large tenders. When making a large order, fleets usually customize the vehicles according to their various applications.

Heavy-duty vehicles are sold both as chassis and as completely finished vehicles. If sold as chassis, the buyer then takes it to a body builder to mount the rest of the body onto the chassis. Body builders are generally small independent shops found in clusters in metropolitan cities like Delhi, Chennai, and Kolkata. These builders install the rest of the body of the truck/bus according to the user requirements. There are a number of reasons why fleets tend to prefer buying chassis and then completing the rest of the body by body builders:

- The cost of having the body completed is much cheaper at independent body builders compared to OEMs.
- Buyers can customize the vehicle more by taking it to vehicle body builders. The applications of vehicles vary greatly and an operator wants a body that best suits their operations. For example, the configuration of a truck intended to transport furniture would be different from one intended to deliver something like cement or bulk

materials. Fleets cannot expect such degree of customization to be available in off-the-shelf low price products that are available from the OEMs' inventory.

- Body building is largely an unregulated sector. The body builders design the body using the material that the customers want, and aspects like safety and fuel efficiency are often compromised.

There are also reasons why some buyers prefer purchasing completely finished vehicles from the OEM. First, some manufacturers offer a more attractive warranty on the vehicle if it is purchased in a completely designed and finished form. Second, acquiring a loan from a financing institution is generally easier if a fully finished vehicle is purchased from a recognized manufacturer.

Reasons for OEMs to upgrade technology and the relevance of fuel efficiency

HDV product development revolves around customer needs and requirements. Generally, the manufacturers are only interested in investing in a technology if there is demand from fleets and there is an expected return on investment. The total cost of operating a vehicle is closely considered when developing a new or improved product. From the manufacturer responses, fuel expenses represent nearly 50 per cent of operating costs, followed by driver salaries. These two cost areas influence the way in which new technology is developed. However, the way in which the manufacturers perceive this is different. For example, one of the manufacturers responded that there was no motivation to invest in the driver cabin and make it more comfortable, since the fleet managers generally do not drive the vehicles themselves. From this OEM's perspective, an investment in cabin comfort only increases the cost of acquisition. This particular manufacturer would rather invest that money in enhancing the fuel efficiency of the vehicles, as this would yield more benefit to the fleet. On the other hand, another manufacturer stated that the driver cabin has always been on their priority list for product development.

The survey revealed that manufacturers in India also stay abreast of technologies developed internationally. The new technologies developed for India are often compared with the technologies offered in Western countries, which are typically more advanced from a technological perspective. Thereafter, a comparison is also made with developments in the BRICS countries, i.e., Brazil, Russia, India, China, and South Africa. These countries are similar to India in terms of infrastructure, economic development, etc.

Product differentiation is another reason for investing in new technology development. The market in India is competitive and manufacturers have to launch products that continually improve on existing levels of technology. Fuel efficiency is often the focus area of improvements. Unlike passenger cars, HDV fuel efficiency is not marketed in terms of kilometers per liter. Rather, the manufacturers claim that their vehicle would deliver a fuel efficiency that is x per cent better than an average model available in the market.

The factors that manufacturers consider when developing a new HDV product include the following:

- The new technology should be affordable. No matter how good a technology is, it will not be accepted readily in the market if the cost is substantially higher than the options already available. The manufacturers have to ensure that increases in cost are well within the range of what a typical customer is willing to pay.

- The technology must have proven real-world benefits. The fleet must have confidence that the new technology provides value for the additional investment and will pay back well within the ownership period.
- The manufacturers aim to keep the payback period for new technologies as low as possible. During product development, 6 to 12 months is the target payback period.

Compared to markets such as North America and Europe, HDVs in India usually do not operate at high speeds. The Ministry of Road Transport and Highways, Government of India, issued a notice in 2014 that requires that all HDVs operate at a maximum speed of 80 km/hr. With this constraint, most of the manufacturers interviewed believe that engines and tires are the most attractive areas for improving efficiency.

Challenges in improving the fuel efficiency of heavy-duty vehicles in India

During the interviews with HDV manufacturers, discussions were held on various challenges involved in introducing fuel-saving technologies. Some of the key takeaways from discussions on this topic area are enumerated as follows:

- As previously discussed, most of the fleets prefer low acquisition cost of the vehicles. Most buyers do not make cost-benefit calculations while purchasing new vehicles and opt for the cheapest vehicle available that can successfully complete the required tasks. This, in turn, discourages manufacturers from investing in technologies.
- Most buyers are skeptical of new technologies. For example, as shared by one of the manufacturers, the reason for the limited popularity of vehicles having high-end electronic features is the belief that it is difficult to find suitable technicians that can service vehicle with advanced electronics.
- The fact that vehicle body builders are very popular amongst bus and truck operators in India is another challenge for OEMs. There is no control over how the vehicle is configured, weighs, or the load distribution over the axles once the vehicle is out of the factory gates. Thus far, body builders have stayed away from the reach of regulators. However, according to interview responses, the Ministry of Road Transport and Highways is in process of issuing bus body norms that would put some restrictions on the body construction of buses.
- Most of the small truck and bus operators prefer local mechanics over workshops authorized by OEMs simply because the cost of service is lower. These mechanics are generally not professionally trained and often tamper with the chassis of the vehicle. This can impact the overall performance of the vehicle. Manufacturers believe that this arrangement might change after Euro V norms are introduced, since most non-OEM technicians would not have the knowledge to repair these vehicles.
- Certain stakeholders believe that testing procedures of in-use vehicles in India can be improved and made more robust. At present, HDVs have to go through a fitness test on yearly basis.

Manufacturers believe that on-board diagnostic (OBD) systems can play a major role, ensuring that the in-use vehicle remains fuel efficient. The data collected by OBDs can also open many doors for the manufacturers in developing new technologies, as it would provide more information about the real-world operations profile of the vehicles. OBD was introduced

in two phases in India. OBD I was introduced in 2010 for all vehicles except LPG, CNG-fueled vehicles, and vehicles with gross vehicle weight (GVW) greater than 3.5 tons. OBD II was introduced in 2013 for BS-IV light commercial vehicles.

Manufacturers' views on HDV fuel efficiency testing procedures

HDV manufacturers feel that mandatory testing procedures should be selected in such a way that it represents real-world conditions. All of the manufacturers interviewed were highly critical of constant speed fuel consumption (CSFC) testing as a mandatory procedure. The reason manufacturers are not in favor of CSFC testing in India is that this method calls for vehicles to be evaluated at only two speeds: 40 km/hr and 60 km/hr. From their perspective, testing at just two steady-state points is not at all representative of real-world driving conditions and how the HDVs are used in India. According to interview responses, CSFC testing has a very low degree of repeatability. Since the test is performed outside of a test track, CSFC depends on environmental factors like wind speed, temperature, etc., which can have non-negligible impacts on the results. For regulatory purposes, manufacturers believe that India should work towards using a simulation model, like VECTO, that can be tailored to unique conditions in India, rather than implementing testing schemes that might not yield many real-world benefits.

Tire manufacturers

The importance of tire technology cannot be overstated as it is considered as a 'low hanging fruit' to improve the fuel efficiencies of the vehicles. Some of the vehicle manufacturers' interviewed also had similar beliefs. The technology in case of tires is quite mature and the question now is of deployment. Rather technological and policy interventions are required to retrieve fuel efficiency benefits through tires.

Deployment of radial tires has some proven benefits in reducing the fuel consumption of vehicles. TERI and ICCT have worked on a paper which analyses the status of tire technology in India. Rolling resistance, the property of the tire which influences fuel consumption, is discussed in detail in the paper. The paper discourses the operational and design parameters of a tire which can impact the rolling resistance. Parameters like construction, application, availability and benefits/demerits of radial and bias tires are also differentiated in the paper. At present, only 18 per cent of the tires sold to the HDV sector are radial. A section of paper also discusses the economic benefits of radial tires over bias tires. Fuel savings in the range 7.7 per cent to 9.2 per cent can be expected on account of shift from bias to radial tires in an HDV in India. Countries around the world have followed diverse pathways to regulate the quality of the tires in the market.

Both radial and bias tire manufacturers were interviewed by TERI to understand their perspective on the issue of radialisation and that India should follow for regulation. The tire industry also has some key concerns regarding the path India should follow in this regard. While some manufacturers (primarily those manufacturing bias tires) support the tire labeling system, others have some reservations regarding the labeling system. Even though the labeling system provides information to the customers but the system itself requires research and should be designed in such a way that there is no scope of misleading the customers. Manufacturers cautioned that often there is a trade-off when it comes to refinement of tire

technology. The regulation should be framed keeping in mind all the relevant aspects of tires—fuel efficiency, safety, comfort, durability, etc.

The manufacturing industry acknowledges that India needs a threshold rolling resistance, i.e., a restriction on the maximum rolling resistance of tires in the market. However, the cut-off rolling resistance should be decided only after proper research. It should be framed keeping in mind the capabilities of Indian bias tire manufacturers and gradually made more stringent with time.

Tire manufacturers also believe that regulations like mandatory tire pressure monitoring systems (TPMS) should considered seriously as optimum tire pressure is one of the easiest way to reduce fuel consumption on account of tires.

Research and testing institute: ARAI

One of the major challenges in forming the fuel efficiency norms in India is to come up with accurate and reliable testing procedures. The Automotive Research Association of India (ARAI) is one of the best known institutes in India for testing vehicles and auto components for fuel efficiency, emissions, and safety. ARAI is a research association of the automotive industry in India and the Ministry of Heavy Industries and Public Enterprises. Apart from testing and evaluation of automotive equipment, other functions of the organization include research and development and product design. ARAI has testing facilities such as engine dynamometers, chassis dynamometers, and a test track at its disposal.

Understanding the perspective of the testing agency and the kind of testing procedures they envision for India is very important, given their stature in the vehicle industry. Thus, discussions were carried out with some of the key persons in ARAI, to derive some insight into the existing HDV testing procedures that are currently in place and the kind of testing roadmap they feel is best for India.

ARAI's perspective on testing procedures for fuel efficiency norms

In the discussions, ARAI indicated that for appropriate assessment of fuel efficiency, the full vehicle tests are necessary. The test procedure must take into account all the aspects of the vehicle and key components like the engine, transmission, rolling resistance, and air drag. ARAI stated that the development of a simulation tool to measure the CO_2 emissions and fuel consumption of the entire vehicle is the best way to achieve this goal. However, development of such a simulation would take a considerable amount of time and investment. Meanwhile, India's goal of reducing fuel use and carbon emissions can only be achieved if action is taken immediately.

Thus, ARAI suggests that India should make it mandatory for the manufacturers to meet minimum fuel efficiency levels based on the results from both CSFC and engine dynamometer tests. In parallel, ARAI believes that India should also work to develop a simulation tool, which is more holistic and takes into account each and every parameter of the vehicle that can affect fuel efficiency. The following are the reasons given by ARAI as to why they believe that the combination of CSFC and engine dynamometer tests are the best path forward for the first phase of the regulation:

- Facilities to test vehicles on CSFC tests and engine dynamometer tests (based on the ESC cycle) are already available in India. Both the regulators and the manufacturers

are comfortable with the testing procedures. Thus, a regulation based on these tests would be easier to enforce when developing a regulation in a shorter timeframe.

- ARAI experts also believe that freight trucks are largely intended to move at constant speeds on highways. The CSFC test is designed to capture that aspect of HDV driving. However, trucks, more often than not, fail to achieve that steady speed cruising driving conditions. As such, ARAI opined that there is a need to improve road conditions and CSFC can be adopted as the test procedure. ARAI does not feel that the testing procedure should be based on more realistic driving cycles and they think that the current CSFC procedure can be continued.
- Chassis dynamometer testing would require huge capital investment. At present, the number of chassis dynamometers is very limited in India. It would require significant investments if a regulation is designed based on testing on a chassis dynamometer.
- The engine is one of the most important components when it comes to fuel efficiency for HDVs in India for two reasons. First, HDVs in India rarely operate at high speeds The latest mandate from MoRTH requires HDVs to operate at a maximum speed of 80 km/hr. The energy losses from engines are most dominant at low speeds (as compared to losses on account of tires and aerodynamics). Second, a limited number of engines are used in a different variety of vehicle configurations. Thus, a regulation based on the engine itself can have far-reaching impacts on improving the fuel efficiency of the overall vehicle.

4 Conclusions and recommendations

The HDV industry in India is quite conscious about efficiency. All types of vehicle owners monitor fuel efficiency in some way or the other. While some owners have the capability to understand the reasons behind low fuel efficiency of their vehicles and try to improve it in an organized manner, others lack those capabilities. The lack of awareness and unavailability of funds for some of the fleet owners are some of the reasons for their passive attitude towards fuel efficiency.

The manufacturers in India study their customers quite closely and have an understanding that fuel efficiency is one of the key parameters while purchasing vehicles. However, there are certain reasons why OEMs cannot invest more than a certain amount to improve fuel efficiency. First, low purchase price of the vehicle is the top priority of most customers. Second, most of the customers prefer purchasing just the chassis from OEMs and then getting it fully furnished by a body builder. This is one of the reasons why new technologies do not have optimum results. In addition, operating factors like poor road conditions, vehicle overloading, and inadequate maintenance procedures also have adverse impacts of fuel efficiency.

India has been testing the fuel efficiency of HDVs using CSFC and engine dynamometer tests for many years. The testing authorities in India feel that such procedures should be made mandatory immediately. This will ensure that there is some regulation in place to meet the goal of saving fuel and reducing carbon emissions. Meanwhile, a suitable vehicle simulation tool can be developed. Manufacturers, on the other hand, do not find CSFC representative and feel that India should follow the path as set by Europe and directly work on a simulation tool. All of the stakeholders unanimously agreed that a regulation on fuel efficiency for new vehicles is not the only solution for reducing fuel consumption in the HDV sector.
Some of the key recommendations based on the discussion with all of the stakeholders are:

- Regarding the test procedures for HDV fuel efficiency testing, using a combination of CSFC and engine dynamometer testing could be a starting point for India. This is primarily because both manufacturers and regulators are familiar with these two testing procedures and it can be immediately brought into effect. However, there is no denying that CSFC has low test to test repeatability and is not representative of driving conditions in India. Thus, a simulation model should be simultaneously worked upon so that it can replace CSFC test in a limited well-defined timeframe.
- India should invest in research. It is required that various kinds of operations and applications of HDVs are documented. To get accurate results out of any kind of testing or simulation, it is absolutely necessary that a driving cycle representative of HDVs application in India is in place.
- There is no control over what a vehicle would look like after it moves out of the factory gates. The shape of the vehicle and vehicle weight has a major effect on the fuel efficiency. Research and regulation on the 'vehicle body builders' is required. Body building codes for buses and trucks should be notified as early as possible.
- The fuel-saving benefits of technology investment will not be realized until road conditions are improved and vehicle overloading is controlled.

- Most of the truck fleet owners in India lack education and awareness. Hence, they cannot carry out the cost–benefit analysis of various technologies available in the market. A green freight programme in India will assist fleet owners, shippers, and other stakeholders to make well-informed decisions about technologies and operational strategies for saving fuel.
- India can begin with a tire labeling system as a starting point to regulate the quality of tires in the market. However, it should be noted that the labeling system in itself requires research and should be designed in a way that is best suited for India. The labeling should also take into account parameters like wet grip, noise, etc., apart from rolling resistance. After the labeling system, India can think of setting a restriction on the maximum rolling resistance of the tires in the market. The restriction should be set after proper research of the market.

5 Bibliography

Society of Indian Manufacturers (2015) Domestic Sales Trend, SIAM Retrieved on December 9, 2015 http://www.siamindia.com/statistics.aspx?mpgid=8&pgidtrail=14

KPMG (2011) Competing in the global truck industry KPMG http://www.kpmg.com/ID/en/IssuesAndInsights/ArticlesPublications/Documents/Competing-in-the-Global-Truck-Industry.pdf

GIZ (2015) Green freight India GIZ

Automotive Tyre Manufacturing Association. (2015). "Indian Tyre Industry: An Overview." Retrieved November 3, 2015, from http://www.atmaindia.org/indian-tyre-overview.html

Bridgestone India. (2015). "Advantages of Radial Tyres."Retrieved November 4, 2015, from http://www.bridgestone.co.in/AdvantagesOfRadialTyre.aspx.

Continental AG Hannover (1999).Truck Tyre Basics. Hannover, Germany.

Michelin.(2015). "Radial vs. Bias Technology."Retrieved November 3, 2015, from http://www.michelinag.com/Innovating/Radial-vs.-Bias-technology.

Pike, E. (2011). Opportunities to improve tire efficiency. Washington, DC, The International Council on Clean Transportation.

MoPNG [Ministry of Petroleum and Natural Gas, Govt. of India] (2014) Press information Bureau. Available at: http://pib.nic.in/newsite/ (Accessed on 27 January, 2016).

MoSPI [Ministry of Statistics and Programme Implementation, Government of India] (2015) Energy statistics, 2015.Central statistics office, Govt. of India.

Sharpe, B.(2015). Market analysis of heavy duty vehicles in India. The International Council on Clean Transportation

MoRTH .(2015). Annual Report 2014-15. Ministry of Road Transport and Highways, Government of India. New Delhi
Available at: http://morth.nic.in/showfile.asp?lid=1656

Annexure 1: Survey for Truck/Bus Manufacturers

Objective

Perception survey to understand how important fuel efficiency is for the manufacturer in overall design/planning and what they feel about fuel efficiency standards. *(How important is it while designing a vehicle?)*

Respondent

Technical or marketing head of the company

Questions

1. Respondent details

1.1 Name

1.2 Designation

1.3 Role in the organization

1.4 Years of employment

Profile of vehicles manufactured by the company

1.5 What is the USP of your company?

1.6 Commercial vehicle types manufactured

1.6.1 Goods

1.6.2 Passenger

1.6.3 Both

1.7 How many plants do you have across India?

1.7.1 1

1.7.2 2

1.7.3 3

1.7.4 >3

1.8 Do you have testing laboratories/ product verification labs at your place? If yes, then what type of testing/verification is currently being done in your R&D division? If no, then where do you outsource the facilities from?

If the manufacturer produces goods vehicles

1.9 What are the total units of goods vehicles sold by you (2014-15)?

1.10 Do you manufacture complete vehicles or only chassis with engine?

1.10.1 Complete vehicle units [%]

1.10.2 Only chassis with engines [%]

1.10.3 Both options available [%]

1.11 What engine capacity categories do you have for goods vehicles and what would be their shares in sales?

1.11.1 <3000 cc [%]

1.11.2 3000-5000cc [%]

1.11.3 5000-8000 cc [%]

1.11.4 > 8000 cc [%]

1.12 What percentage of your goods vehicles sold come with automatic transmission?

1.12.1 <2%

1.12.2 2-5%

1.12.3 5-10%

1.13 What is the payload capacity of the goods vehicles manufactured by you?

1.13.1 3.5 tons – 7.5 tons [%]

1.13.2 7.5 tons – 12 tons [%]

1.13.3 12 tons – 25 tons [%]

1.13.4 25 tons> [%]

1.14 What are your major goods vehicles sales markets/regions?

1.14.1 North

1.14.2 So

1.14.3 W

1.14.4 E

1.14.5 C

1.14.6 Pan-India

1.15 How many months/days of inventory do you hold on average?

1.15.1 7 days

1.15.2 15 days

1.15.3 1 month

1.15.4 1-2 months

1.15.5 >2 months

1.16 How many service centers do you have in the country catering to your goods vehicles?

1.16.1 _____number

If the manufacturer produces PASSENGER vehicles

1.17 What are the total units of passenger vehicles sold by you (2014-15)?

1.17.1 _____

1.18 Do you manufacture complete passenger vehicles or only chassis with engine?

1.18.1 Complete vehicle units [%]

1.18.2 Only chassis with engines [%]

1.18.3 Both options available [%]

1.19 What engine capacity categories do you have for passenger vehicles and what would be their shares in sales?

1.19.1 <3000 cc [%]

1.19.2 3000-5000cc [%]
1.19.3 5000-8000 cc [%]
1.19.4 > 8000 cc [%]

1.20 What percentage of your passenger vehicles come with automatic transmission?
1.20.1 <2%
1.20.2 2-5%
1.20.3 5-10%

1.21 What fuel variants do your passenger vehicles come in?
1.21.1 Diesel
1.21.2 CNG
1.21.3 Electric

1.22 What percentage of buses manufactured by you are low-floor?
1.22.1 10-20%
1.22.2 20-30%

1.23 What is the share of buses in terms of seating capacity sold by you?
1.23.1 9 – 15 seats [%]
1.23.2 15 – 30 seats [%]
1.23.3 30 – 45 seats [%]
1.23.4 45 – 60 seats [%]

1.24 What kind of buses do you manufacture along with their shares in sales?
1.24.1 Luxury (with AC, recliner seats, etc.) [%]
1.24.2 Non-luxury [%]

1.25 What are your major passenger vehicles sales markets/regions?
1.25.1 North
1.25.2 So
1.25.3 W
1.25.4 E
1.25.5 C
1.25.6 Pan-india

1.26 How many months/days of inventory do you hold on average?
1.26.1 7 days
1.26.2 15 days
1.26.3 1 month
1.26.4 1-2 months
1.26.5 >2 months

1.27 What is the average size of fleets that you cater to for goods vehicles?
1.27.1 <5 vehicles

1.27.2 5-10 vehicles
1.27.3 10-25 vehicles
1.27.4 >25 vehicles

1.28 What is the average size of fleets that you cater to for goods vehicles?
1.28.1 <5 vehicles
1.28.2 5-10 vehicles
1.28.3 10-25 vehicles
1.29 >25 vehicles

1.30 How many service centers do you have in the country catering to your buses?
1.30.1 _____number

Technology

Understanding the decision making process of the organization with regards to introduction of fuel-saving technology or product features and fuel efficiency in general.

1.31 What is a typical design cycle for your vehicle models (e.g., 4 years)?
1.31.1 1-2 years
1.31.2 2-4 years
1.31.3 4-5 years
1.31.4 More than 5 years

1.32 What are the motivation factors for a new product design?
1.32.1 E.g. Market share, Unavailability of a product in a particular segment/domain, Competitor products, technology upgrade

_____

1.33 How do you decide which technologies or features will end up in the final vehicle design?
(Cost considerations, Market requirements, Product differentiator, Fuel efficiency, Component availability, Standards/regulations, etc.) Please rank the top 3 reasons.

_____

1.34 Is fuel efficiency part of this decision-making process? If so, how does it compare with other design considerations such as cost, durability, warranty, etc. mentioned above?

_____

1.35 Are customers conscious about the fuel efficiency levels of the vehicles they buy? If so, then are there any studies that have been conducted to understand how they value fuel efficiency?

_____

1.36 Do you utilize a payback calculation to estimate how long it will take a technology to pay for itself in terms of fuel savings? If so, what are typical upper bounds that you utilize for the payback time (e.g., 2 years)?

_____

Understanding if they have faced any challenges in the introduction of a new technology?

1.37 In which part of the vehicle is it generally easiest to introduce new technologies? (Engine, chassis, transmission, electronics, etc.) What are some of the key reasons for your choice?

_____

1.38 Are new technologies typically introduced across your entire vehicle product mix or are new technologies marketed to specific segments or types of fleets?

_____

Technology improvement plan in the near to long term

1.39 What are the new technologies and features that you expect to introduce in the near-term (3-5 years) that would increase the fuel efficiency levels of your vehicles? What potential increase in fuel efficiency do you expect from these interventions? What will these new technologies require in terms of capital investment?

Note: we are not interested in learning about specific new technologies or products that are considered confidential. Rather, we are interested about learning the general technologies areas where the interventions are planned.

Intervention	Potential improvement in fuel efficiency	Additional cost	Expected time of deployment

1.40 Are your research and development efforts in collaboration with any other companies? If so, please describe.

_____

1.41 How are your vehicles tested for performance and durability?

1.42 What do you envision as being obstacles in terms of technology integration or how the technology will perform in the real-world?

1.43 In the past, have you had a particular challenge with the introduction of a given technology or feature?

_____

1.44 Which of your vehicle segments are most receptive to advanced technologies?

_____

Market

1.45 Market considerations

1.46 What are the marketing tools that you generally use to market new products?

1.46.1 New technology

1.46.2 Durability

1.46.3 Fuel efficiency

1.46.4 Pay load capacity

1.46.5 Low maintenance

1.46.6 Others _____

1.47 Do you use results from various standards/norm tests as marketing tools? Are these results or a subset of results made available to your customers?

1.48 How does fuel efficiency factor into your current marketing strategy? Do you expect this to change going forward?

1.49 How do you currently market fuel efficiency of your vehicles?

1.50 Does your marketing strategy differ based on the type or size of customer fleet? If yes, then do you also provide customized solutions as a marketing strategy for fleets?

1.51 Are there instances where you modify sales orders based on customer preferences? Please cite some examples.

Policy and compliance

1.52 What are the standards/regulations that you presently have to meet for your HDVs? (e.g. emissions, noise, evaporative emissions, safety, etc.)

1.53 Which of the above is the most difficult to comply to?

1.54 What are the key challenges faced by you in complying with the various emissions norms (BSIII/IV) being put forward by the Government? (e.g. increased costs, requirement of R&D, etc. – if cost, then ask what % increase is expected)

1.55 How do you expect that increasing emissions norm standards (i.e., Bharat III to IV and V) affect your vehicle design process in terms of engine technology?

1.56 What emission control technologies do you have at your disposal to achieve Bharat V and VI?

1.57 How do you expect the introduction of diesel particulate filters (DPFs) and other similar ECTs to affect engine efficiency?

1.58 The Government is planning to introduce BSV norms for all vehicles by 2018, or alternatively, BSVI norms by 2020. What is your opinion about the same?

1.59 What are your expectations for a similar fuel efficiency policy for HDVs?

1.60 How do you think fuel efficiency norms would affect your design process for engine and vehicle-level (i.e., non-engine) technologies?

Annexure2: Survey for Component Manufacturers

Objective

Perception survey to understand how important fuel efficiency is for the component manufacturer in overall design/planning and what they feel about fuel efficiency standards. *(How important is it while designing components of a vehicle?)*

Respondent

Technical or marketing head of the company

Questions

2. 1.1 Respondent details

2.1 Name

2.2 Contact details (phone no. & e-mail id)

2.3 Designation

2.4 Role in the organization

2.5 Years of employment

Profile of the components manufactured by the company

2.6 What is the USP of your company?

_____

2.7 What types of components do you manufacture?

2.7.1 Engine

2.7.2 Tyres

2.7.3 Transmission

2.7.4 Fuel system

2.7.5 Others _____

2.8 How many plants do you have across India?

2.8.1 1

2.8.2 2

2.8.3 3

2.8.4 >3

2.9 Do you have testing laboratories/ product verification labs at your place? If yes, then what type of testing/verification is currently being done in your R&D division? If no, then where do you outsource the facilities from?

2.10 Who are your major customers?

2.10.1 Truck manufacturer [%}

2.10.2 Bus manufacturers [%}

2.11 What percentage of the components manufactured by you were sold as spare parts?

If the component manufactured is Engine

2.12 What was the total number of engines sold by you in 2014-15?

2.13 What engine capacity categories do you have for vehicles and what is its share in sales?

2.13.1 <3000 cc [%]
2.13.2 3000-5000cc [%]
2.13.3 5000-8000 cc [%]
2.13.4 > 8000 cc [%]

2.14 What is the range of the maximum engine power of the engines manufactured by you?

2.14.1 100 – 150 bhp [%]
2.14.2 150 – 200 bhp [%]
2.14.3 >200 bhp [%]

2.15 What is the range of maximum torque delivered by your engines?

2.15.1 200 – 250 Nm [%]
2.15.2 250 – 300 Nm [%]
2.15.3 >300 Nm [%]

2.16 What kind of fuels do your engines use?

2.16.1 BS III [%]
2.16.2 BS IV [%]
2.12.4 CNG [%]

2.17 What type of fuel injection system is used in your engines?

2.17.1 CRDI [%]
2.17.2 Direct injection [%]
2.17.3 Other [%]

2.18 What kind of induction systems are used in your engines?

2.18.1 Turbo charged [%]
2.18.2 With EGR [%]
2.18.3 Super charged [%]

2.19 Who are major OEM customers?

2.20 In which region do you sell spare parts of the engine?

2.20.1 N [%]
2.20.2 S [%]
2.20.3 W [%]
2.20.4 E [%]
2.20.5 C [%]

2.20.6 Pan India [%]

2.21 How many months/days of inventory do you hold on average?

2.21.1 7 days

2.21.2 15 days

2.21.3 1 month

2.21.4 1-2 months

2.21.5 >2 months

2.22 How many service centers do you have in the country catering to your engines?

2.22.1 _____number

If the component manufactured is Tyre

2.23 What kinds of tyres do you manufacture?

Type of tyre	% Manufactured	% for buses	% Trucks
Radial			
Cross ply			
Biased			
Others			

2.24 In which region do you sell spare tyres?

2.20.1 N [%]

2.20.2 S [%]

2.20.3 W [%]

2.20.4 E [%]

2.20.5 C [%]

2.20.6 Pan India [%]

2.25 How many months/days of inventory do you hold on average?

2.25.1 7 days

2.25.2 15 days

2.25.3 1 month

2.25.4 1-2 months

2.25.5 >2 months

2.26 Who are your major OEM customers?

2.27 What was the total number of tyres sold by you in 2014-15?

If the component manufactured is Fuel System

2.28 What is the capacity of engines you fuel systems are manufactured for?

2.28.1 <3000 cc [%]

2.28.2 3000-5000cc [%]
2.28.3 5000-8000 cc [%]
2.28.4 > 8000 cc

2.29 Please tell us about your last year's sales figures.
2.29.1 CRDI systems [%]
2.29.2 Direct injection system [%]

2.30 Who are your major OEM customers?

2.31 In which region do you sell spare parts of the engine?
2.31.1 N [%]
2.31.2 S [%]
2.31.3 W [%]
2.31.4 E [%]
2.31.5 C [%]
2.31.6 Pan India [%]

2.32 How many months/days of inventory do you hold on average?
2.32.1 7 days
2.32.2 15 days
2.32.3 1 month
2.32.4 1-2 months
2.32.5 >2 months

2.33 How many service centers do you have in the country catering to your engines?
2.33.1 _____number

2.34 What was the total number units sold by you in year 2014-15?

If the component manufactured is transmission

Types of Gear	% Manufactured	% for buses	% Trucks
Automatic			
6 speed			
4 speed			
>6 speed			

2.35 Who are your major OEM customers?

2.36 In which region do you sell spare parts ?
2.36.1 N [%]

2.36.2 S [%]
2.36.3 W [%]
2.36.4 E [%]
2.36.5 C [%]
2.36.6 Pan India [%]

2.37 How many months/days of inventory do you hold on average?
2.37.1 7 days
2.37.2 15 days
2.37.3 1 month
2.37.4 1-2 months
2.37.5 >2 months

2.38 How many service centers do you have in the country catering to your product?
2.38.1 _____number

2.39 What was the total number of units sold by you in year 2014-15?

Technology

Understanding the decision making process of the organization with regards to introduction of fuel-saving technology or product features and fuel efficiency in general.

2.40 What is a typical design cycle for your product models (e.g., 4 years)?
2.40.1 1-2 years
2.40.2 2-4 years
2.40.3 4-5 years
2.40.4 More than 5 years

2.41 What are the motivation factors for a new product design?
2.41.1 E.g. Market share, Unavailability of a product in a particular segment/domain, Competitor products, technology upgrade

2.42 How do you decide which technologies or features will end up in the final product design?
(Cost considerations, Market requirements, Product differentiator, Fuel efficiency, Component availability, Standards/regulations, etc.) Please rank the top 3 reasons._

2.43 Is fuel efficiency part of this decision-making process? If so, how does it compare with other design considerations such as cost, durability, warranty, etc. mentioned above?

2.44 Are your customers conscious about the effect that your component will have on the fuel efficiency levels of the vehicles they manufacture? If so, then are there any studies that have been conducted to understand how much your components affect fuel efficiency? *Understanding if they have faced any challenges in the introduction of a new technology?*

2.45 Keeping in mind the overall fuel efficiency of the vehicle, which other vehicle components do you feel pose constraints while developing a new technology?

2.46 Are new technologies typically introduced across your entire component spectrum or are new technologies marketed to specific segments?

Technology improvement plan in the near to long term

2.47 What are the new technologies and features that you expect to introduce in the near-term (3-5 years) that would increase the fuel efficiency levels of vehicles overall? What potential increase in fuel efficiency do you expect from these interventions? What will these new technologies require in terms of capital investment?

Note: we are not interested in learning about specific new technologies or products that are considered confidential. Rather, we are interested about learning the general technologies areas where the interventions are planned.

Intervention	Potential improvement in fuel efficiency	Additional cost	Expected time of deployment

2.48 Are your research and development efforts in collaboration with any other companies? If so, please describe.

2.49 How are your products tested for performance and durability?

2.50 What do you envision as being obstacles in terms of technology integration or how the technology will perform in the real-world?

2.51 In the past, have you had a particular challenge with the introduction of a given technology or feature?

2.52 Which of your product segments are most receptive to advanced technologies?

Market

Market considerations

2.53 What are the marketing tools that you generally use to market new products?

2.53.1 New technology

2.53.2 Durability

2.53.3 Fuel efficiency

2.53.4 Pay load capacity

2.53.5 Low maintenance

2.53.6 Others _____

2.54 Do you use results from various standards/norm tests as marketing tools? Are these results or a subset of results made available to your customers?

2.55 How does fuel efficiency factor into your current marketing strategy? Do you expect this to change going forward?

2.56 How are your contracts designed with OEMs? (long term/short term, product mix, product specifications etc)

2.57 Are there instances where you modify sales orders based on customer preferences? Please cite some examples.

Policy

2.58 What are the standards/regulations that you presently have to meet for your products? (e.g. emissions, noise, evaporative emissions, safety, etc.)

2.59 Which of the above is the most difficult to comply to?

2.60 What are the key challenges faced by you in complying with the various emissions norms (BSIII/IV) being put forward by the Government? (e.g. increased costs, requirement of R&D, etc. – if cost, then ask what % increase is expected)

2.61 How do you expect that increasing emissions norm standards (i.e., Bharat III to IV and V) affect your product design process in terms of engine technology?

2.62 What emission control technologies do you have at your disposal to achieve Bharat V and VI?

2.63 How do you expect the introduction of diesel particulate filters (DPFs) and other similar ECTs to affect engine efficiency?

2.64 What are your expectations for a fuel efficiency policy for HDVs?

2.65 How do you think fuel efficiency norms would affect your design of your product?

Annexure 3: Survey for Truck Fleet

Objective

To understand the perceived importance given to fuel efficiency while purchasing and planning the operations of the truck fleet

Respondent

A truck fleet owner/senior management who leases or operates trucks for scheduled and/or non-scheduled services.

Respondent details

1.1 Name:
1.2 Designation:
1.3 Job description:
1.4 Years with the organization:

Fleet details

2.1 How many trucks do you have in your fleet?
2.1.1 _____number

2.2 What kinds of permits do your trucks have?
2.2.1 National _____ numbers
2.2.2 State _____ numbers

2.3 What kinds of goods do you transport?
2.3.1 _____

2.4 What is the payload capacity of the trucks in your fleet?
2.4.1 3.5 tons – 7.5 tons _____number
2.4.2 7.5 tons – 12 tons _____number
2.4.3 12 tons – 25 tons _____number
2.4.4 25 tons> _____number

2.5 What is the nature of truck ownership?
2.5.1 Owned _____ number
2.5.2 Leased _____ number

2.6 Truck brands owned
2.6.1 TATA _____ number
2.6.2 VOLVO_____ number
2.6.3 EICHER _____ number
2.6.4 Force motors _____ number
2.6.5 Mahindra _____number
2.6.6 Ashok Leyland _____number
2.6.7 Others _____number

2.7 What is the total annual kilometers done by an average truck in your truck fleet in 2014-15?
2.7.1 _____ kms

2.8 What is the total annual fuel consumption (in liters) of your truck fleet in the last year (2014-15)?
2.8.1 _____ liters

2.9 What are the regions of operation of your truck fleet?
_____

Procurement

3.1 Do you buy semi finished trucks and retrofit it according to your needs or do you buy complete finished trucks?
3.2 What percentage belongs to semi finished category?
3.3 What are the factors which influence your decision making while buying trucks? Which of these factors could be top 3?(Brand, durability, long life, low maintenance, fuel efficiency, easy serviceability, affordability etc.)
3.4 What are the costs apart from capital cost you keep in mind while buying new vehicles?(eg. Maintenance costs, cost of service, fuel costs etc).
3.5 Do you calculate the savings from increased fuel efficiency? If so, then how?
3.6 Do you purchase second hand trucks? How do you estimate its fuel efficiency before buying (if at all)?
3.7 Are there any specific brands in the market which offer higher fuel efficiency than other brands with vehicles of same specification of trucks?
3.8 Do you ever select a particular brand of vehicle because of superior fuel efficiency? If yes, then which brand's vehicles are most fuel efficient in your fleet?
3.9 Do you ever utilize third-party test results in your evaluation process?
3.10 What are your sources of information for new technologies and features?(advertisements, pamphlets, expos etc)
3.11 Do you feel you are provided with adequate information about fuel efficiency while buying a truck?

Operation

4.1 Under what heads are your operational expenses distributed? (fuel, driver salaries, maintenance etc.)

Heads	Expenses
Fuel	
Driver salaries	
Maintenance	
Insurance	

4.2 Do you monitor fuel efficiency of your fleet? If yes, do you monitor it vehicle by vehicle or do you use any other technique?
4.3 What are the methods that you use to evaluate a truck's fuel efficiency? How often to do you evaluate fuel efficiency?
4.4 What is the average fuel efficiency of different kinds of trucks in your fleet?
4.5 How do your operating characteristics (e.g., loading, terrain, driving pattern) affect your fuel efficiency?
4.6 Do you incentivize your drivers to save fuel?
4.7 How are the drivers of the truck paid? Per km/ per shift?
4.8 Do you train you drivers to improve fuel efficiency of trucks?
4.9 How frequently are your trucks serviced? What are the systems do you have in place to ensure maintenance?
4.10 How does the service and maintenance frequency change with geographic location?
4.11 How are typical contracts designed? Weight of the goods shipped/ distance/ terrain?
4.12 Which area of the truck requires the most replacement and/or maintenance?
4.13 What measures do you take to ensure that the truck remains fuel efficient?

Technology

5.1 How will you monitor a manufacturer's claim to better fuel efficient vehicles?
5.2 Have you ever invested in your vehicle with a motive to increase fuel efficiency? (better tyres, engine oil etc)
5.3 Are new technologies typically introduced across your entire fleet? Or, are new technologies deployed in selected segments or pilot programs?
5.4 In the past few years, what new fuel-saving technologies or operational practices have you adopted?(eg, better tyres, engine oil) Please describe your experiences, both good and bad with deploying new technologies and strategies for saving fuel.
5.5 How has diesel price de-regulation impacted your views on the value of fuel-saving technologies?
5.6 What is average end life of a truck in your fleet?
5.7 What are the factors that you consider before retiring a truck from your fleet?
5.8 What are the new technologies and features that you expect to become available in the near-term (3-5 years) (for eg, better tyres, power engines etc)?

5.9 Are you aware of any technology that is not currently offered in Indian market or is too expensive but is none the less important?

Regulation/Information

6.1 What are the current regulations that most impact your business? Do you expect these to change in the near future? (eg banning of 10 year old diesel vehicles in Delhi, emission norms, over weight restrictions)

6.2 How often are your vehicles tested/inspected for PUC? What is the requirement in your given jurisdiction?

6.3 Do you currently have any vehicles with BS-IV engines? If so, how do you manage when vehicles travel outside of BS-IV cities?

6.4 Is there any fuel efficiency difference between BS III and BS IV vehicle?

6.5 In what form do you think fuel efficiency information should be provided? Km/l or l/t-km?

Annexure4: Survey for Bus Fleet

Objective
To understand the perceived importance given to fuel efficiency while purchasing and planning the operations of the bus fleet.
Target respondent
A bus fleet owner/senior management who leases or operates buses for scheduled and/or non-scheduled services.

Survey Outline
Respondent details

1.5 Name:
1.6 Designation:
1.7 Job description:
1.8 Years with the organization:

Fleet details
2.10 How many buses do you have in your fleet?

2.11 Ownership of the fleet
2.11.1 Public
2.11.2 Private

2.12 Type of operations
2.12.1 Inter-city
2.12.2 Intra-city
2.12.3 Both inter and intra-city

2.13 Are your buses registered as stage or contract carriages?
2.13.1 Stage carriage _____ number
2.13.2 Contract carriage _____ number

2.14 Number of buses
2.14.1 AC
2.14.2 Non-AC
2.14.3 Total

2.15 What is the nature of bus ownership?
2.15.1 Owned _____ number
2.15.2 Leased _____ number

2.16 Bus brands owned

2.16.1 TATA _____ number
2.16.2 VOLVO_____ number
2.16.3 EICHER _____ number
2.16.4 Force motors _____ number
2.16.5 Mahindra _____number
2.16.6 Ashok Leyland _____number
2.16.7 Others _____number

2.17 How many people did you transport in 2014-15?

2.17.1 _____ people

2.18 What is the total annual kilometers done by all your bus fleet in 2014-15?
2.18.1 _____ kms

2.19 What is the total annual fuel consumption (in liters) of your bus fleet in the last year (2014-15)?
2.19.1 _____ liters

2.20 What are the regions of operation of your bus fleet?
_____

Procurement decisions

3.1 What are the factors which influence your decision making while buying busess? Which of these factors could be top 3?(Brand, durability, long life, low maintenance, fuel efficiency, easy serviceability, affordability etc.)
3.2 What are the costs apart from capital cost you keep in mind while buying new vehicles?(eg. Maintenance costs, cost of service, fuel costs etc).
3.3 Do you calculate the savings from increased fuel efficiency? If so, then how?
3.4 Do you purchase second hand buses? How do you estimate its fuel efficiency before buying (if at all)?
3.5 Are there any specific brands in the market which offer higher fuel efficiency than other brands with vehicles of same specification of buses?
3.6 Do you ever select a particular brand of vehicle because of superior fuel efficiency? If yes, then which brand's vehicles are most fuel efficient in your fleet?
3.7 Do you ever utilize third-party (other fleets') test results in your evaluation process?
3.8 What are your sources of information for new technologies and features?(advertisements, pamphlets, expos etc)
3.9 Do you feel you are provided with adequate information about fuel efficiency while buying a bus?

Operation

4.14 Under what heads are your operational expenses distributed? (fuel, driver salaries, maintenance etc.)

Heads	Expenses
Fuel	

Driver salaries	
Maintenance	
Insurance	

4.15 Do you monitor fuel efficiency of your fleet? If yes, do you monitor it vehicle by vehicle or do you use any other technique?

4.16 What are the methods that you use to evaluate a bus's fuel efficiency? How often do you evaluate fuel efficiency?

4.17 What is the average fuel efficiency of different kinds of buses in your fleet?

4.18 How do your operating characteristics (e.g., loading, terrain, driving pattern) affect your fuel efficiency?

4.19 Do you incentivize your drivers to save fuel?

4.20 How are the drivers of the bus paid? Per km/ per shift?

4.21 Do you train you drivers to improve fuel efficiency of buses?

4.22 How frequently are your buses serviced? What are the systems do you have in place to ensure maintenance?

4.23 How does the service and maintenance frequency change with geographic location?

4.24 How are typical contracts designed? Weight of the goods shipped/ distance/ terrain?

4.25 Which area of the bus requires the most replacement and/or maintenance?

4.26 What measures do you take to ensure that the bus remains fuel efficient?

Technology

5.1 How will you monitor a manufacturer's claim to better fuel efficient vehicles?

5.2 Have you ever invested in your vehicle with a motive to increase fuel efficiency? (better tyres, engine oil etc)

5.3 Are new technologies typically introduced across your entire fleet? Or, are new technologies deployed in selected segments or pilot programs?

5.4 In the past few years, what new fuel-saving technologies or operational practices have you adopted?(eg, better tyres, engine oil) Please describe your experiences, both good and bad with deploying new technologies and strategies for saving fuel.

5.5 How has diesel price de-regulation impacted your views on the value of fuel-saving technologies?

5.6 What is average end life of a bus in your fleet?

5.7 What are the factors that you consider before retiring a bus from your fleet?

5.8 What are the new technologies and features that you expect to become available in the near-term (3-5 years) (for eg, better tyres, power engines etc)?

5.9 Are you aware of any technology that is not currently offered in Indian market or is too expensive but is none the less important?

Regulation/Information

6.6 What are the current regulations that most impact your business? Do you expect these to change in the near future? (eg banning of 10 year old diesel vehicles in Delhi, emission norms, over weight restrictions)

6.7 How often are your vehicles tested/inspected for PUC? What is the requirement in your given jurisdiction?

6.8 Do you currently have any vehicles with BS-IV engines? If so, how do you manage when vehicles travel outside of BS-IV cities?

6.9 Is there any fuel efficiency difference between BS III and BS IV vehicle?

6.10 In what form do you think fuel efficiency information should be provided? Km/l or l/t-km?

About TERI

A unique developing country institution, TERI is deeply committed to every aspect of sustainable development. From providing environment-friendly solutions to rural energy problems to helping shape the development of the Indian oil and gas sector; from tackling global climate change issues across many continents to enhancing forest conservation efforts among local communities; from advancing solutions to growing urban transport and air pollution problems to promoting energy efficiency in the Indian industry, the emphasis has always been on finding innovative solutions to make the world a better place to live in. However, while TERI's vision is global, its roots are firmly entrenched in Indian soil. All activities in TERI move from formulating local- and national-level strategies to suggesting global solutions to critical energy and environment-related issues. TERI has grown to establish a presence in not only different corners and regions of India, but is perhaps the only developing country institution to have established a presence in North America and Europe and in the Asian continent in Japan, Malaysia, and the Gulf.

TERI possesses rich and varied experience in the electricity/energy sector in India and abroad, and has been providing assistance on a range of activities to public, private, and international clients. It offers invaluable expertise in the fields of power, coal, and hydrocarbons and has extensive experience on regulatory and tariff issues, policy and institutional issues. TERI has been at the forefront in providing expertise and professional services to national and international clients. TERI has been closely working with utilities, regulatory commissions, government, bilateral and multilateral organizations (The World Bank, ADB, JBIC, DFID, and USAID, among many others) in the past. This has been possible since TERI has multidisciplinary expertise comprising of economist, technical, social, environmental, and management.