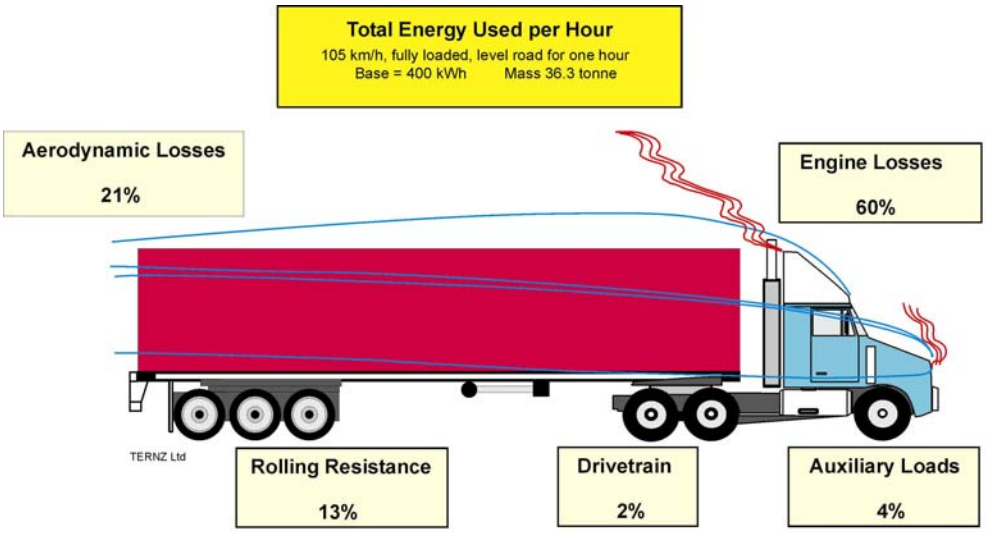
TERNZ

TRANSPORT ENGINEERING RESEARCH NEW ZEALAND LIMITED

Heavy Vehicle Efficiency



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Executive Summary

The objective of this project was to develop initiatives and interventions that will deliver energy reductions in the road freight sector. Rail freight and coastal shipping are responsible for a relatively small proportion of the energy consumed by the transport sector and the potential for energy savings by these modes is considered to be limited. For this reason, the focus of this project was on the heavy road vehicle sector only.

The project was in two parts:

- The assimilation of New Zealand and overseas information in order to identify, in broad terms, the range of possible interventions which could be considered to reduce energy consumption.
- Consultation with key stakeholders on the effectiveness of current initiatives, and barriers and opportunities for the introduction of new initiatives to save fuel.

A third task to be undertaken as a separate project is aimed at developing a business case for the adoption of the most promising initiatives. This third task has not proceeded at this stage.

The road transport industry (heavy vehicles including buses) is a significant energy user consuming 41.5 Petajoules (PJ) of energy in 2004. In 2002 this sector used 19% of the transport energy and 7.6% of the total energy used in New Zealand. Historically the increase in energy used by this sector has been approximately 1.6 times the change in GDP. Figure 1 shows the energy used from 1998 to 2004 and the projected energy requirements based on this relationship with GDP. Unless significant energy conservation measures are introduced, the energy consumed by the road freight sector will double within 15 years based on historic trends.

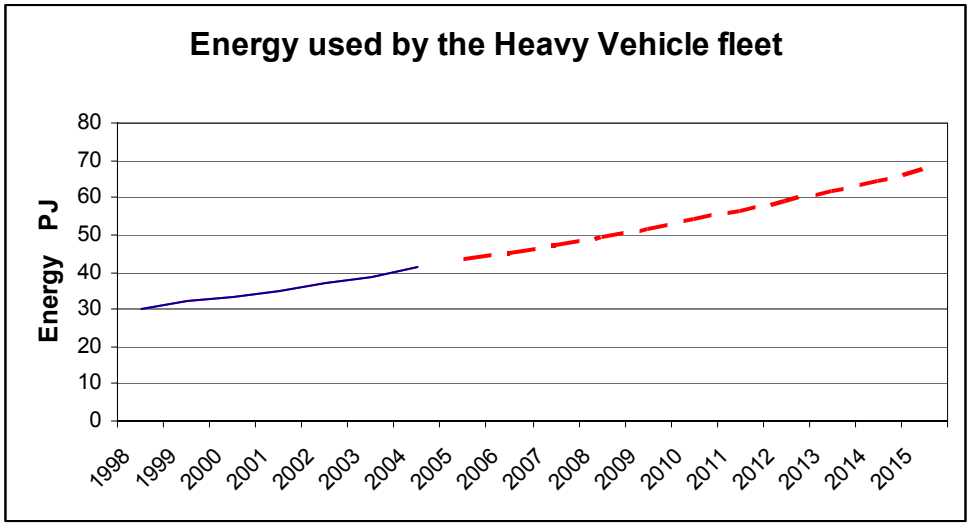

Figure 1: Predicted energy requirements of the heavy vehicle fleet.

Heavy vehicles are energy intensive with fuel accounting for over 11% of the cost to operate these vehicles. Because of the low profit margins in many sectors of the industry, it has been estimated that a saving of 10% in fuel can improve profitability by as much as 30%. Some of the long distance line-haul vehicles can travel up to 500,000km per year and will use 250,000litres of fuel.

The characteristics of the heavy vehicle fleet suggest that energy efficiency initiatives should be targeted towards:

- The largest fleets. There are only about 50 fleets that employ more than 50 people but they operate approximately 30% of all of the heavy vehicles.
- Combination vehicles as they use 4 times as much energy as single trucks because of the greater distance they travel, on average, and their greater engine capacity.
- The hire and reward sector as this group operates approximately 85% of the combination vehicles. Most of these operators belong to the industry associations affiliated to the Road Transport Forum NZ.
- Operators who are active in managing safety. These fleets may not be the largest but are generally very receptive to new initiatives that will improve their operation.

There are a wide range of factors that affect fuel use including the design of the vehicle, engine capacity, the nature of the load, and how the vehicle is driven. An international literature review and personal contact with the leading agencies involved in promoting transport fuel reduction in the United Kingdom and North America identified a range of factors including:

- Driver behaviour. The difference in fuel consumption between a good and a poor driver can be as much as 35%. This difference is largely due to differences in road speed, gear selection, the engine speeds at which gears are changed, aggressiveness of accelerator use, and the amount of time the driver leaves the truck idling.
- Vehicle speed. A reduction in average speed of 8km/h can result in a fuel saving of 10% to 15%. There is a strong link between speed, safety and fuel consumption.
- Air-conditioning. The use of air-conditioning can increase fuel consumption by 3% to 4%. Open windows also increase fuel use. Maximum use of the cab's air ventilation system should be made.
- Aerodynamic losses. Cab roof deflectors, front bumper air dams, minimising inter-vehicle spacing, smooth sided trailers, side skirts and bonneted trucks rather than cab over trucks all reduce fuel consumption.
- Matching engines and transmissions to the transport task.
- Maintenance. Poorly-tuned engines can use 50% more fuel than well-tuned ones. Clogged air filters increase fuel consumption by up to 10%.
- Tyres. Under-inflation increases fuel consumption reduces tyre life and is a major contributor to flat tyres and blowouts.

Information on the fuel-saving initiatives used overseas was collated and a list was made of the initiatives that have been introduced and may be suitable for adoption in New Zealand. That list and the other findings were used as the basis of a series of consultation meetings with transport operators, equipment suppliers, transport industry associations and the relevant government agencies. From the feedback it appears that:

- Very few operators currently monitor fuel consumption.
- Many operators find the current fuel cards unreliable as a means of monitoring fuel consumption because multiple vehicles may be filled with the same card, different drivers may use the same vehicle or auxiliary equipment is also fuelled (e.g. refrigeration units).

- Fuel efficiency plays only a minor part in new vehicle purchase decisions. Factors such as Road User Charges play a much bigger role.
- Knowledge of truck performance and specification is highest amongst the purchasers of the larger rigs, especially those with fleets of more than 5 vehicles. The purchasers of small to mid range trucks such as city delivery vans rely largely on the knowledge of the truck sales staff.
- Current driver training does not adequately cover fuel efficient driving practices.
- Measures aimed at improving vehicle utilisation could be very effective in reducing fuel consumption.
- Increased mass and dimensions could improve overall fuel efficiency
- Economic driving not only saves fuel but improves safety, reduces vehicle maintenance, and increases tyre life.
- There is support for the recognition of best practice and awards as a means of raising awareness.
- The industry would like to see government agencies coordinate the information they produce with common branding etc. as this would be seen as being more effective.
- There is a need to monitor and facilitate the introduction of new technology.
- The use of case studies was strongly supported.
- The use of triple bottom line reporting and key performance indicators that include fuel conservation should be encouraged.
- There is a strong preference for measures that do not require the use of regulations.

Energy saving initiatives can be divided into three groups:

1. Government regulations.

   These are initiatives that require changes in the regulations and other forms of direct government intervention. Examples include: road pricing measures such as e-RUC, improving fuel quality, the biodiesel trial scheme, the review of heavy vehicle limits and the enforcement of speed.

2. Technology developments

   The greatest gains in energy efficiency are likely to be through advances in vehicle technology that will result from, for example, the US 21st Century Truck programme and similar programmes in Europe and Japan. The US Department of Energy 21st Century Truck programme, has set a target of 50% improvement in engine efficiency by 2010.

3. Transport operator

   Many of the operator-based initiatives involve information dissemination and research. They are aimed at:

   - improving fuel monitoring
   - awareness raising of the ways in which transport operators can achieve fuel savings
   - assisting transport operators with the purchase of new fuel-efficient vehicles
   - the adoption of industry codes and best practice
   - improving vehicle maintenance
   - fuel-efficient driver training
   - benchmarking
   - improving logistics and vehicle utilisation

- overcoming the barriers to the adoption of new technologies

Government is actively pursuing a number of initiatives of a regulatory nature and these are summarised in the report. There is very little that New Zealand can do influence the development of vehicle technologies as there is no vehicle manufacturing industry here. There is however considerable scope to improve energy efficiency through operator-based measures. The only initiatives that have been introduced in New Zealand recently aimed specifically at improving the energy efficiency of the road transport sector are the "Energy Efficiency Ways" toolkit prepared for the Energy Federation of New Zealand and the Vehicle Selection Guide prepared for Land Transport NZ. These are steps in the right direction but are only a small part of what is required to inculcate an energy efficiency culture in the road transport sector.

Some of the benefits that will result from improved technology will not be captured if initiatives aimed at the transport operator are not introduced as it is the operator who selects the vehicle and the technology on that vehicle. Also poor driving habits can reduce the potential benefits of any new technologies.

It is recommended that EECA and Land Transport NZ introduce new initiatives that encourage transport operators to become more energy efficient and to encourage fuel efficient driving. Other jurisdictions have already introduced similar packages, for example the UK Road Haulage Modernisation Fund and the work of the Energy Savings Trust. In Canada the Federal Office of Energy Efficiency runs the Fleetsmart and Smart Driver Programmes and in the USA there is the Smartway Transport partnership, a voluntary programme run by the US Environmental Protection Agency.

The main elements of a New Zealand operator-focused programme should include:

- Energy efficient driver training
- Increasing skills and awareness amongst operators on how to monitor and minimise fuel consumption. This could be through the development of a package that includes case studies, fuel management guides and other material similar to that produced by the UK Transport Energy Best Practice programme.
- Freight logistics reductions in freight travel demand.

Of importance will be ensuring the transport industry is onboard and this can best be achieved through the involvement of the industry associations, especially the Road Transport Forum NZ, Road Transport Association, National Road Carriers, the Institute of Road Transport Engineers NZ and the trade magazines, NZ Trucking, and Truck and Driver.

Energy savings of 10% to 15% p.a. (4.2 PJ to 6.2PJ p.a.) should be able to be achieved from an information-based package given that differences in driver behaviour alone can result in variations of up to 35% in the amount of fuel used and considerable savings can be achieved through improved maintenance and other measures. The UK SAFED driver development programme which was funded by the Road Haulage Modernisation Fund resulted in a short-term saving in fuel use of 9.4% and an expected long-term saving of at least 4.5%. A similar scheme in Canada, Fleetsmart, found that one of the smaller transport operators (< 20 prime-movers) that participated in the programme achieved a minimum fuel saving of 15% in the first year of operation. Further savings will result from the other elements of an operator-based initiative.

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Update on the proposed Vehicle Emissions Screening Programme

References to the proposed screening programme are on pages 36, 37, 40 and 42. Since this report was written it has been announced that the proposed screening programme would not proceed. Alternative measures to manage vehicle emissions are being developed and include a check for visible smoke emissions at vehicle inspections. The public education programme, which will include information on the benefits of vehicle maintenance, is proceeding. More information on the vehicle emissions policy is available on the Ministry of Transport's website: www.transport.govt.nz..

CHAPTER ONE: INTRODUCTION

The objective of this project is to develop initiatives and interventions that will deliver energy reductions in the freight transport sector. Rail freight and coastal shipping are responsible for a relatively small share of the transport sector and the potential for energy consumption reductions by these modes is considered to be limited. For this reason, the focus of this project is on the road freight sector only (EECA 2003). While the focus of the project has been largely on road freight transport, many of the initiatives and interventions that have been identified are equally applicable to the bus and coach industry.

The project was in two parts:

- The assimilation of New Zealand and overseas information in order to identify in broad terms the range of possible interventions which could be considered as ways of achieving reductions in energy consumption.
- Consultation with key stakeholders on the effectiveness of current initiatives, and barriers and opportunities for the introduction of new initiatives to save fuel.

A third task to be undertaken as a separate project is aimed at identifying suitable interventions and the development of a business case for their adoption. This third task has not proceeded at this stage.

It was beyond the scope of this project to consider the impact energy efficiency initiatives may have on other environmental, safety and economic benefits that are objectives of the New Zealand Transport Strategy.

Road freight transport is an essential part of the New Zealand economy with all goods transported by road at some stage in their journey from manufacturer or producer to the final customer in New Zealand or overseas. Road freight transport, however, is a major energy user, especially fossil fuels and any reduction in energy use will be good for the environment, public health and the economy.

New Zealand consumed a total of 487.07 PJ of energy in the year ended March 2002 (http://www.eeca.govt.nz/strategy/index.asp). Of this passenger and freight transport used 196.21PJ or 40%. Heavy vehicles used 37.25PJ in 2002 rising to 41.53PJ in 2004 or 19% of the transport energy and 7.6% of the total energy used in New Zealand in 2002. The amount of energy being consumed by the freight transport sector is increasing and as explained in this report, is expected to double within 15 years based on current trends.

Worldwide there are growing concerns that the emission of greenhouse gases are causing global climate change. The Kyoto Protocol, to which New Zealand (NZ) is a signatory, aims to reduce the total greenhouse gas emissions of developed countries (and countries with economies in transition) to 5% below the level they were in 1990. Led by the United Nations, the Protocol sets targets for the greenhouse gas emissions of developed countries for the period 2008 to 2012 (the first commitment period) (UN 1997). Different countries have different targets. New Zealand's target is to reduce its greenhouse gas emissions to the level they were in 1990, or to take responsibility for excess emissions.

Emissions can be a significant cause of health problems, including asthma, heart

disease, and bronchitis. A report from National Institute of Water and Atmospheric Research Ltd (NIWA), commissioned by the Ministry of Transport and released in 2002, estimated that around 400 people die prematurely each year due to exposure to vehicle emissions. This problem is worse in urban centres with high traffic rates and congestion, where a large segment of the population is exposed to air pollution.

In addition to health problems, air pollution causes problems that are less direct and quantifiable such as poor visibility (including smog and haze) and staining of building surfaces. Air pollution can also be damaging to New Zealand's international reputation for having a clean environment.

Saving fuel can also improve road safety. Research conducted at Monash University found that the fuel consumption of crash-involved vehicles was higher than that of vehicles not involved in crashes (Haworth and Symmons 2001). This study found that speed reduction and smooth driving gave both safety and fuel-economy benefits.

The road freight sector has been defined as that associated with the operation of heavy vehicles with a gross mass of more than 3.5tonne.

Heavy vehicles are very energy intense with, for example, a typical logging truck travelling 130,000 km per annum using 73,600 litres of fuel. For such a vehicle, fuel accounts for 14% of the total operating cost. Other trucks that do not travel off-highway will use less fuel per km but will still have fuel bills that are over 11% of their total operating costs. Some of these highway trucks travel over 500,000km a year and will use over 250,00litres of fuel over that time. Fuel savings consequently are a significant part of the cost of running a transport business. It has been estimated that a 10% savings in fuel can translate to an increase of company profitability of 15% to 35%.

This report

- Provides an overview of the heavy vehicle fleet, growth rates and sector-by-sector demand.
- Reviews potential energy-saving technologies and practices
- Reviews energy-saving initiatives from international jurisdictions
- Identifies, in broad terms, energy-saving initiatives with potential for NZ

CHAPTER TWO: CHARACTERISTICS OF THE HEAVY VEHICLE FLEET

This section provides an estimate of energy used by the heavy vehicle fleet, the characteristics of the fleet and sectors that could be targeted for energy efficiency initiatives.

The number of vehicles and the distance they travelled were determined from an analysis of Road User Charges data obtained from Land Transport New Zealand Transport Registry. Only the results directly relevant to energy use are included here but further information on the composition of the heavy vehicle fleet can be found in Baas and Bolitho (2003), Baas and Arnold (1999) and Bolitho and Baas (2003).

Energy consumption was calculated using the following equation:

$$TFU_{IS} = \left(\left(FUF \times FC\right)_P + \left(FUF \times FC\right)_D\right) \times VKT_{IS} \qquad (1)$$

Where:
- TFU_{IS} = Total fuel used per industry sector (litres)
- FUF = Fuel use factor (l/km)
- FC = Percentage of vehicles using diesel or petrol in the corresponding industry sector (-)
- VKT_{IS} = Total vehicle kilometres per industry sector
- P = Petrol
- D = Diesel

Energy consumption was then calculated by converting the total litres of fuel used to kilograms and then multiplying by the lower heating value (Heywood 1989). Fuel use data was obtained from National Road Carriers Inc. (verbal communication J. Smith) and is based on the values supplied by transport operators when using the NRC vehicle operating cost model. Average fuel use factors of 0.3litres per km for single unit trucks and 0.5 l/km for combination vehicles have been used.

In order to avoid confusion, "vehicles" is the generic term used to describe single units such as buses, tractors and trailers. Combinations of vehicles (trucks towing trailers) are called rigs. Primemovers are any heavy vehicle with an engine including a truck, bus or tractor (fitted with a fifth wheel turntable).

ENERGY USED BY THE FLEET AS A WHOLE

Table 1 shows the estimated total distance travelled by prime-movers and the energy they used.

Table 1: distance travelled and energy consumption

Year	Prime mover Distance million km	Energy used PJ
1998	2,044	30.19
1999	2,171	32.11
2000	2,257	33.43
2001	2,367	35.11
2002	2,511	37.25
2003	2,619	38.78
2004	2,810	41.53

Figure 1 shows the annual energy use and a prediction of future energy requirements of the heavy vehicle fleet based on historic trends and an analysis under taken by Bolitho and Baas (2003) that found that for every 1% in GDP there will be a 1.6% increase in vehicle travel (R-squared = 0.729). It has been assumed that GDP will increase on average by 3% per year.

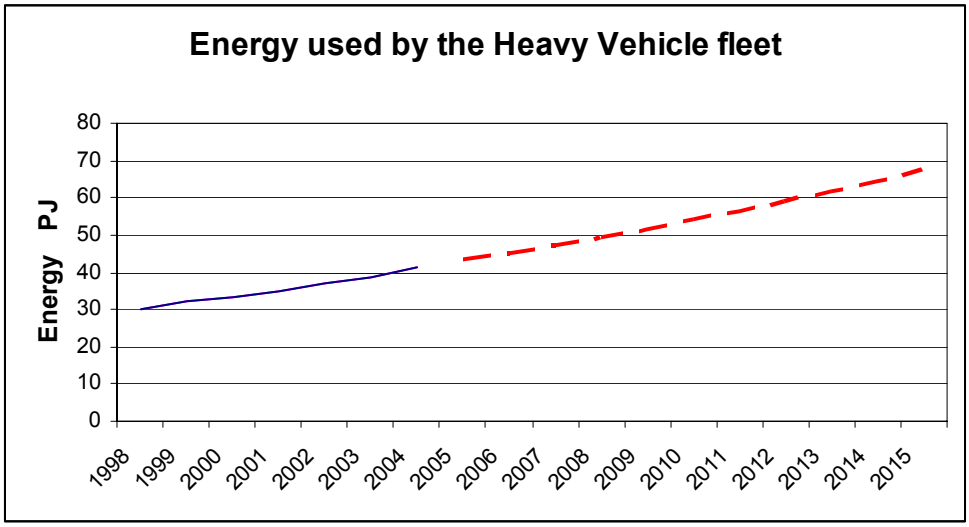

Figure 1: Predicted energy requirements of the heavy vehicle fleet.

TARGETING BY VEHICLE TYPE: SINGLE VEHICLES VERSUS RIGS.

Fleets typically have either single vehicles or rigs depending on the nature of the work they specialise in. About 85% of the rigs are operated by enterprises that are contracted to cart goods for their clients (commonly referred to as "hire and reward"). The rest are used to cart the goods owned by the enterprise that owns the vehicles (own account); for example, milk tankers are owned and operated by Fonterra for the transport of their own product. Generally single vehicles are operated in services that are allied to other industry groups such as manufacturing, contracting, farming, retail support, local authority services, tourism and utility maintenance services.

Tables 2 and 3 shows the number, distance travelled and the energy used by single vehicles and rigs respectively.

Table 2: Single vehicle energy uses

	Distance travelled by single vehicles million km	Energy used by single vehicles PJ	Number of single vehicles	Energy per single vehicles GJ/single vehicle
1997	1,212	15.3	59023	258
1998	1,215	15.3	60025	255
1999	1,282	16.1	61734	261
2000	1,324	16.7	63045	264
2001	1,379	17.3	64793	268
2002	1,463	18.4	69099	266
2003	1,538	19.4	73524	263
2004	1,664	20.9	78153	268

Table 3: Energy used by rigs

	Distance travelled by rigs million km	Energy used by rigs PJ	Number of rigs	Energy per rigs GJ/truck
1997	829	14.9	17747	840
1998	829	14.9	18125	822
1999	889	16.0	18220	877
2000	933	16.8	18588	902
2001	988	17.8	19189	926
2002	1,048	18.8	19622	960
2003	1,081	19.4	20250	959
2004	1,146	20.6	20279	1015

Of note is that while the total distance travelled by single vehicles was greater than that of rigs by approximately 45% and the total energy used by both groups was very similar, the difference in energy density (energy per primemover) was nearly 4 times higher for rigs than for single vehicles because of the higher average distance they travel and their higher fuel consumption.

Figure 2 shows the change in energy use per primemover. The energy density of single vehicles has remained largely unchanged but for rigs it has increased by approximately 20% in the 8 years from 1997 to 2004 inclusive.

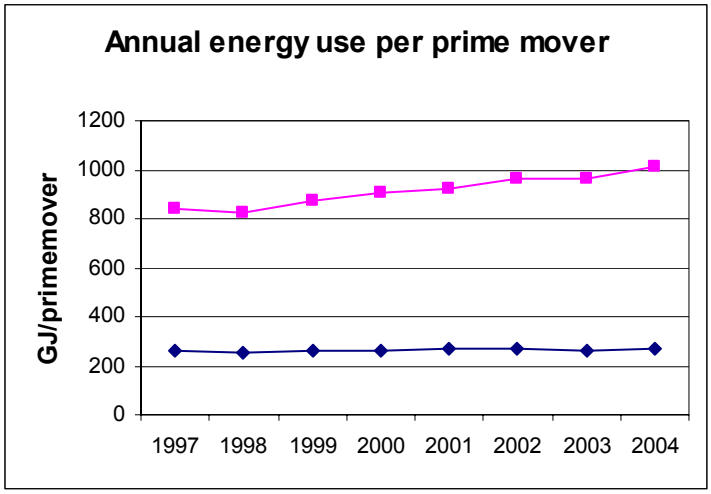

Figure 2: Energy used per single vehicle and rig

HIGH USE VEHICLES

A small number of the larger, high-use heavy vehicles account for a major proportion of the payload transported and RUC purchased and may be a suitable group for targeting new energy efficiency initiatives. Vehicles weighing more than 10 tonne and travelling more than 20,000 kilometres per year carry the bulk of the payload in terms of tonne-km. Figure 4 indicates that 85% of the payload in 2003 was transported by vehicles with 10 tonne licenses or more and travelling 20,000 kilometres a year (or more). In 2001 this figure was 84% and the 1997 percentage was 82%.

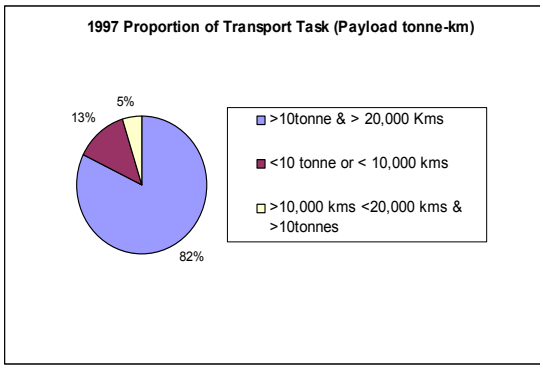

Figure 3: Proportion of the transport task tonne-km in 1997

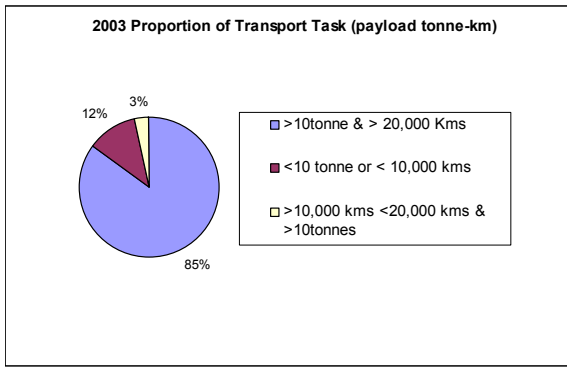

Figure 4: Proportion of the transport task tonne-km in 2003

Similarly the percent of RUC purchased and the number of heavy vehicles is compared in Table 4. In 2003, 72% of the RUC purchased was by heavy vehicles weighing 10 tonne or greater and travelling more than 10,000 kilometres per year. This is consistent with the earlier years. Vehicles 10 tonne or more and travelling over 20,000 kilometres per year accounted for 68% of the RUC purchased. This latter group comprises of 58% of the trailers but only 27% of the trucks. As trailers need to be towed by trucks, over 52% of this group are combination vehicles.

The very high mileage vehicles that travel more than 80,000 km per year are, with very few exceptions, all combination vehicles (truck-trailers, semi-trailers and B-trains).

Table 4: Number of the larger heavy vehicles

	Year	Trucks	Trailers	Totals	% HV RUC Purchased
All HV's					
	1997	76,868	19,604	96,472	100%
	1998	78,248	19,985	98,233	100%
	1999	80,058	20,163	100,221	100%
	2000	81,733	20,603	102,336	100%
	2001	84,092	21,169	105,261	100%
	2003	**93,899**	**22,427**	**116,326**	**100%**
HV's 10 tonne and over 10,000 kms					
	1997	26,299	13,248	39,547	71%
	1998	26,472	13,390	39,862	70%
	1999	27,247	13,704	40,951	71%
	2000	28,272	14,237	42,509	72%
	2001	29,369	14,786	44,155	72%
	2003	**32,696**	**16,185**	**48,880**	**72%**

HV's 10 tonne and over 20,000 kms					
	1997	19,803	10,408	30,211	67%
	1998	19,678	10,523	30,201	66%
	1999	20,559	10,805	31,364	67%
	2000	21,588	11,401	32,989	68%
	2001	22,521	11,925	34,446	68%
	2003	**25,061**	**13,099**	**38,160**	**68%**

INDUSTRY SECTORS

Table 5 shows the distance travelled and estimated energy used by different industry sectors in 2001. In deriving the energy used, an estimate was made on the proportion of single vehicles and rigs that are used in each sector. The distance travelled by each industry sector was based on the information supplied by vehicle owners when purchasing RUC in 1997 and adjusted using other information on the growth that had occurred in the different sector. The largest sectors in terms of energy use are, in order of size:

1. General freight and line haul
2. Dairy
3. Construction
4. Forest and logging
5. Stock haulage
6. Wholesale and retail
7. Manufacturing

Of these groups the most cohesive for targeting purposes are dairy, forest and logging and stock transport.

Table 5: Distance travelled and energy used by industry sector in 2001

Industry Group	Million km	Energy used PJ
Dairy Supply	188	3.3
Stock haulage	108	1.8
Horticulture	34	0.5
Other Agriculture	53	0.8
Mining & Quarrying	20	0.3
Manufacturing	104	1.5
Construction	180	2.5
Wholesale & Retail	134	1.8
Forestry & Logging	122	2.2
Refrigerated haulage	73	1.2
Furniture removal	35	0.4
General freight, line haul	642	9.5
Government, local body	42	0.5
Private transport	107	1.3
Trade & truck dealers	20	0.3
Other	506	7.2

Table 6 lists the predicted distances travelled in millions of kilometres and energy used by 2010 for the different industry sectors. The distances were calculated

assuming a growth in Gross Domestic Product (GDP) of 3% per annum and a Transport Factor multiplier of 1.5 (Bolitho, Baas et al. 2003), except for the forestry and dairy sectors where more detailed industry predictors were available.

The Transport Factor multiplier (TF) was calculated from a regression analysis on actual GDP versus actual kilometres travelled by heavy vehicles for the years 1997 to 2001. This showed that for every 1% increase in GDP there has historically been a 1.5% increase in heavy vehicle travel hence the 1.5 multipler (Bolitho, Baas et al. 2003).

Table 6: Estimated distance travelled and energy used by industry sector by 2010

Industry Group	Million km	Energy Used PJ
Dairy Supply	287	5.0
Lifestock	165	2.8
Horticulture	51	0.8
Other Agriculture	80	1.1
Mining & Quarrying	31	0.5
Manufacturing	159	2.3
Construction	274	3.9
Wholesale & Retail	205	2.7
Forestry & Logging	186	3.3
Refrigerated haulage	111	1.9
Furniture removal	53	0.7
General freight, line haul	979	14.9
Government, local body	64	0.8
Private transport	163	2.1
Trade & truck dealers	31	0.5
Other	771	10.9

In order to succeed in significantly reducing the energy consumed by the freight transport industry it will be necessary to achieve a reduction in the TF. Many factors affect TF, for example, the introduction of just-in-time delivery generally increases TF as more partial loads are carried in order to meet strict delivery times. Increased truck size and mass will generally decrease TF as the same quantity of freight will be able to be transported on fewer trucks. Using travel demand as the indicator for energy consumption rather than the transport factor is undesirable because it is possible to suppress travel by suppressing the economy without changing the transport factor. Shrinking the economy is not a government objective. Ideally the transport factor should be reduced without any negative effects on the economy

TRANSPORT ENTERPRISES

Transport enterprises range in size from single vehicle operations, through to fleets with over 500 heavy vehicles. Its diversity is akin to that of the retail and building sectors with a mixture of sole traders through to large corporations. Table 7, which is based on Statistics NZ data for 1998 to 2000, shows the size and number of economically significant transport enterprises.

Only 24 transport enterprises had 100 or more full-time-equivalent employees or working proprietors. Approximately 85% of the enterprises were small and employed 5 or fewer people (including working proprietors). As a group the small enterprises employed nearly 32% of the people involved in road transport. On the other hand the

largest 1.2% of enterprises (with a workforce of 50 of more full time equivalents) accounted for nearly 30% of the people involved in road transport and consequently were likely to operate approximately 30% of the heavy vehicles. Some of the largest transport enterprises are listed on the stock exchange and provide integrated storage, logistics and transport services. Many of the larger enterprises also employ owner-drivers as part of their operations. The current profile is much the same except that the largest enterprises now have a greater share of the transport market.

To place energy use across different groups in perspective:

- A fleet of 200 vehicles that represent the average of all heavy vehicles will use 0.1 PJ of energy per year
- A fleet of 200 log trucks will use approximately 0.31PJ of energy per year because of the greater distance they travel and the amount of off-highway travel
- A fleet of 200 stock trucks will use approximately 0.22 PJ of energy per year.

CONCLUSIONS

The characteristics of the heavy vehicle fleet and transport operations suggest a number of groups that could targeted for energy saving initiatives. These include:

- The largest fleets first. The largest 1.2% of the enterprises (with a workforce of 50 of more full time equivalents) operate approximately 30% of the heavy vehicles.
- Combination vehicles towing one or more heavy trailers. The larger, high mileage vehicles undertake a major proportion of the transport task.
- The hire and reward sector. This sector operates 85% of the combination vehicles. This group is largely represented by the Road Transport Forum of New Zealand and its affiliated associations.
- Operators who are active in managing the safety of their fleets and are seen as leaders in their field. These fleets may not be the largest or in the hire and reward sector but will be receptive to any new initiatives, especially ones that reduce their costs.

While these groups are relatively large, they can be identified relatively easily or belong to recognised industry associations. They also include the most energy-intensive users.

Table 7: Transport enterprises in terms of employment

Economically Significant Enterprises[3]

Year	No employees and 1 working proprietor		Full-time Equivalents[1]										Total[2]	
			0.5 - 5[4]		5.5 - 9		9.5 - 49		49.5 - 99		99.5+			
	Enterprises	Full-time Equivalents	Enterprises	Full-time Equivalents	Enterprises	Full-time Equivalents	Enterprises	Full-time Equivalents	Enterprises	Full-time Equivalents	Enterprises	Full-time Equivalents	Enterprises	Full-time Equivalents
1998	1,595	1,530	2,616	5,830	263	1,850	335	6,300	29	2,040	22	4,150	4,860	21,720
1999	1,500	1,430	2,485	5,640	274	1,940	330	6,010	37	2,540	20	3,890	4,646	21,450
2000	1,722	1,610	2,374	5,440	302	2,120	352	6,600	34	2,230	24	4,310	4,808	22,300

(1) Full-time Equivalent Persons Engaged (FTE) equals the sum of the full-time employees and working proprietors plus half the part-time employees and part-time working proprietors.
(2) Figures have been rounded and discrepencies may occur between sums of components and totals.
(3) Defined as enterprises with greater than $30,000 annual GST expenses or sales or enterprises in a GST exempt industry.
(4) Excludes enterprises with a single working proprietor, either part-time or full-time.

Statistics NZ
NZSIC 7114 Freight Transport by Road.
1997 Industry Coverage.

CHAPTER THREE: FACTORS AFFECTING FUEL EFFICIENCY

Figure 5 gives an overview of the factors affecting the fuel efficiency of heavy vehicles. Each of the major factors identified is further expanded on in the following sections.

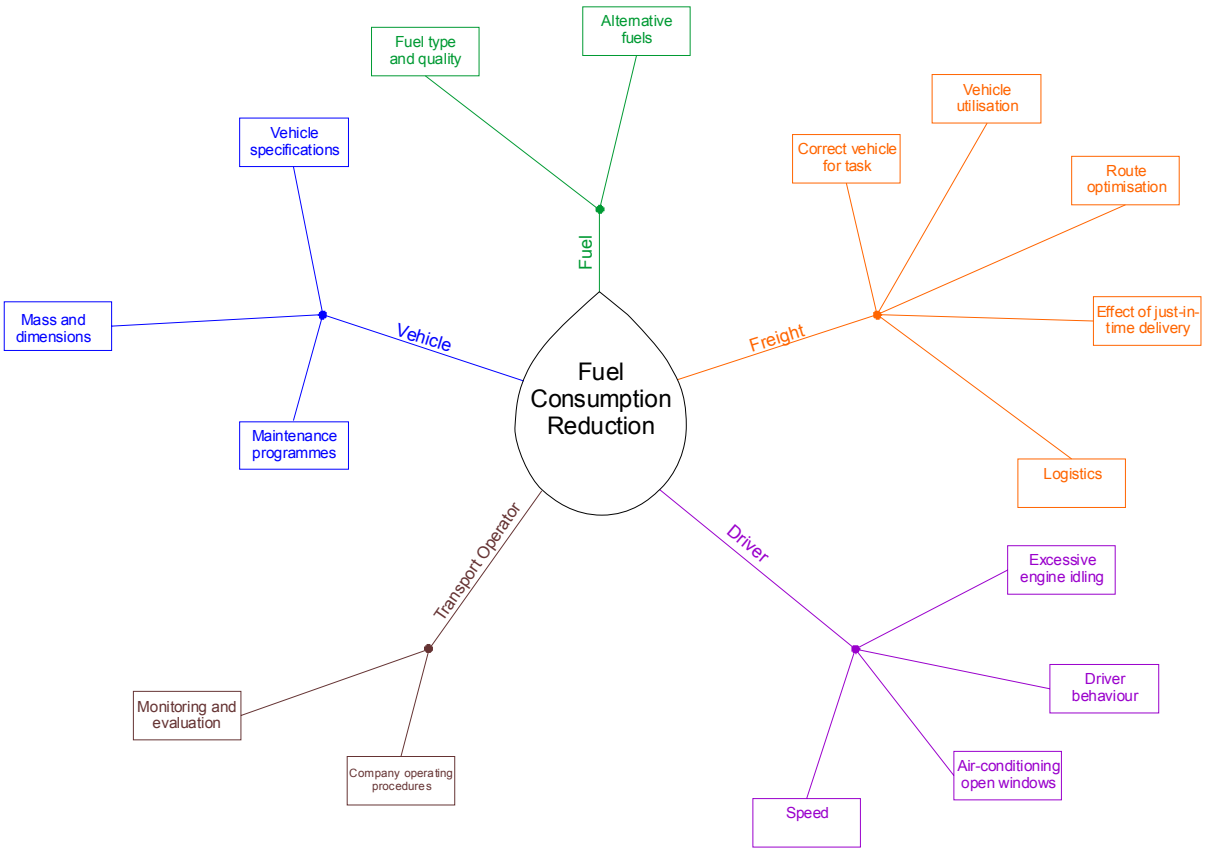

Figure 5: Factors affecting fuel efficiency

VEHICLE

Figure 6 depicts an energy audit for a six-axle tractor semi trailer with a mass of 36.3 tonne. The base energy values listed are typical values for current vehicles. The target values are those set by the 21st Century Truck programme, a multi-year research project in the US sponsored by the US Department of Energy (Bradely 2000). Table 8 lists the potential energy savings highlighted in *Figure* 6. It should be noted that the target of 44% engine efficiency has now been revised to 50% by 2010. This will reduce the engine losses per hour to 112 kWh with a total energy use per hour of 225 kWh.

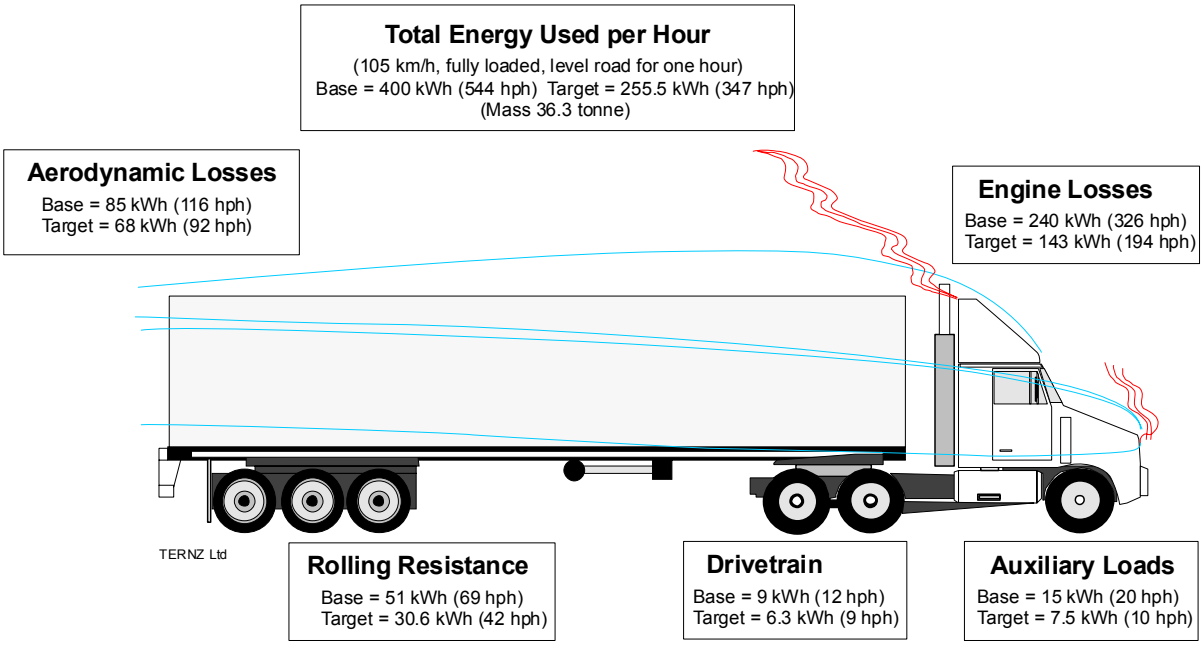

Figure 6: Energy Audit of six-axle tractor semi trailer

Table 8: Energy audit and potential fuel efficiency improvements for line-haul trucks[a] (source Bradely 2000)

Energy loss sources	Baseline	Improvement (%)	Target
Engine losses per hour (kWh)	240	10[b] 30[c]	143.0[d]
Auxiliary loads (kWh)	15	50	7.5
Drivetrain losses (kWh)	9	30	6.3
Aerodynamic losses (kWh)	85	20	68.0
Rolling resistance losses (kWh)	51	40	30.6
Total energy used per hour (kWh)	400		256
Fuel consumption at constant 65 mph (mpg)	6.6	56	10.3
Fuel economy multiplier	1.0		1.56
Vehicle tare weight reduction		15–20	
Total fuel economy (ton-miles/gal) multiplier	1.0	71	

[a]Fully loaded on level road at 65 mph for 1 h.
[b]10% net engine efficiency improvement after losses in efficiency due to emissions requirements.
[c]Due to reduced power needs.
[d]This value is calculated by dividing the sum of the road loads and other losses by the engine efficiency to get the total energy requirement, the new engine losses are then the total energy requirement minus the road loads

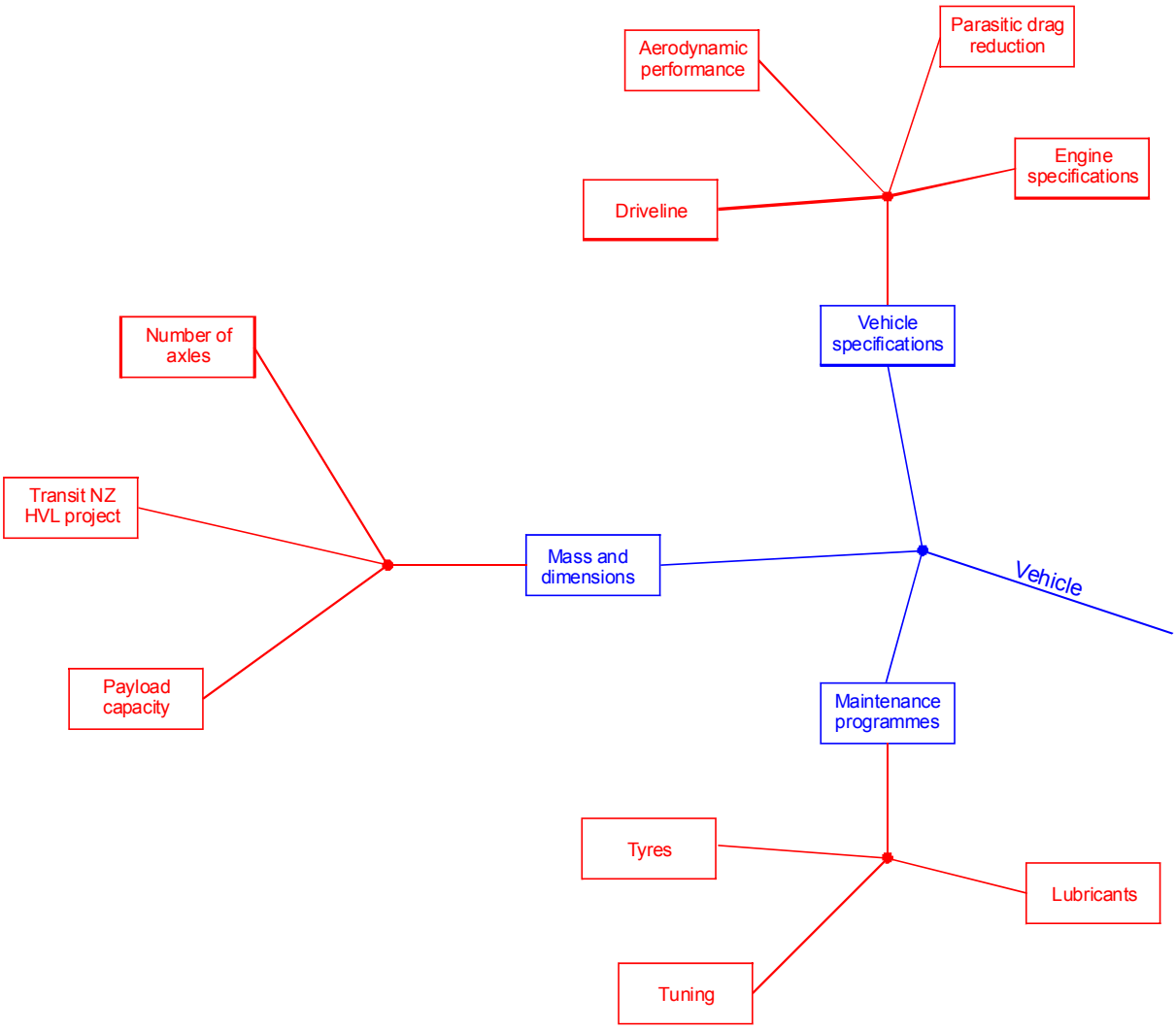

Figure 7: Vehicle Factors affecting fuel efficiency

Vehicle Specifications

Aerodynamic Performance

At highway speeds over half the energy required to move the vehicle along the road is used in overcoming aerodynamic drag. Reducing aerodynamic drag by 25 % results in savings of fuel consumption of 10 to 15 % at highway speeds (Bradely 2000). All vehicles will benefit from aerodynamic drag reduction, and the higher the operating speed and the longer the drive duration, the greater the benefit will be. Table 9 lists the potential fuel savings from reducing aerodynamic drag on various parts of a heavy vehicle combination.

Table 9: Potential fuel savings from reducing aerodynamic drag

Item	Potential Savings
Cab roof deflectors (Williams, Simmons et al. 1981)	6% – 16%
Minimizing Inter-vehicle gaps (OEE	2% - 5%

Canada 1998)	
Side skirts on trailers (OEE Canada 1998)	3%
Bonneted rather than cab over primemovers[1]	2 cents/km

[1]The HV weights and dimensions rule has meant that cab-over primemovers are used in a majority of combinations. See section on "Payload Capacity" on page 17.

In the US 51% reductions in aerodynamic drag have been demonstrated in wind tunnel tests for tractor semi trailer configurations (US CCTP 2003).

Parasitic Drag Reduction

One of the goals of the 21st Century Truck program is to reduce parasitic drag by 50 % equating to an energy saving of 7.5 kWh (Bradely 2000). It is planned to achieve this by replacing the engine mounted air compressor, hydraulic pump and air conditioning pump with electrically driven units that will only operate when required. The use of these technologies will require the use of the emerging 42-volt automotive electrical system; these systems are not commercially available at present. Electrification of air compressors, water pumps and oil pumps has been shown to reduce fuel consumption by 18% (US CCTP 2003).

Engine Specifications

Over the past 15 years there has been a trend towards higher horsepower engines in primemovers in NZ. A fuel efficiency benchmarking study in Canada found that there was a growing move to larger engines (more than 425 hp), with only 9% of vehicles having engines less than 350 hp (OEE Canada 2000). A 5-hp increase in engine size will reduce fuel efficiency by 2% (OEE Canada 1998). Matching engine size to the required task will give the best fuel economy (OEE Canada 1998).

The majority of new heavy vehicle engines are now electronically controlled; this provides a 7% to 15% improvement in fuel economy. It is important that as repairs are made to these engines and specifically to the injector pumps that the electronic units are not replaced with manual pumps.

Cruise control is an option on new engines and this technology can provide fuel savings of up to 6% if used correctly. Adaptive cruise control (ACC) is a new technology available on some models in the US and Europe. It uses radar or laser headway sensors to detect vehicles in front in the same lane. If that vehicle is travelling slower, the adaptive cruise control system sends a signal to the engine or braking system to decelerate the vehicle until the same speed is reached with an appropriate headway. If the vehicle ahead turns or moves lanes then the ACC system will accelerate the vehicle back up to the preset speed.

In the US ACC systems for heavy vehicles have been available for use as original equipment or aftermarket systems since 2001 (IVsource 2000). It has been projected that by 2004, 14 percent of heavy vehicles in the US will be equipped with ACC. The uptake of ACC is faster in heavy vehicles than cars. ACC systems well improve fuel economy as well as providing safety benefits.

The use of electrically driven thermostatically-controlled coolant fans instead of fans driven by the engine reduces fuel consumption by 5%. A fixed-drive fan can use 10% of engine power all of the time and may only be needed 2% - 5% of the time (OEE Canada 1998).

Specifying a high-torque-rise engine can improve fuel efficiency and reduce emissions. This type of engine produces its greatest torque at very low engine speeds, reducing the number of times a driver has to downshift while climbing hills and extending engine life.

Tyres

A new category of wide single tyre having a width greater than 445 mm is beginning to be used in Europe. This tyre type is often termed a 'Mega Tyre'. It offers stability, load volume advantages and lower rolling resistance than dual tyre assemblies, while maintaining load capacity.

A major research programme was undertaken by the European Commission (Cost 334, Faber and Hahn 2000) with the aim of establishing the relative effects of mega and dual tyre assemblies with regard to road pavement damage, vehicle operating costs, vehicle safety and comfort, and the environment (particularly fuel use and noise). The purpose of the programme was to provide reliable information on the use of mega tyres to national governments, and the European Union. The final workshop for Cost 334 was held during the 7th Heavy Vehicle Weights and Dimensions Conference in June 2002. The major conclusions of Cost 334 were that mega tyres reduced rolling resistance, vehicle operating costs, environmental costs and road surface maintenance costs (Penant 2002; Penant and Jacob 2002).

Internationally there is significant research being conducted on truck tyre design to reduce the tyre rolling resistance.

Transmission and Driveline

Semi-Automatic and Automatic Transmissions

Semi automatic and fully-automatic HV transmissions are gradually finding acceptance in the NZ market. These types of transmissions offer as good or better fuel efficiency than standard manual transmissions (OEE Canada 2001).

Mass and Dimensions

Effect on Vehicle Selection

There has been a faster increase in the distance travelled by four-axle trucks and four-axle trailers than three axle trucks and three axle trailers (Baas and Bolitho 2003). This trend results in an increase in the tare (unladen) weight of the vehicles even though the gross weight is fixed resulting in a consequent reduction in the payload carried per trip. This trend appears to be largely driven by operators trying to minimise their Road User Charges which favours the use of more axles for pavement protection reasons. The trend towards adding extra axles does however also result in an increase in fuel use per tonne-km of travel.

Transit NZ HVL project

Transit NZ is currently undertaking a major investigation into whether the maximum weight and length of heavy vehicles should be increased. Such a change in weights and dimensions could lead to significant reductions in fuel use.

Many HV transport operators have, in anticipation of government approval of either scenario A and or scenario B of the Transit NZ heavy vehicle limits project, bought more powerful primemovers than needed under current mass regulations.

Payload Capacity

Under current regulations a cab-over truck and trailer combination has a greater load volume than a bonneted truck and trailer unit. Also the cab over truck-trailer combination has a greater payload volume than tractor semi trailer or B-train combinations.

Maintenance Programmes

Tyres

Tyre failure is the most common reason for a road-side repair of a heavy vehicle. According to a report in Heavy Duty Trucking (Putz 2003) more than 80% of tyre problems are caused by under-inflation and could be eliminated through better tyre maintenance, especially proper tyre inflation. Under-inflation not only reduces the durability of tyres but also increases rolling resistance. A 15psi drop in a tyre's pressure will increase rolling resistance by 6% resulting in increased fuel usage (Winkler and Fancher 2000). The effect of tyre inflation and speed on rolling resistance is illustrated in Figure 8. A 16-km/h increase in speed increases the rolling resistance by 7% to 10%.

Tyre pressures should be checked on a regular basis with a tyre pressure gauge to ensure they are inflated to the manufacturers' recommended pressure. Tyres on the same axle should be equal in diameter, this is particularly so for dual-tyre pairs.

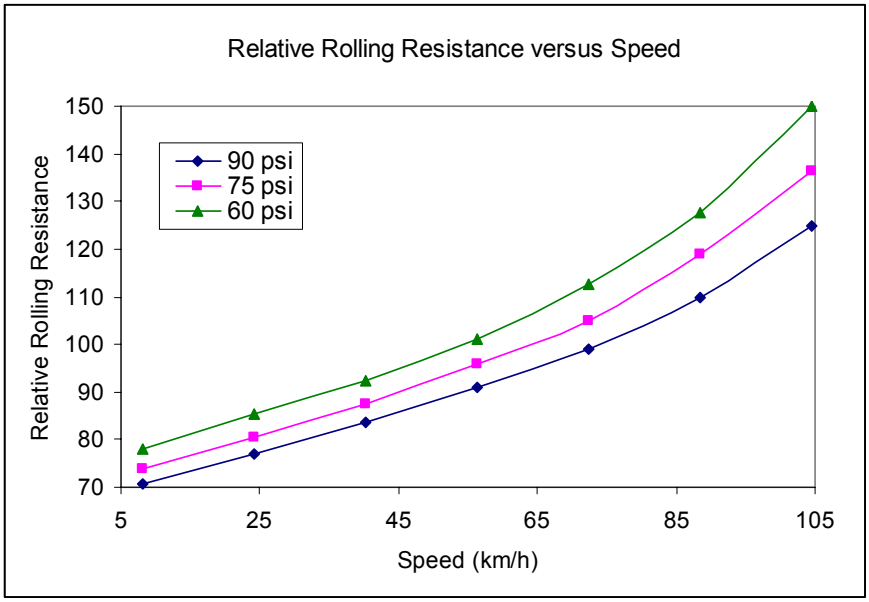

Figure 8: Rolling resistance versus speed

Systems have now been developed and are increasingly being used in Europe and North America that continuously monitor tyre pressure and inflate the tyres when required, even when the vehicle is moving. Savings of US$1,000 per trailer per year have been reported from increased tyre life and reduced breakdown costs. Keeping tyres correctly inflated can decrease tread wear by up to 15 % and flats and blowouts can be all but eliminated (Thomas 2002).

Integrated Vehicle Tyre Monitoring (IVTM) is a system developed by WABCO and Michelin. This device provides on-board tyre identification, pressure measurement and is able to detect slow punctures and help prevent major tyre failures (Penant 2002).

Tuning

A poorly tuned engine can use up to 50% more fuel than a well tuned one. A clogged air filter can cause a 10% increase in fuel consumption (OEE Canada 1998). There is, however, no data available of the incidence of poorly tuned engines or clogged air filters making it difficult to determine what the overall savings may be if engine tuning was targeted.

Lubricants

Worn-out engine oil increases engine friction resulting in increased component wear and fuel consumption. The use of low viscosity engine oils, where appropriate, can also reduce fuel consumption.

FUEL

At present diesel fuel is used almost exclusively for powering heavy vehicles in developed countries. There are projects running in the US, Canada and Australia where HVs are being converted to run on CNG. During the 1980's and early 1990's some Auckland city buses were converted to run on CNG with reported advantages of quieter running engines, small power increases and improved emissions.
Alternatives to the use of diesel fuel in HV's are:

- Biodiesel - Diesel fuel made from vegetable oils. May be blended with mineral diesel
- Diesahol - A blend of mineral diesel and methanol or ethanol
- Compressed Natural Gas (CNG)
- Liquefied Natural Gas (LNG)
- Hydrogen

All of these options will improve the emissions output of heavy vehicles but will not reduce the overall energy consumption. In the Bibendum challenge, a biannual event sponsored by Michelin, high efficiency, low or zero emission vehicles are tested to rank their performance (Michelin Corp 2003). In 2003 for the first time heavy vehicles were included in the challenge. Fuel types used for class 8 heavy vehicles were LNG and diesel fuel cell combinations.

FREIGHT

Figure 9 lists the main freight factors affecting HV fuel efficiency. HV utilisation is currently estimated by the Road Transport Forum (RTF) to be in the order of 49% to 53% (equivalent

to being fully laden for ½ for the time). This is only an estimate, as actual utilisation has not been measured. If NZ could achieve a level of utilisation approaching that of Australia (approx 67%) there would be approximately 5,000 fewer combination vehicles on the road and a reduction of 25% in km travelled. This would result in commensurate fuel saving of up to 10.4PJ, reductions in transport costs, reductions in greenhouse gas emissions, and improvements in safety. Such a saving is probably not achievable given the road and operating conditions in New Zealand but does illustrate the potential to achieve significant savings through improved utilisation. In the UK heavy vehicle utilisation is over 70% while in the USA it is 32%, probably because of the high demand for just-in-time delivery.

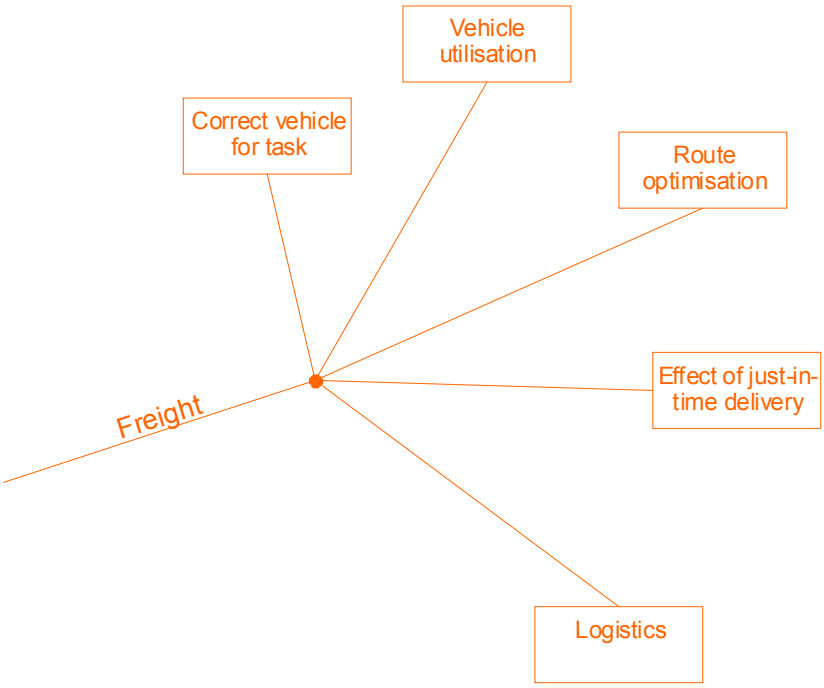

Figure 9: Freight factors affecting heavy vehicle fuel economy

DRIVER

Figure 10 shows the main areas in which the driver affects fuel efficiency. Studies by the Technology and Maintenance Council (TMC) of the American Trucking Association have shown that the difference in fuel economy between poor and good drivers is up to 35% (OEE Canada 1998). Case studies conducted by National Resources Canada as part of their FleetSmart program have shown differences of up to 12 litres per 100 km between best and worst drivers (OEE Canada 2003). Two of these case studies are included in Appendix A.

The marked difference in fuel economy between drivers is due to speed, gear ratios used (difference in engine RPM) and gear change points. Driver education and incentive programmes have been used by the Canadian companies highlighted in the case studies in Appendix A to improve the fuel use of individual drivers.

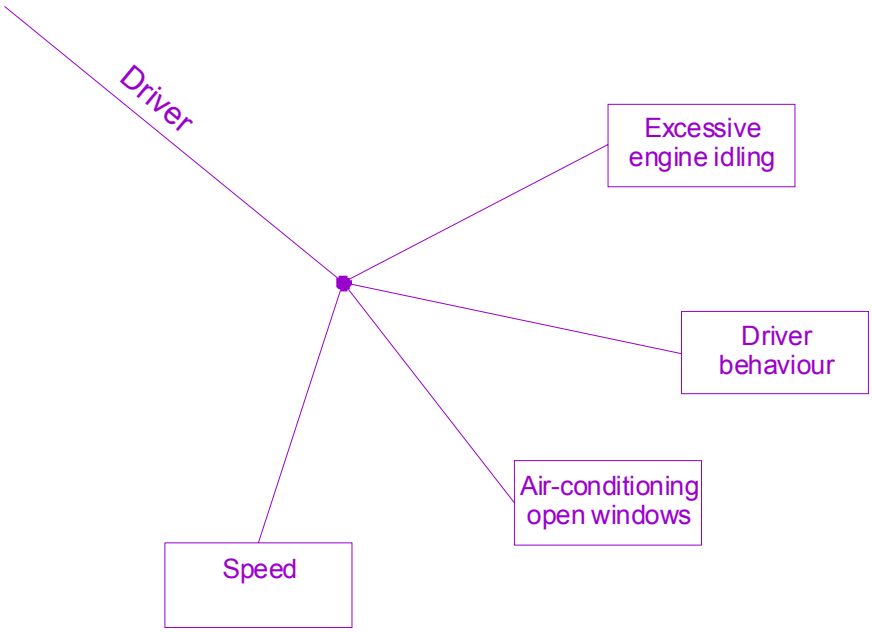

Figure 10: Driver factors affecting fuel economy

Excessive engine idling is less of a problem in NZ than in colder climates like the US and Canada where, in winter, trucks are often left idling to provide heat while the driver sleeps. Modern engine control units can be programmed to shut the engine down after a set period of idling; using this feature would reduce fuel use in some NZ fleets.

Using air conditioning increases fuel use by 3% - 4% (OEE Canada 1998), driving with the window down also increases fuel use by increasing aerodynamic drag. The best fuel efficiency is gained by using the in-cab ventilation system; however there will be occasions and operating environments where this is not sufficient and highlights the need to carefully match the vehicle specification to the operating environment.

Operating speed has a significant effect on fuel use, a reduction of 8 km/h in average speed travelled can result in a 10% - 15% improvement in fuel consumption.

TRANSPORT OPERATOR

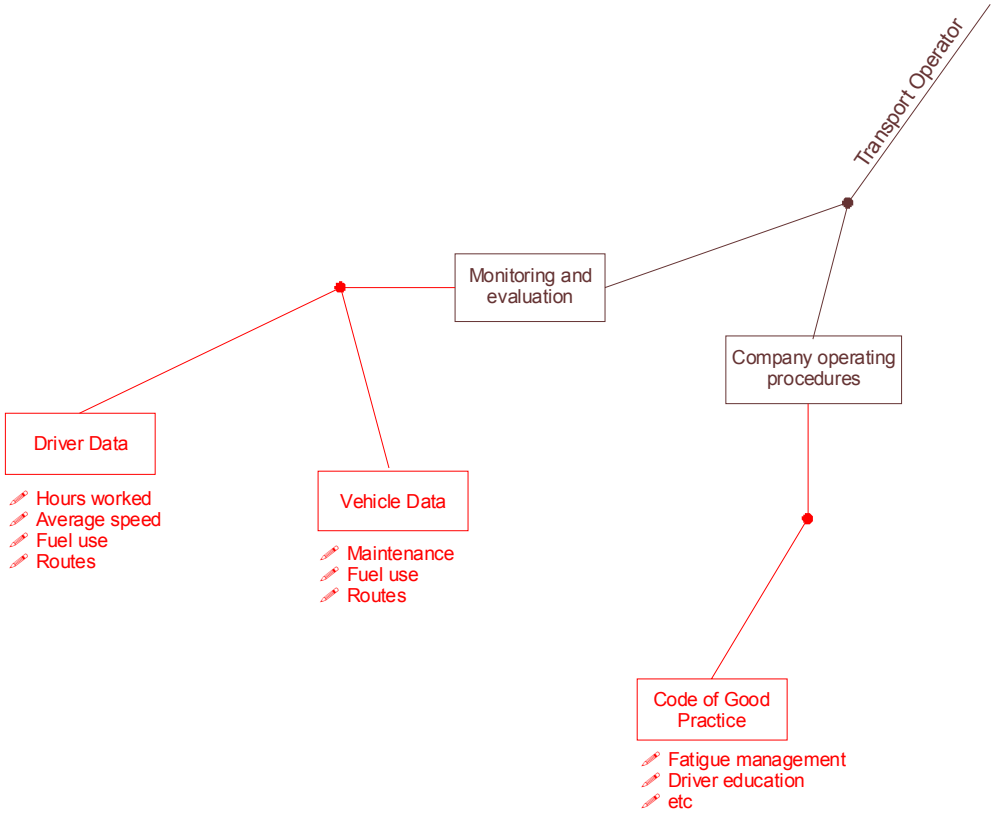

Figure 11: Transport operator factors affecting fuel economy

The prevailing culture within a transport company is largely determined by the environment created by management through the procedures put in place to monitor, review and reward employees. Figure 11 highlights the transport operator factors affecting fuel economy. A common trait of the companies that reported fuel savings under the Canadian FleetSmart programme was that fuel use per vehicle and per driver had been monitored and a driver education scheme and incentive program was in place (see Appendix A). With good monitoring of vehicle performance the maintenance programs can be tailored to specific vehicle types to ensure optimum vehicle performance is achieved.

One of the smaller transport operators (< 20 primemovers) involved in the Canadian FleetSmart program reported a minimum fuel saving of 15% in the first year of operation (OEE Canada 2003).

The current state of fuel-saving initiatives within NZ's fleets needs to be established.

The road transport industry is heavily regulated in comparison to many other sectors in the economy. This is not really surprising as the transport industry undertakes most of its business on public facilities using vehicles that are in some ways incompatible with the light vehicles that also use the roading network because of their sheer size and weight. A high level of competition within the industry, and a relatively low cost of entry, means that profitability often depends on how close the operator can operate to the limits of the law especially in terms of driving hours, maintenance standards and weight limits. This regulatory focus affects the interest the industry has in fuel efficiency.

CHAPTER FOUR: FUEL SAVINGS INITIATIVES IN OTHER COUNTRIES

The link between economic growth and the growth in freight volumes being transported by heavy vehicles has been established in most developed countries. Because of this and the growing awareness of the negative environmental effects of transport emissions many developed countries, to varying degrees, have initiated programs to improve fuel efficiency and reduce emissions from transport-related sources. The following sections contain a brief summary of the programs that are in place in the United States, Canada, the United Kingdom and Australia.

UNITED STATES

At the federal level the Department of Energy (DOE) and the Environmental Protection Agency (EPA) head the major initiatives to reduce transport related emissions, improve fuel consumption and reduce the US's dependence on imported fuel sources. Major initiatives to reduce transport emissions and improve fuel efficiency are:

- Tightened emissions standards for new heavy vehicles (EPA)
  - The next round on tightening is set to take effect in 2007.
- Idling Technology Program (EPA)
  - A program to reduce the time HV's are left idling. The uptake of new technologies that can be used to provide heating and cooling when the truck is not moving are being encouraged.
- SmartWay Transport Partnership (EPA)
  - Voluntary partnership where freight operators track emissions and fuel consumption.
  - The use of new technologies such as automatic tyre inflation systems, low viscosity lubricants, reduced idling and improved routing and scheduling systems are being encouraged.
  - Partners who achieve superior performance are eligible to display EPA's SmartWay Transport Partnership logo in their advertising, marketing and business-to-business communications.
- FreedomCAR (DOE)
  - Fuel savings strategies for light vehicles
- 21st Century Truck Program (DOE)
  - The 21st Century Truck program is a joint venture between the truck and bus industries and the Federal Government (Bradely 2000). The goals of this program are to:
    - Double the line-haul truck fuel efficiency on a ton-miles-per-gallon basis.
    - Triple the light truck and delivery van fuel efficiency on a ton-miles-per-gallon basis.
    - Triple the fuel efficiency of heavy-duty transit buses on a miles-per-gallon basis.

CANADA

At the federal level the Office of Energy Efficiency (OEE), a division of Natural Resources Canada, administers energy efficiency programs. Significant programs have been developed that target the transport sector and specifically the heavy transport sector:

- FleetSmart program
  - This program offers free practical advice on how energy-efficient vehicles and business practices can reduce a fleet's operating costs, improve productivity and increase competitiveness. Two case studies from transport operators participating in this program are included in Appendix A. A review of Fleetsmart found that one of the smaller transport operators (< 20 prime-movers) that participated in the programme achieved a minimum fuel saving of 15% in the first year of operation.
- SmartDriver program
  - Information and education material aimed at enabling truck drivers to better understand the factors that affect fuel efficiency and the role driving style plays in fuel consumption.

UNITED KINGDOM

To help the government meet its greenhouse emissions targets, the Energy Saving Trust was established as a non-profit company. It was initially founded to tackle domestic energy consumption but in 1996, a new division was developed with the specific aim of reducing greenhouse gas emissions from road transport. Known as TransportEnergy (http://www.transportenergy.org.uk/transportenergy/), it receives the majority of its funding from Government (in particular, the Department for Transport and the Department for Trade and Industry) with support from the private sector. In Scotland and Wales, the Scottish Executive and Welsh Assembly Government wholly or partly-fund TransportEnergy programmes.

TransportEnergy is actively working with industry, the public sector and community through a range of programmes to:

- Encourage the uptake of new cleaner vehicles and use of cleaner fuels by fleets and consumers
- Clean up commercial diesel vehicles
- Work with fleets to improve the efficient use of their vehicles as well as reducing travel

The three key programmes are:

1. Transport Energy Best Practice which provides free, independent advice to help operators optimise the efficiency of their existing operation
2. Transport Energy Power Shift which offers both advice and grants to increase the take up of vehicles that run on LPG, natural gas and electricity

3. Transport Energy CleanUp which provides grants for the fitting of diesel emission reduction equipment such as particulate traps or oxidation catalysts.

The Transport Energy Best Practice programme has included the production of;

- guides on, for example, safe and efficient driving, telematics, fuel saving devices, truck aerodynamics and computerised routing and scheduling for efficient logistics
- case studies
- benchmarking guides on key performance indicators
- software to support the best practice guides
- other information on, for example, fuel saving tips.

Transport Energy has funded road-side driver training which is undertaken in a specially built semi-trailer set up as a classroom at Truck Stops, rest areas, depots and other places where drivers stop. This training is free for drivers from small to medium-sized transport operators and is subsidised for the larger fleets. They have also invested in a 6 degree of freedom truck simulator based at TRL and have trained over 600 drivers in this facility. They also provide free fuel efficiency seminars for freight operators. By the end of July 2003 10,000 drivers had attended these free seminars.

Transport Energy provides consultancy support via a free phone number. This provides up to 2 hours of free distance advice. Site-specific advice is provided at a heavily subsidised rate. This includes a one-day analysis of the transport operation by a specialist advisor including advice on management practice, vehicle selection and fuel monitoring. They also provide assistance for the development and implementation of voluntary workforce key performance indicators.

A major UK Government initiative has been the Road Haulage Modernisation Fund of £100million which initially ran for 3 years and was extended for 2004-05. Programmes run by the Transport Energy were funded by the RHMF. Of greatest relevance to energy and perhaps one of the most successful RHMF projects was the "Safe and Fuel Efficient Driving" (SAFED) training programme that teaches drivers defensive driving techniques and vehicle maintenance to reduce fuel consumption and increase driver safety. Early results suggest that a day's SAFED training produces an average fuel saving of 9.4% (Department of Transport UK 2004).

An independent review of the UK SAFED programme (Department of Transport UK 2004) noted that:

- "All stakeholders interviewed were very supportive of the training. They suggested that it was well known and well regarded by the industry. This was backed up by a number of positive articles in the trade press. We (the reviewers) spoke to a few people who carried out the training and they felt that it was worthwhile and were impressed by the improvements in fuel efficiency that could be achieved.
- One of the main barriers to SAFED training was the perception that driving fuel efficiency meant that journey times would be lengthened. There is now evidence from the training to show that this is not the case. Driving times are broadly comparable over the same distance using SAFED techniques and not

using them. This combined with the cost savings identified have helped in getting training widely accepted within the industry.

- We carried out a survey of drivers who had attended the SAFED course. Of those we spoke to all had found the training to be useful and had made use of the techniques that they had learnt. The drivers also said that they had maintained these changes to their driving styles since the course and would recommend the training to others.
- As part of the SAFED training day, drivers do two on-road circuits of 40minutes each, one at the start of the day and one at the end of the day with the driver applying the techniques he has learnt. The results of this show the potential savings that are possible if drivers apply SAFED techniques. The results of this are impressive with an average improvement in fuel economy of 9.4%.
- We would expect SAFED training to be viable on a full commercial basis in due course, though there may be a case for further support in the very short tem to ensure the scheme does not lose momentum. We recommend that the Department for Transport continue to take the lead in promoting a SAFED standard, exploring the potential for its recognition/accreditation, and supporting the industry in exploring the scope for a link with insurance premiums.

The extension of the RHMF for the 2004-05 financial year provided, in terms of fuel efficiency:

- a further phase of the Driver Training programme to promote and embed Safe and Fuel Efficient Driving (SAFED) techniques. During 2004-05, 2,500 drivers were trained to drive in a more fuel-efficient way, helping them save some 9 per cent of their fuel bills worth over £2,000 per annum.
- One hundred instructors were also trained to be able to give the necessary tuition, in order to help maximise the benefits from the funding provided. The total 6,000 drivers trained to date are estimated to be saving about 17,000 tonnes of diesel per year worth £13 million, as well as reducing accidents and vehicle wear. Also, 50,000 copies of the SAFED guide were distributed via the instructors.
- a further phase of the Fuel Economy Advisor programme to promote more fuel-efficient operations. The programme completed 2,700 seminars disseminating and embedding best practice. In addition detailed site specific advice was provided for 500 small and medium sized operators. Applying a range of techniques including vehicle aerodynamics, more energy efficient tyres, fleet management, routeing and planning etc, can typically save 5-10 per cent of an operator's fuel bill.
- a further phase of training for 500 drivers using the truck driver simulator and a world class cohort study to better evaluate the training potential of this new technology has been welcomed by experts around the world;

AUSTRALIA

At the federal level the Australian Greenhouse Office (AGO) established in 1998 administers the 'climate change package' and 'measures for a better environment' budgets. The AGO is responsible for implementing greenhouse gas abatement

measures across all industry groups. The following initiatives have been put in place for the transport sector:

- TravelSmart program
  - Encourages light vehicle users to use other modes of transport. It aims to inform and motivate people to changing their travelling behaviour.
- Fuel Consumption Guide and vehicle labels
  - Provides fuel consumption information on light vehicles.
- Alternative Fuels Conversion Program
  - Designed to assist operators and manufacturers of heavy commercial vehicles and buses (>3.5 t GVM) to convert to Compressed Natural Gas (CNG) or Liquefied Petroleum Gas (LPG). The program provides grants to vehicle owners to offset costs of fuel conversions and upgrades and to purchase new vehicles. A register of type-approved engine products is maintained to assist purchasers.
- Greenhouse challenge
  - Provides technical assistance on ways to reduce emissions and provides information on latest innovations.
  - Increases technical ability in collecting emissions data and monitoring emission reduction strategies.
  - Provides ‘success stories’ from various industry sectors to give exposure to achieving companies and ‘how to’ information to others. A success story from the freight transport sector is included in Appendix C.
  - Recognition for greenhouse gas abatement efforts though Greenhouse challenge logo use.

CHAPTER FIVE: IDENTIFICATION OF CANDIDATE ENERGY SAVING INITIATIVES

A United States Department of Transportation report on global climate change (US DOT 1998) states that there are three ways of reducing greenhouse gas emissions from personal vehicle travel:

- Reduce vehicle travel
- Increase fuel economy
- Switch to fuels with a lower-cycle carbon content.

These areas equally apply to the HV transport sector; vehicle travel can be reduced by improving existing vehicle utilisation or by increasing the payload capacity of each vehicle. Changes in logistics, including decentralisation of production facilities, can also reduce travel. Fuel economy can be improved through speed reduction, better driving technique and reductions in aerodynamic drag, and rolling resistance.

A list of candidate initiatives, based on the programmes that have been successfully implemented overseas and a knowledge of the New Zealand situation are shown below. These formed the starting point for the subsequent industry consultation.

TRANSPORT OPERATOR

The type of equipment purchased, how it is maintained and the way the company is managed have a significant impact on fuel consumption. Initiatives targeted at transport operators have the potential to produce significant energy savings.

Purchasing new equipment

When purchasing new HVs, decisions are made that affect the fuel efficiency of the vehicle for its entire operating life. As detailed on page 21, significant fuel use savings can be made by purchasers being aware of new technologies available and their effect on fuel efficiency. The role of aerodynamics and rolling resistance needs to be better understood so that informed decisions can be made when specifying a new vehicle. In 1999 the Forest Engineering Research Institute of Canada (FERIC) launched a research project, known as Star Truck, to demonstrate to the Canadian forest industry how better vehicle specification, using commercially available technologies, could optimise log haul operations, reduce fuel consumption and environmental impacts and improve the mechanical availability of equipment (FERIC 2002).

This Star Truck Project involves two major elements:

- The demonstration and monitoring of trucks equipped with the latest technologies and designs in actual field operations;
- A knowledge and technology transfer initiative to inform forestry stakeholders of the results of the demonstration project and the benefits of better vehicle specification.

Initiative Number 1:

Provide information to transport operators on:

- *Fuel efficiency considerations in new vehicle purchase e.g. new technologies, engine capacity, aerodynamics, rolling resistance etc.*
- *The levels of fuel savings possible.*

Initiative Number 2:

Work with selected transport operators to specify a highly fuel-efficient new vehicle and then monitor the fuel consumption of this vehicle and a baseline vehicle in the same fleet. Provide feedback to industry stakeholders on the results.

Day-to-Day Operations

Monitoring of fuel usage on a per-vehicle and per-driver basis during the course of day-to-day operations can provide valuable feedback on potential fuel-saving areas. For example, poor driving practices and vehicles requiring maintenance can be identified and comparisons can be made between to performance of old and new vehicles.

Initiative Number 3:

Develop a package of material that provides information on the cost savings and environmental benefits of:

- *Monitoring fuel consumption on a per vehicle and per driver basis*
- *Conducting regular maintenance on engine, driveline and tyres*
- *Replacing old less-efficient vehicles*
- *Informing drivers of fuel-efficient driving practices*
- *Implementing fuel-efficient driving schemes for drivers*

Work with transport operators to implement monitoring programmes.

Utilisation (Routing and scheduling)

In NZ heavy vehicle utilisation is between 50% and 53%. This compares to approximately 67% in Australia. Improving vehicle utilisation will reduce the number of trips required for a given freight task.

Initiative Number 4:

Investigate further the factors affecting HV utilisation in the NZ context and provide feedback to transport operators and industry stakeholders on potential ways to improve HV utilisation.

DRIVER

Studies in both the US and Canada have shown that fuel consumption differences of up to 35% exist between the best and least fuel-efficient drivers. Educating drivers on fuel-efficient driving practices has the potential to provide considerable savings. The section on "Drivers" on page 19 details some of the potential areas in which savings could be made.

Initiative Number 5:

Develop educational material on good, fuel-efficient driving practices that can be used by educators and fleets to encourage good driving practices. This material could be similar to the Canadian SmartDriver material.

Initiative Number 6:

Develop joint strategies with Land Transport NZ and NZ Police aimed at reducing heavy vehicle speed.

TRANSPORT INDUSTRY GROUPS

Strong transport associations exist in NZ with the purpose of improving the operating conditions of their members. Groups such as the Road Transport Forum, Regional Road Transport Associations, National Road Carriers, IRTENZ and Log Truck Safety Council represent significant parts of the HV transport industry.

Initiative Number 7:

Provide information on fuel-savings initiatives to the different road transport industry groups. Develop linkages with these groups as a means of encouraging their members to adopt new fuel savings initiatives.

FREIGHT PRODUCERS

The freight producers are important stakeholders in the road transport system as the users of transport services.

Initiative Number 8:

Provide information on fuel-saving initiatives for freight producers. Highlight the importance of supporting transport operators who are part of initiatives to improve fuel efficiency and have good monitoring procedures in place. Encourage the inclusion of fuel savings measures in the key performance indicators that some major users have with their transport operators.

GOVERNMENT INDUSTRY PARTNERSHIPS/INITIATIVES

Government/industry partnerships such as the Greenhouse challenge in Australia and the SmartWay transport partnership in the US provide important linkages between government and industry and allow standards or best practice that include fuel efficiency to be created and monitored (see sections 0 and 0). The use of a fuel efficiency logo on vehicles and in business communications by qualifying operators can be a strong incentive to implement a fuel efficiency program.

The Transit NZ heavy vehicle limits project was initiated through a joint government (Transit NZ)-industry interaction. The vehicles proposed in both Scenario A and B offer productivity gains over current vehicles.

Initiative Number 9:

Develop industry partnerships similar to the Greenhouse challenge in Australia and the SmartWay transport partnership in US. As part of this provide feedback to transport operators through case studies on member transport operators who have achieved good fuel savings.

Initiative Number 10:

Support joint government-industry initiatives related to vehicle mass and dimensions, with a view to improving fuel efficiency.

RESEARCH

One of the features of the US and Canadian work is the role that research plays in improving fuel efficiency. To achieve benefits, research outputs have to be transferred back to the end-users. To provide ongoing fuel saving strategies the following areas need to be further researched:

- Determination of baseline performance
- Support for improving utilisation and logistics
- Identifying the underlying factors that affect transport efficiency
- Reviewing international advances in heavy vehicle fuels, new technologies and emission reducing strategies.

Initiative Number 11:

Develop a strategic research plan to provide medium and long-term information on fuel-efficiency improvements.

ASSESSMENT OF CANDIDATE INITIATIVES

Table 10 lists the candidate initiatives, their benefits, timeframe, potential uptake, indicative cost and effect on transport growth in terms of transport factor (TF). A description of the different ratings for each category is listed below.

Benefit time frame (time from the start of the initiative to full uptake):

- Short, 2 – 3 years
- Medium, 3 – 5 years
- Long term, 5+ years.

Potential uptake (proportion of the fleet likely to uptake the initiative):

- Low - poor uptake
- Medium
- High - high level of penetration in to transport industry.

Indicative benefit-to-cost ratio in terms of total energy saved relative to the cost of the initiative:

- Low
- Medium
- High

Effect on transport factor (refer to page 4 for a description of TF).

- Positive – improve fuel efficiency
- Neutral – no effect
- Negative – worsen fuel efficiency

Table 10: Assessment of Candidate Initiatives

	Description	Benefit Timeframe	Potential Uptake	Indicatory Cost Benefit	Effect on Transport Factor
Initiative 1	Vehicle Specification	Medium	Medium	High	Neutral
Initiative 2	High efficiency vehicle	Medium	Medium	High	Neutral
Initiative 3	Day to day operations	Short	High	High	Neutral
Initiative 4	Utilisation	Medium	Medium	High	Positive
Initiative 5	Driver education	Short	High	Medium	Neutral
Initiative 6	Speed	Short	High	High	Neutral
Initiative 7	Industry groups	Short	Medium	Medium	Neutral
Initiative 8	Freight producers	Medium	Low	Medium	Neutral
Initiative 9	Industry partnerships	Short	Medium	High	Neutral
Initiative 10	Mass and Dimensions	Medium	High	High	Positive
Initiative 11	Research	Short/Long	High	High	Positive

CHAPTER SIX: CONSULTATION

A series of consultation meetings were held with transport operators, heavy vehicle suppliers, industry groups and relevant government departments where the findings of the literature review were outlined and the candidate initiatives discussed. The people consulted were chosen for their broad knowledge of the industry. The following is a summary of the comments that were received. They are not necessarily the view of the authors of this report.

TRANSPORT OPERATORS

Few operators currently monitor fuel use on a per driver or per vehicle basis. A number of operators would not be able to do this with fuel cards as either multiple vehicles are refuelled on the same card and/or, drivers change trucks and/or in some cases the fuel tanks on refrigeration units are filled when refuelling the truck.

Another option for monitoring fuel consumption is to use the prime-mover's on-board computer system used for engine management. However not all prime-movers have this feature, especially many of the Japanese sourced vehicles.

Fuel efficiency seldom plays a major role in new-vehicle purchase decisions. It is considered more important to set-up a vehicle to minimise Road User Charges than to optimise fuel consumption as RUCs typically cost 1.5 times as much as fuel.

The engines on American and European prime-movers can be programmed to shut down after a specified period of idling.

Current driver training generally does not cover fuel-efficient driving practices.

Fonterra is looking at implementing the Canadian Fleetsmart programme and monitoring fuel use per truck. They would use electric milk pumps in preference to power-take-off (PTO) driven pumps if the fuel tax was higher. A 20 % productivity improvement could be made if RUCs and weights and dimensions were changed so that their standard combination had one less axle and a GCM of 48 tonnes. The super-routes concept in Scenario B of the Transit NZ heavy vehicle limits project would provide significant benefits and encourage milk collection hubs to be developed. This would allow the use of more efficient vehicles to transport product between processing plants. As well as being generally more productive, there would be added efficiencies through reduced tare mass and increased payload capacity by not having to carry pumping gear, which is currently fitted to all tankers.

Measures aimed at improving vehicle utilisation and increasing mass and dimensions would be very effective in reducing fuel consumption.

HEAVY VEHICLE SUPPLIERS

Fuel efficiency seldom plays a part in purchase decisions, especially for smaller trucks. For the larger trucks, RUCs and journey time play a more dominant role. New Zealand heavy vehicles have more axles than are needed to carry the load. The higher number of axles is economically most efficient because of RUCs. Provided

RUCs accurately reflect road wear, this is the most economically efficient vehicle. However operators are not charged for emissions so this is not taken into account when making vehicle decisions.

The knowledge of truck specification issues is highest amongst those buying the larger rigs such as B-trains but those purchasing the mid-range trucks rely on the truck-sales staff.

Few operators monitor driver fuel use. Drivers currently charge more fuel to the fuel card than the truck uses, e.g. to fill up the company ute and for the truck's refrigeration units.

Fuel challenge in NZ Trucking magazine was something that worked well.

Speed limiters should be set to 90 km/h. If you give a person a truck capable of doing 130km/h, sooner or later he will drive it that way (Authors' note: trucks are geared to ensure the engine is running at relatively low speeds on the highway for fuel efficiency and engine wear reasons. Trucks that have built-in speed limiters that are set by the vehicle supplier. Many operators request higher speed-limiter settings when purchasing vehicles.)

Initiatives 1,2,3,5 and 7 would fall on deaf ears, government needs to create the environment where operators will want to save fuel.

A growing trend in maintenance management is to link the maintenance interval to the amount of fuel burned e.g. service at 20,000km if fuel is used at the rate of 2.0 km/litre and at 25,000km if the fuel usage was 2.5 km/litre.

Economic driving not only saves fuel but also reduces the cost of tyres and the cost of maintenance including clutches, drivelines and brakes.

It was suggested that an information pack could be left with all new vehicles giving drivers information on fuel efficient driving.

Support the recognition of best practice and awards as a means of raising awareness.

Strong support for promotion and education as a means of reducing fuel consumption.

The maintenance of tyre pressures could be improved.

INDUSTRY GROUPS

Executives of the Road Transport Forum NZ and the National Road Carriers Inc and the Chairman of the NZ Institute of Road Transport Engineers were consulted. The following us a summary of their comments.

Currently very few fleets monitor fuel consumption.
The initiative aimed at influencing new vehicle purchasing will require a lot of effort.
Some operators already take fuel efficiency into account. The others (about 90% of

operators are small with less than 5 trucks) believe that it won't be economically viable to specify a truck for fuel efficiency until cartage rates increase. The information needs to be specific to the application, e.g. local delivery. At present personal preference plays a major role in vehicle selection.

The industry associations are already trying to encourage the adoption of fuel monitoring and best practice. They would strongly support awards and other means of recognising best practice.

The National Road Carriers (Inc) are introducing the "Free-Cargo" service for members that will assist them with obtaining backloads and other means of increasing vehicle utilisation. NRC also provides an extensive cost-model evaluation service that enables operators to understand their costs, including that of fuel.

It is very difficult to influence the users of transport services. Longer opening hours of, for example, supermarket loading bays would avoid wasted trips.

Case studies along the lines used in the UK are preferred to demonstration projects.

Do not want multiple information packages, need standardised format so message is repeated, not mixed. This could be in the form of a folder with various leaflets produced by the different agencies but branded the same, and the use of a common website containing all heavy vehicle related information of interest to truck operators.

Without mass and dimension increases, fuel savings will be limited to 8% to 10%.

There is a need to facilitate the introduction of new technologies. For example, hybrid trucks, which are now being developed, should be available by 2007.

The industry associations such as RTF, NRC and IRTENZ would welcome the opportunity to participate in any fuel-saving initiatives.

GOVERNMENT AGENCIES

A meeting was held with LTSA policy staff and then a combined meeting with EECA, LTSA, Transit NZ, Climate Change Office and the Ministry of Transport. The following are the purely views of those who attended the meetings, not government policy.

A joint effort involving EECA and LTSA was suggested by LTSA aimed at improving information on, for example, specifying new vehicles as this is also important from a safety perspective.

It was recognised that there is a risk of different agencies giving competing information if efforts are not coordinated. A number of avenues are available for disseminating information including the trade magazines, trade shows, conferences, simple to use computer programmes and Roadshows. Many operators do not read reports and other more formal means of communication.

It was suggested that the Industry Standards TERNZ has been developing for the industry could be expanded to include fuel efficiency.

The current fleet is generally multipurpose, which affects the ability to have the right vehicle available to undertake a specific task. This in turn affects vehicle utilisation.

Driver education encouraging fuel efficient driving also improves safety and hence is of interest to Land Transport NZ as well as EECA. Driver education needs to be linked to what the transport operator is doing as the transport operator will be the enabler.

There was strong support for the use of case studies amongst the Government agencies.

Industry-wide support is seen as being very important from both a safety and a fuel conservation perspective. A coordinated approach is required involving the various government agencies and industry bodies.

Any mass and dimension concessions could include conditions that are aimed at improving energy efficiency. Other regulatory options could include the licence fee being dependent on engine horsepower.

The adoption of new vehicle technologies could be accelerated by requiring them to meet, for example, the Euro 3 engine requirements. The sulphur content of fuel is currently a barrier but this is being addressed.

There is currently no benchmarking on, for example, transport productivity and transport costs. Also the barriers to the adoption of new technology are not known. A survey is required to determine, for example how operators select vehicles, how they can be influenced and why they do certain things.

The use of triple-bottom-line reporting and key performance indicators that include fuel conservation should be encouraged. Government could take the lead by only using good quality transport operators who have been audited.

The Emissions Rule will help to target the worst polluters.

There is a strong preference for measures that do not require the use of regulations.

When asked what initiatives they would focus on it they were starting again, the senior staff member at the UK Department for Transport who has been spearheading their fuel saving initiatives mentioned the following:

- fleet management (including fuel monitoring by vehicle and driver)
- driver education
- getting the industry onside.

CHAPTER SEVEN: LINKAGES TO OTHER GOVERNMENT INITIATIVES

GREENHOUSE GAS EMISSION REDUCTION INITIATIVES.

Figure 12 was prepared by the Climate Change Office and summarises ways in which greenhouse gases from transport could be addressed.

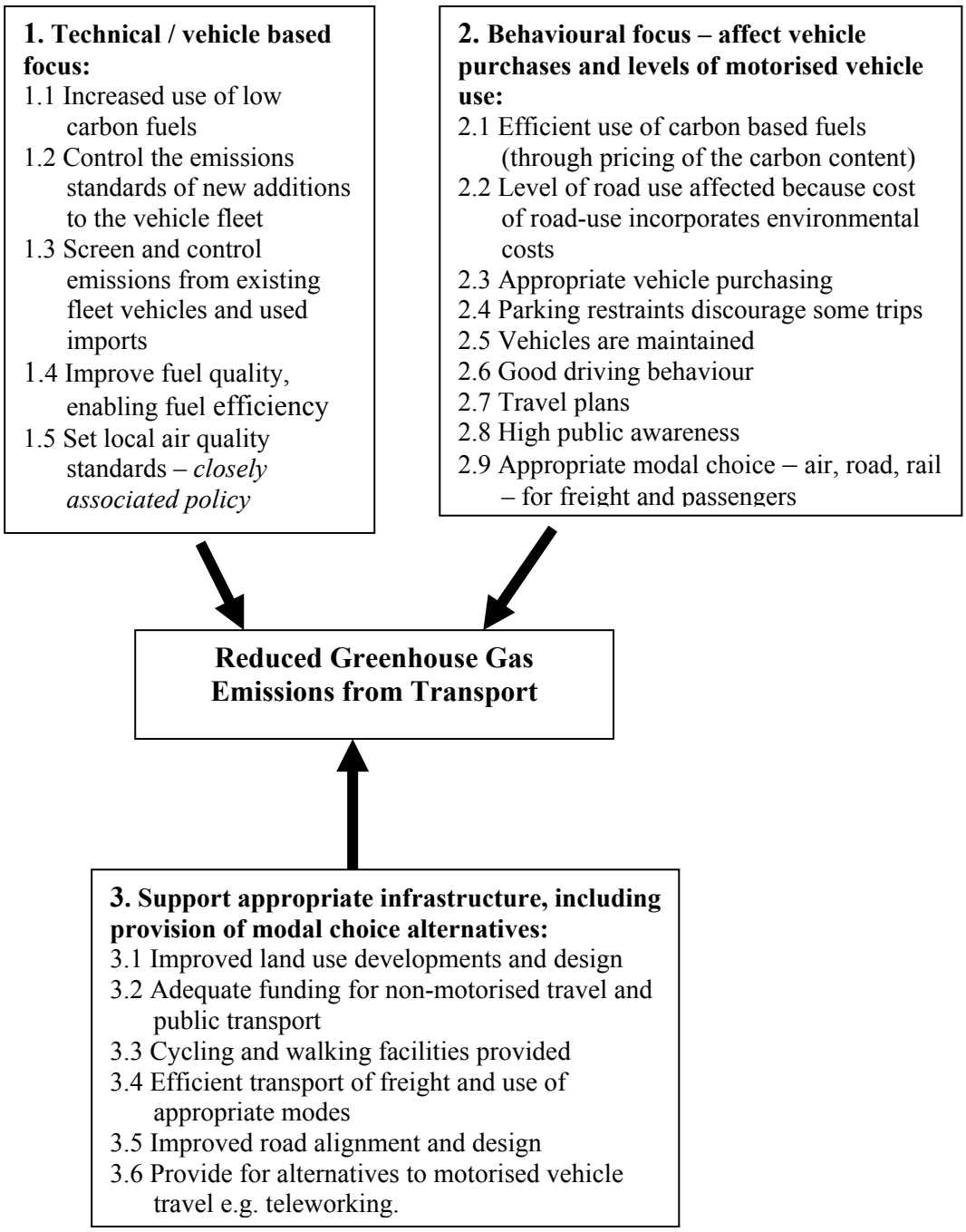

Figure 12: Ways in which greenhouse gases from transport could be addressed

The following are of greatest relevance to this investigation:

1. Technical changes affecting vehicle performance

1.1 Increased use of low carbon fuel including LPG and biodiesel. Hybrid trucks may also be an option in the future with the first ones expected to come on the market in 2007.

1.2 Emission standards for new vehicles. New emission standards have been or are being produced in Europe and the US, for example the Euro III and IV engine requirements and the US 21st Century Truck Programme. Amongst the truck manufacturers, the European manufacturers are generally technology leaders followed by the US manufacturers (many of these companies are now merged and the difference between European and US trucks is becoming less clear). Japanese manufacturers are market followers. No trucks, only trailers, are manufactured in New Zealand. In setting emission standards for heavy vehicles, consideration should be given to perhaps only adopting the European and American requirements.

1.3 Emission screening of existing vehicles in the fleet and used imports.

1.4 Improve fuel quality. Two issues regrading fuel quality have been raised during this review: 1) the level of sulphur in diesel preventing the use of the new Euro 3 engines; 2) contamination of stored fuel. A number of transport operators store their own fuel. Some assistance to them in ensuring their fuel does not become contaminated by, for example, rain water would be beneficial in terms of ensuring energy efficiency.

2. Encouraging appropriate transport purchase and use decisions

2.1 Relating the cost of fuel to its carbon content. The cost of fuel in comparison to Road User Charges was raised as an issue during our consultation. An increase in the cost of diesel with a corresponding reduction in RUC could result in the use of heavy vehicles with fewer axles giving a corresponding increase in payload capacity. The typical weight of an axle assembly is approximately 1 tonne.

2.3 Encourage purchase of more energy efficient vehicles and new technology.

2.5 Encourage owners and operators of vehicles to undertake regular vehicle maintenance:- tuning, tyre pressure etc.

2.6 Encourage appropriate driver behaviour on the road though less aggressive driving practice.

3. Appropriate roading Infrastructure and provision of alternatives to driving

3.4 Encourage the most appropriate mode of freight transport. This is being addressed in part by MOT through, for example a review of national freight and logistics issues from 2004 onwards.

3.5 Improve road alignment, gradient and traffic flow measures to reduce congestion and minimise emissions. This is largely the responsibility of Land Transport NZ, Transit NZ, the road controlling authorities and MOT.

CHAPTER EIGHT: CANDIDATE INITIATIVES

Table 11 lists both the new initiatives that were identified during the course of this study and projects that Government has currently underway, as identified by the Climate Change Office.

Table 11: Energy efficiency initiatives

Target	**Description**	**Comments**	**Current Govt work programme** Key Government agencies involved	**New initiatives** Key Government agencies
Fuel supply and storage	Improve fuel quality • sulphur content • on-site storage	• fuel standards / govt agreements • information on fuel testing and good storage procedures	MED (Fuel standards review) MOT (related vehicle stds) CCO (Neg with NZ Refinery)	EECA (fuel storage guidance)
Transport operators	Fuel consumption monitoring and management	• information on fuel monitoring • improve fuel monitoring services (e.g. improvements to fuel card scheme) • case studies • encourage support services such as the NRC cost model and free-cargo.		EECA Land Transport NZ
	Improved logistics and vehicle utilisation	• information • case studies		EECA Land Transport NZ MOT
	Adoption of best practice	• development of industry standards and key performance indicators • advisory services		EECA Land Transport NZ OSH
	Fuel tax and RUC	Review the balance between fuel tax and		MOT

		Road User Charges to ensure the correct signals are sent to operators (ideally cost neutral)		
Vehicles	Vehicle specification and purchase	• information and guidance on specifying new vehicles and energy saving options • whole of life costs including when to replace older vehicles • monitoring of new technologies and barriers to their application • training for purchasers and maintenance providers		EECA MED Land Transport NZ MOT MfE
	Vehicle maintenance	• information on maintenance management including VMRS and other maintenance tracking schemes • awareness raising of the need to maintain tyre pressures • development of maintenance key performance indications and best practice for workshops • support for driver daily vehicle inspection • improved vehicle inspection		EECA Land Transport NZ
	Fuel pricing and charges	• fuel pricing • road use charges (e.g. RUC and e-RUC) • urban congestion charges	CCO IRD Customs The Treasury MOT Transit NZ Local Government	
	Biodiesel	• biodiesel pilot scheme	EECA MED MOT MfE CCO	

	New technologies and fuels	• review and support the adoption of new technologies and fuel advances		MED EECA
	Emission standards	• vehicle emission standards based on European and North American developments		MOT Land Transport NZ
	Emission screening of existing vehicles	• emission testing during COF inspection (especially particulates) • emission testing of second hand imported vehicle	MOT Land Transport NZ EECA	
	Mass and dimensions	• heavy vehicle limits reviews	MOT Transit NZ Land Transport NZ	
	Provide for the appropriate infrastructure including road, rail and shipping	• improvement in road alignment, gradient and traffic flows • encourage most appropriate mode of freight transport	Land Transport NZ Transit NZ	MED MOT
Drivers	Driver education	• improve training for drivers on fuel efficient driving • awareness raising on fuel efficient driving e.g. through the trade magazines • fuel efficient driving schemes (could include rewards and incentives)		EECA Land Transport NZ
	Speed	joint industry/Land Transport NZ and Police strategies for managing driver speed	Land Transport NZ MOT NZ Police	
	Industry – government partnerships	• awareness raising through publications, training, industry conferences, roadshows etc. • development of a scheme similar to		EECA MfE

		the Australian Greenhouse challenge and US Smartway programmes		
Users of transport services	Information for the users of transport services on how they affect fuel use, safety and transport costs	This could include: • case studies • improvements to contract key performance indicators • assistance with improving logistics, e.g. inwards and outwards goods opening hours and procedures		EECA Land Transport NZ
	Government use of transport services	• Govt agencies and local authorities use good quality, audited transport providers		EECA MED MOT MfE
Information and innovation	Research support	• benchmarking • research on transport logistics and vehicle utilisation • best practice and key performance indicators • barriers to the adoption and adaptation of new technologies • new technologies • identify the underlying factors that affect transport efficiency and safety • biodiesel and other alternative fuels • driver behaviour • organisational change • relationship between road design and energy consumption		MOT EECA MfE MED Land Transport NZ

Of note is the involvement of a number of different Government agencies in each initiative as shown in Table 12.

Table 12: Multiple agency contributions

	EECA	LTNZ	MOT	MfE	MED	CCO	OSH	Transit NZ	Treasury	IRD	Customs	Other
Improve fuel quality	√		√		√	√						
Fuel consumption monitoring/management	√	√										
Improved logistics and utilisation	√	√	√									
Adoption of best practice	√	√					√					
Fuel surcharge, RUC etc.			√									
Information to assist vehicle purchasers	√	√										
Vehicle maintenance	√	√										
Fuel pricing and charges			√			√		√	√	√	√	Local govt
Biodiesel pilot scheme	√		√	√	√	√						
New technologies and fuels	√				√							
Vehicle emission standards		√	√									
Emission screening of existing vehicles	√	√	√									
Mass and Dimensions		√	√					√				
Infrastructure		√	√		√			√				
Driver education	√	√										
Speed		√	√									Police
Industry – govt partnership	√	√		√								
Information for the larger transport users (e.g. supermarkets)	√	√										
Government use of transport	√		√	√	√				√			
Research support	√	√	√	√								

CHAPTER NINE: RECOMMENDATIONS

A number of Government initiatives are currently underway that will affect the energy efficiency of heavy vehicles. This includes road pricing measures such as e-RUC, improving fuel quality, the biodiesel trial scheme and the review of heavy vehicle limits. These measures are generally regulatory in nature, for example, fuel and vehicle standards, mass and dimensions limits and the enforcement of speed. Given that the transport industry is strongly influenced by regulation in how it behaves, this regulatory focus has to be part of the package. However these measures on-their-own will be insufficient to halt the increase in the fuel consumed by the freight transport sector. The energy used by this sector is expected to double within 15 years based on current trends.

The greatest gains in energy efficiency are likely to be thorough advances in vehicle technology that will result from, for example, the US 21st Century Truck programme and the various European and Japanese initiatives.

However improvements are also required at the transport operator level if the advances in vehicle technology are to be captured. This includes ensuring that the best vehicles are selected in terms of technology and for the task, drivers practice energy efficient driving techniques, route selection and logistics are efficient and vehicles are well maintained. There is little new Zealand can do in terms of developing new truck technologies but much can be done at an operator level especially given the differences in the fuel used by good versus poor drivers and the effect vehicle selection and maintenance has on fuel consumption.

Many of the operator-based initiatives involve information dissemination and research. They include the development and dissemination of information on:

- improving fuel monitoring
- awareness raising of the ways in which transport operators can achieve fuel savings
- assisting transport operators with the purchase of new fuel-efficient vehicles
- the adoption of industry codes and best practice
- improving vehicle maintenance
- fuel-efficient driver training
- benchmarking
- improving logistics and vehicle utilisation
- overcoming the barriers to the adoption of new technologies

It is recommended that EECA and Land Transport introduce new initiatives that encourage transport operators to become more energy efficient. Such initiatives are likely to result in short to medium term gains. Other jurisdictions have already introduced similar packages, for example the UK Road Haulage Modernisation Fund and the Energy Savings Trust. In Canada the Federal Office of Energy Efficiency runs the Fleetsmart and Smart Driver Programmes.

The main elements of an operator focused programme should include:

- Energy efficient driver training
- Increasing awareness and skills amongst operators in how to monitor and minimise fuel consumption. This could be through the development of a package of that

includes case studies, fuel management guides and other material similar to that produced by the UK Transport Energy Best Practice programme.
- Freight logistics reductions in freight travel demand.

Of importance will be ensuring the transport industry is on-board and this can best be achieved through the involvement of the industry associations, especially the Road Transport Forum NZ, Road Transport Association, National Road Carriers, the Institute of Road Transport Engineers NZ and the trade magazines, NZ Trucking, and Truck and Driver.

Energy savings of 10% to 15% p.a. (4.2 PJ to 6.2PJ p.a.) should be able to be achieved from an information-based package given that differences in driver behaviour alone can result in variations of up to 35% in the amount of fuel used and considerable savings can be achieved through improved maintenance and other measures. The UK SAFED driver development programme which was funded by the Road Haulage Modernisation Fund resulted in a short term saving in fuel use of 9.4% and an expected long-term saving of at least 4.5%. A similar scheme in Canada, Fleetsmart, found that one of the smaller transport operators (< 20 prime-movers) that participated in the programme achieved a minimum fuel saving of 15% in the first year of operation. Further savings will result from the other elements of an operator-based initiative.

The only initiatives that have been introduced in New Zealand recently aimed specifically at improving the energy efficiency of the road transport sector are the "Energy Efficiency Ways" toolkit prepared for the Energy Federation of New Zealand and the Vehicle Selection Guide prepared for Land Transport NZ. These are steps in the right direction but are only a small part of what is required to inculcate an energy efficiency culture in the road transport sector.

It is recommended that EECA proceed with the third stage of this project which is to prepare a detailed business case for the adoption of the most promising initiatives. It is recommended that the business case should include energy efficient driver training and assistance for transport operators based on the UK Transport Energy Best Practice, Canadian Fleetsmart and the US Smartway Partnership programmes. It will also need to consider the wider objectives specified in the New Zealand transport Strategy.

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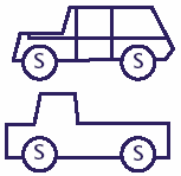
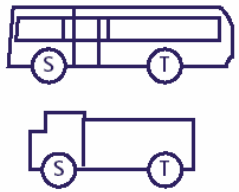
Appendix A RUC (ROAD USER CHARGES) VEHICLE TYPES

Powered Vehicles

No. of Axles	Types of Axles	Example Vehicles	Vehicle Type No.
2	2 axles, both single tyred		1
	2 axles, 1 single tyred and 1 twin tyred		2
	Any other configuration		1
3	3 axles, one single tyred and two twin tyred		6
	Any other configuration		5
4	Any configuration		14
5 or more	Any configuration		19

Unpowered Vehicles

No. of Axles	Types of Axles	Example Vehicles	Vehicle Type No.
1	Any configuration		24
2	2 spaced axles, both single tyred		27
	1 group of 2 close axles, both twin tyred		29
	2 spaced axles, both twin tyred		30
	Any other configuration		28
3	1 group of 3 close axles all twin tyred		33
	Any other configuration		37
4 or more	Any configuration		43

Appendix B FLEETSMART CANADA – CASE STUDIES

B.1 Bison Transport - Winnipeg, Manitoba

Bison Transport is a rapidly growing truckload carrier headquartered in Winnipeg, Manitoba, with terminals in Calgary, Alberta, and Mississauga, Ontario. In Canada, Bison operates from Quebec to British Columbia. It also operates in each of the 48 continental U.S. states. It currently has a fleet of 550 power units and a trailer fleet of 1100 fifty-three-foot trailers, including air-ride and logistics vans, heated trailers and regular dry vans.

Bison currently employs 700 drivers and 1000 people in total. The company has expanded rapidly over the past several years; in 1991, the company had a fleet of 18 tractors with 32 employees. Bison also operates over 37 160 m² (400 000 square feet) of warehouse and distribution space in Winnipeg.

In 2001, the company was chosen as one of Canada's top 50 best-managed private companies, making it a repeat winner of this award. In 2000, Bison Transport received the National Fleet Safety Award and the Fleet Management Award from Natural Resources Canada's FleetSmart for its energy management and greenhouse gas emissions reduction program.

Fuel economy has long been a priority with Bison. Its current fuel economy is 36.7 litres per 100 km (7.7 mpg), making it one of the top fleets for fuel economy in the country.

Fuel Economy Program

Downloading engine reports, reviewing results with drivers and posting the results for drivers to see have been an integral part of Bison's fuel economy program for several years. Specific areas for improvement were also reviewed with the drivers. During their four-day orientation program, drivers receive two hours of training on fuel-efficient driving techniques using the Natural Resources Canada's SmartDriver program. Further individual coaching has been provided as required for drivers with lower fuel economy. Over the past several years, all new tractors have been spec'ed with in-dash fuel economy readouts so drivers can note their fuel economy instantaneously as they are driving. Drivers have found this real-time report of fuel economy to be a useful tool for improving their fuel economy.

About two years ago, the company pilot tested in-cab heaters. The pilot test showed that the heaters would have a payback period of two years on fuel savings alone, not including savings on engine life and maintenance costs. The company now has in-cab heaters installed in all of its trucks. Although specific numbers are not available, fleet idling time has reduced considerably since the addition of the heaters. Drivers are allowed to idle their engines overnight when the temperature drops to -20°C or lower. Jon Sigurdson, Fuel Manager at Bison, explains, "We don't want to take a chance on the truck not starting."

Satellite Communications

To further improve its operating efficiency and customer service, the company recently added satellite communication and on-board computer capabilities to each power unit. This has allowed Bison to improve the accuracy and timeliness of its fuel economy data. Mr.

Sigurdson notes, "We were not in a position to download engines on some of our units on a frequent basis. Some units could only be downloaded every second or third month. With the new system, we download every unit weekly. As a result, our fuel economy reports for each month truly reflect that month's results, not a mixture of results from several months."
Many other efficiencies have been realized with the satellite tracking. Mike Ludwick, Vice-President Information Systems, notes that satellite tracking has reduced the time that drivers need to spend on the phone to provide routine information such as location, logbook hours and basic dispatch information (clients address, spelling names, how to get there, etc.). This saves a lot of time for both the driver and the fleet coordinator. That time is now spent on managing people. For example, more time can now be spent interacting with drivers in setting up loads, home time, hours of service, etc.

Mr. Ludwick notes other benefits from the system. "Driver retention has improved and vehicle use is up. Our long distance phone bills have been reduced. Overall, our operation is more efficient. Customer service has improved. In fact, our clients can now go to our Web site to determine the exact status of any of their shipments. Going without the satellite system is simply not an option for us any more."

The computer system has been combined with the Bison Web site to improve customer service. Bison's latest on-line tool is i-View, a system that allows clients to view on-line PODs (proof of delivery) and other shipping documents for their shipments. Bison scans the documents into the system, and it is immediately available for clients to view, print, e-mail, etc.

Fuel Economy Goals

Not resting on its laurels, Bison is now focusing on improving its fuel economy. Mr Sigurdson, who has five years of experience with the company, was recently appointed to the newly created position of Fuel Manager. The company has also formed a fuel management committee that includes members of the executive and management teams. This committee meets once a month. A smaller working committee, which includes the Vice-President Finance and Administration, the Vice-President Information Systems and Mr. Sigurdson, meets once a week.

Mr. Sigurdson's first priority was fuel purchasing. He set up a fuelling network in the United Sates and Canada under a card lock program that allows the drivers to fuel up at strategic locations. Before, the driver could fuel up anywhere. "This program is saving us a lot of money," he notes. "We buy 40 million litres of fuel a year, even a saving of one cent per litre means a saving of $400,000 annually."

Even with the improvements in operating efficiency and fuel economy that the company has achieved in recent years, it is looking for further improvement. "Each improvement of 0.5 litres per 100 km (0.1 mpg) reduces our fuel bill by about $280,000 a year," notes Mr. Sigurdson. "That is a strong incentive to improve fuel economy. We believe we can improve our fleet fuel economy by at least another 2.2 litres per 100 km (0.5 mpg)."
This will be accomplished through a number of initiatives. A new fuel economy reporting system, developed by Mr. Sigurdson, provides a monthly summary of fuel use by vehicle including fuel economy, total fuel consumed, fuel consumed while idling, cost of fuel consumed while idling and average vehicle speed. He reviews these reports carefully to

determine where improvements can be made. This information can also be used to guide vehicle purchasing as the most fuel-efficient vehicle types for Bison's operations are identified. They can also be used as input for developing company programs aimed at improving fuel economy, such as an anti-idling program. For example, Mr. Sigurdson is aware that a large portion of Bison's idling time occurs in the summer, when the engine idles to keep the cab air conditioned. He is now beginning to look at in-cab cooling systems.

Fuel Economy Incentive Program

As another initiative, the company is now completing the successful pilot testing of a fuel economy incentive program that it expects to have fully operational in early 2002. The on-board computer and satellite communication system makes such a program feasible for Bison as it provides the data necessary to drive the available program on a timely and accurate basis. The on-board system tracks by driver. This is a critical point for Bison because it does a lot of slip seat operations, which means more than one driver uses a specific truck. With the new system, it can pinpoint a driver's performance no matter what unit the driver operates or who else operates it.
Using historical fuel economy data, the company has established a fuel efficiency benchmark for each of the five tractor types in its fleet. If drivers exceed this target for a three-month period, they receive a financial bonus. The more they exceed the target, the larger the bonus. Every driver is eligible for the bonus as long as the target is met. The target has been set so that a certain percentage of drivers already exceed the benchmark.
"We pay the bonus every three months. This allows the variations in fuel economy due to weather, load factors and routes to even out somewhat," explains Mr. Sigurdson. He also notes a change in driver attitude with the pilot incentive program. Drivers are now asking how they are doing because the program gives them the motivation to improve.

Driver Training

Bison is also sharpening its focus on improved driver training in fuel-efficient driving techniques. "While components of SmartDriver will continue to be used, the training will also include vehicle specific instructions in maximizing fuel economy. Our driver training will now be specific to each of our truck types. For example, instruction will now cover proper shift points for each type of truck we have in the fleet," notes Mr. Sigurdson. Fuel economy tips are now being included with pay envelopes. At present, these are general tips that apply to each vehicle type. In the future, he hopes these tips will be specific for each driver.

As with most fleets, Bison experiences a difference of up to 12 litres per 100 kilometres between its most and least fuel-efficient drivers. Mr. Sigurdson wants to reduce this gap. As a result, increased training and coaching efforts are being concentrated on the one third of drivers who have the poorest fuel economy. He is personally coaching about 35 drivers and meeting with them at least once per month to review their fuel economy and vehicle performance reports. Before meeting with a driver, he is careful to make sure that a lower fuel economy is not due to a mechanical problem.
One of the key reports that Mr. Sigurdson uses to review fuel economy performance with a driver is a standard output from the on-board computer system. This report identifies the amount of time a driver spends at combinations of vehicle speed and engine rpm levels. The

report quickly identifies idle time and if a driver is revving the engine too high for the vehicle speed and therefore adversely affecting fuel economy.

The Bottom Line

For Bison Transport, improving fuel economy is good for the company's bottom line and the environment. The targeted improvement of 2.2 litres per 100 kilometres (0.5 mpg) in fuel economy would save the company buying 2.7 million litres of fuel a year, reducing the company fuel bill about $1.4 million. Greenhouse gas emissions would be reduced by about 7000 tonnes a year.

B.2 Terra Nova Transport - Petitcodiac, New Brunswick

Terra Nova Transport is a Less-Than-Truckload carrier operating out of Petitcodiac, New Brunswick. It began in 1983 and currently operates a fleet of 19 tractor-trailers and two straight trucks. Originally a livestock hauler, Terra Nova Transport became a dry-vans-only operation in 1995.

With a terminal in Brampton, Ontario, the company operates mainly in a triangular service area, from the Maritimes to the Eastern Seaboard of the United States, to Ontario and back into the Maritimes. It also does runs to California, Florida and Texas in the U.S.
With the rapidly rising diesel fuel prices experienced in the late 1990s, the company needed to improve its fuel economy. Two major steps were taken. First, the company started keeping records of fuel economy by vehicle. Secondly, using the SmartDriver program information from FleetSmart, it initiated a fuel economy incentive program. With these initiatives, the company has substantially improved its fuel economy.

The Fuel Economy Program

While specific numbers for 1999 are not available, Darlene Corey, who administers the program for Terra Nova Transport, estimates that fuel economy has improved by at least 15 percent since the program was introduced. Fleet fuel economy was 39.2 litres per 100 kilometres (7.2 mpg) in 2000. It has improved even further in 2001 to 38.2 litres per 100 kilometres (7.4 mpg).

"We also track fuel prices and let the drivers know where they can get the best price for their fuel. Before, drivers filled up at any station that we have an account with. Now they get their fuel where they can get the best price. This has reduced our fuel costs by about 2.2 cents per litre."

Administrative costs for the incentive program are low. Ms. Corey uses a spreadsheet to track the distance driven by a unit and the amount and cost of the fuel purchased. Data are entered from the driver's trip reports. Data entry is usually done every day to keep records current. In total, this takes about two hours per week. Completing the fuel economy summary data, which is done every three months, takes about one day.

The fuel economy incentive program was initiated in January 2000. Although some drivers responded immediately, about half of the drivers responded after the first year of the program. This response is consistent with typical incentive programs.

Keeping Drivers Informed

One of the keys to the success of the program has been keeping drivers well informed so they know exactly what their fuel economy performance has been and, therefore, what they need to do to reach the incentive target. Drivers are provided with a copy of their fuel economy results each month, the fleet average fuel economy and the results for each of the other drivers. A congratulatory note is sent to each winner. The company's monthly newsletter also has reminders about the program.

The Incentives

To date, the company has used a different incentive for each quarter to help stimulate interest in the program. These incentives are described in Table 1.

Table 1: Incentives

Time frame	Incentive target	Payment	Number of drivers receiving rewards
January - March 2000	Post the best fuel economy	1st place - $200 2nd place - $100	2 (maximum number of drivers who could win)
April - June 2000	Lowest cost per mile* Achieve over 35.3L/100km (8.0 mpg)	1st place - $500 2nd place - $300 $100	2 drivers No winners
July - September 2000	Beat the boss on average cost per mile Increase previous 3-month-average fuel economy · 2.00 to 3.99% · 4.00 to 5.99% · 6.00 to 7.99% · 8.00 to 9.99% · 10.00% and up	$200 $100 $200 $300 $400 $500	6 of 11 drivers received bonus
October - December 2000	Beat the boss on cost per mile Be within 0.5 mpg of the boss and 0.03 cents per litre of the boss's fuel cost	$200 $300	2 drivers received bonus
January -	Match or exceed your 3-	0.00 to 0.24 mpg	6 of the 12 eligible

March 2001	month-average fuel economy based on January, February and March 2000	-$100 0.25 to 0.49 mpg - $200 0.50 or over mpg - $300	drivers received the award
April - June 2001	Match or exceed the fleet average for April, May and June of 2000	0.00 to 0.24 mpg -$100 0.25 to 0.49 mpg - $200 0.50 or over mpg- $400	8 of the 15 eligible drivers received the award
July - September 2001	Match or exceed your personal 3-month-average fuel economy based on July, August and September 2000	0.00 to 0.24 mpg -$100 0.25 to 0.49 mpg - $200 0.50 or over mpg- $400	10 of the 15 eligible drivers received the award

* Lowest cost per mile is a combination of fuel economy and price paid at the pump.

Table 2: Fuel Economy

Time frame	Fuel economy				
	2000		2001		Percent improvement in fuel economy over previous year
	L/100km	mpg	L/100km	mpg	
January - March	42.7	6.62	41.4	6.83	+ 3.1%
April - June	38.2	7.39	37.2	7.59	+ 2.7%
July - September	36.7	7.70	36.1	7.82	+ 1.7%
October - December	40.1	7.05	N/A	N/A	
Average for year	39.4	7.18	N/A	N/A	

The Bottom Line

"We have certainly improved our fuel economy by at least one mile per gallon," notes Ms. Corey. "Given the size of our operations, this means a saving of 180 000 litres of fuel per year, or nearly $100,000." Greenhouse gas emissions reductions would be 470 tonnes per year.

Appendix C AUSTRALIAN GREENHOUSE CHALLENGE - SUCCESS STORIES

C.1 Bunker Freight Lines Pty Ltd

Commitment to Performance

Transport company Bunker Freight Lines is improving the fuel efficiency and performance of its fleet - and reducing its total greenhouse gas emissions - through regular updates of vehicle engine technologies.

The company's 80 prime movers and 250 trailers travel more than 30 million kilometres each year, making it one of Australia's largest long distance linehaul operators. Based in Victoria, the privately owned company also has depots in Queensland, New South Wales, South Australia and Western Australia to repair and service its fleet, and employs 200 staff.
Since 1988, Bunker Freight Lines has been actively involved in monitoring the fuel efficiency and emission output of its fleet through productivity improvement programs. Through joining the Greenhouse Challenge in 1999, the company has put additional measures in place to enhance its productivity and reduce its environmental impact.
Mr Ron Bunker, Managing Director of Bunker Freight Lines, is committed to continuously improving vehicle fuel economy and reducing greenhouse gas emissions. "Bunker Freight Lines staff have worked hard to improve the company's operational efficiencies, and Greenhouse Challenge has helped us find innovative ways to address both operational and environmental issues," he said.

Keeping greenhouse in check

Today the company is using a greater number of large prime movers and trailers, which have the advantage of carrying more freight and travelling longer distances while constraining the growth of greenhouse gas emissions.
The proportion of B-Double trailers in the Bunker Freight Lines fleet has grown to 62 per cent to supply the growing B-Double market. About 31 per cent of vehicles are now road trains. Fleet upgrades have allowed the configuration of most vehicles to be changed as needed from B-Double to road train, with 92 per cent of the fleet now capable of the dual role.
The challenge for Bunker Freight Lines has been to achieve efficiencies in its fleet by carrying more tonnes of freight per litre of fuel consumed, thus reducing its CO_2 emissions per tonne of freight carried.
In 1998 the company's fleet travelled more than four times further than in 1994, but with an increase in fuel economy and more tonnes of weight carried per litre of fuel, CO_2-equivalent emissions remained steady.
From 1998 to 1999, Bunker Freight Lines decreased its emissions from 34,641 to 34,009 tonnes of CO_2-equivalent. The company expects the levels of CO_2 emissions to reduce further in 2000 with the replacement of 42 per cent of its fleet with vehicles made according to best practice vehicle and engine design specifications.
The company is working to achieve further savings in emissions and fuel consumption by introducing innovative design in prime movers and aerodynamic packages on trailers.

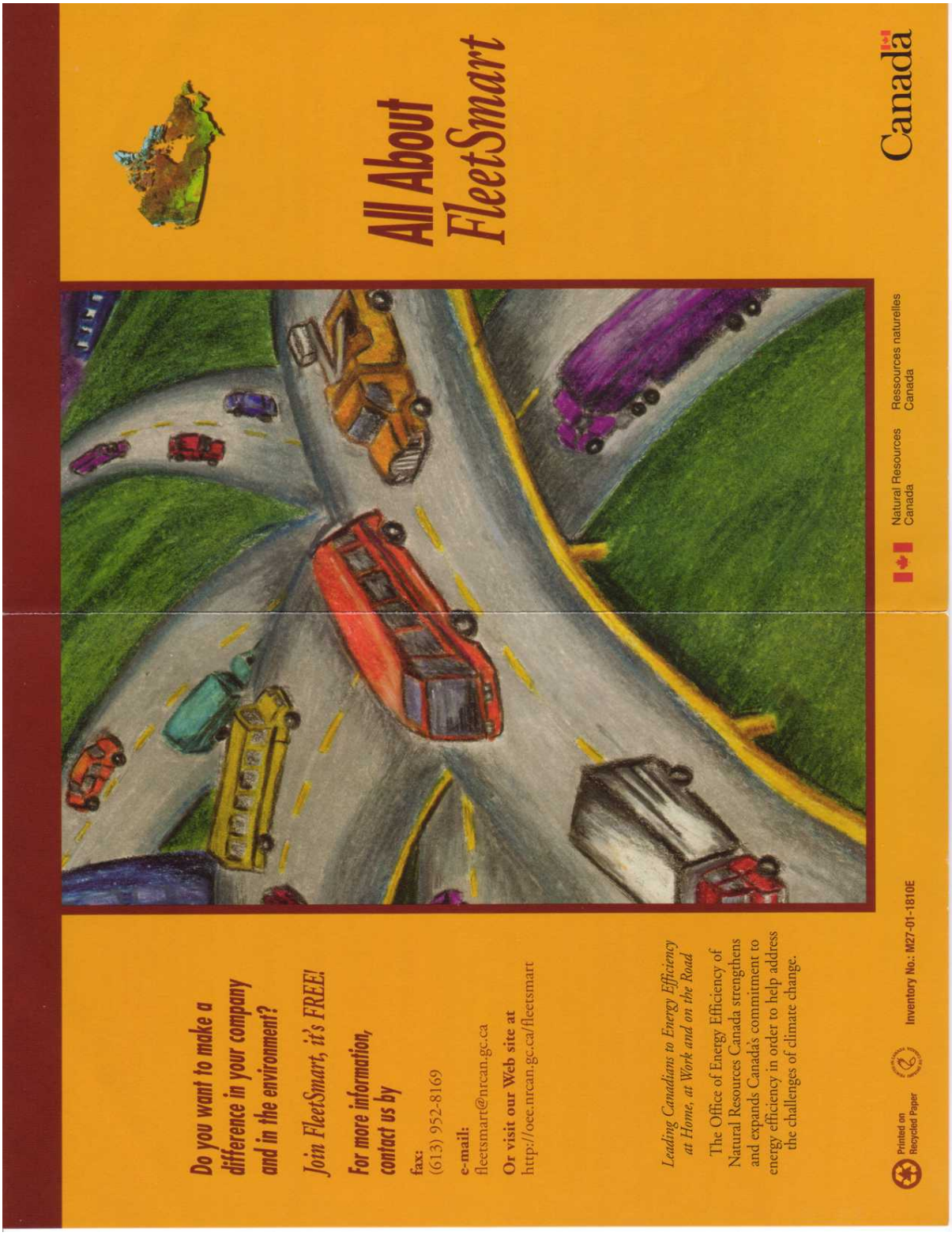
R & D

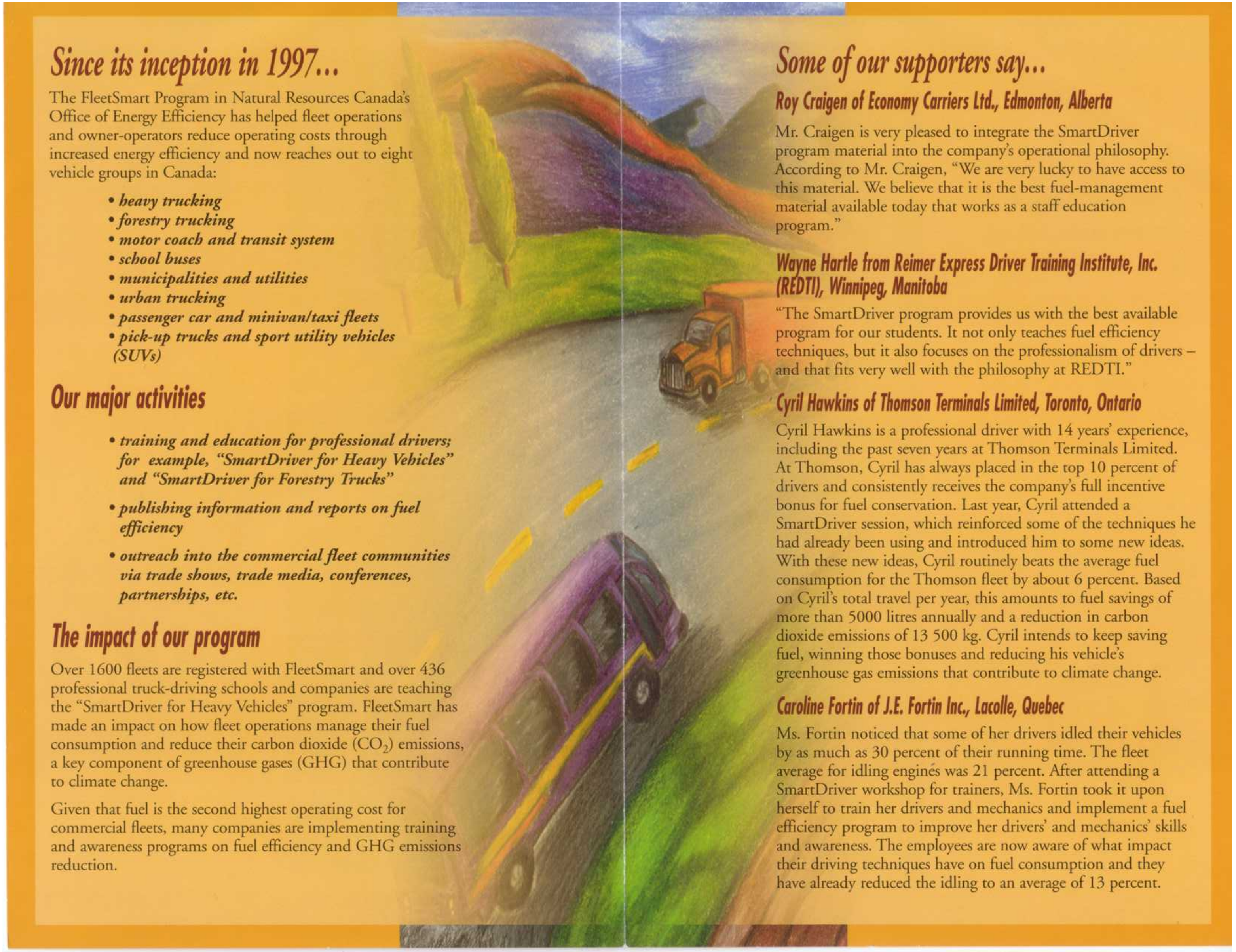
Bunker Freight Lines is undertaking research and development to improve the vehicle performance of its fleet. Working with trailer designers and engineers, Bunker is aiming to introduce its own trailer design to enhance fuel efficiency and vehicle performance.
With air turbulence and tyre drag proven to be major causes of extra fuel usage, measures such as skirts on trailers and different tyre treads will be trialled and tested for efficiency gains. Bunker Freight Lines will also be examining new designs to reduce the air turbulence that occurs within two-trailer configurations such as road trains and particularly B-Doubles.
As part of its commitment to continuous improvement, Bunker Freight Lines also regularly reviews and tests new quality lubricants and coolants to assess the major fuel benefit claims from different manufacturers and to ensure its fleet is operating at optimum efficiency.

Capturing new developments

Bunker Freight Lines, since joining the Greenhouse Challenge, has invested more than five million dollars in equipment and systems to improve the productivity of its operations. Some of these initiatives have included upgrading vehicles to the latest design and technology.
With new vehicle and trailer designs, workshop staff work programs will be streamlined for better productivity. Less time is to be spent on greasing outdated drive line designs, and changing engine oil and filters, allowing for greater concentration on important maintenance programs.
Bunker Freight Lines believes that future prime mover and trailer designs will play a major role in increasing economy in the fleet, and plans to continue the company's ongoing replacement program.

Appendix D CANADIAN FLEETSMART MATERIAL





Since its inception in 1997...

The FleetSmart Program in Natural Resources Canada's Office of Energy Efficiency has helped fleet operations and owner-operators reduce operating costs through increased energy efficiency and now reaches out to eight vehicle groups in Canada:

- *heavy trucking*
- *forestry trucking*
- *motor coach and transit system*
- *school buses*
- *municipalities and utilities*
- *urban trucking*
- *passenger car and minivan/taxi fleets*
- *pick-up trucks and sport utility vehicles (SUVs)*

Our major activities

- *training and education for professional drivers; for example, "SmartDriver for Heavy Vehicles" and "SmartDriver for Forestry Trucks"*
- *publishing information and reports on fuel efficiency*
- *outreach into the commercial fleet communities via trade shows, trade media, conferences, partnerships, etc.*

The impact of our program

Over 1600 fleets are registered with FleetSmart and over 436 professional truck-driving schools and companies are teaching the "SmartDriver for Heavy Vehicles" program. FleetSmart has made an impact on how fleet operations manage their fuel consumption and reduce their carbon dioxide (CO_2) emissions, a key component of greenhouse gases (GHG) that contribute to climate change.

Given that fuel is the second highest operating cost for commercial fleets, many companies are implementing training and awareness programs on fuel efficiency and GHG emissions reduction.

Some of our supporters say...

Roy Craigen of Economy Carriers Ltd., Edmonton, Alberta

Mr. Craigen is very pleased to integrate the SmartDriver program material into the company's operational philosophy. According to Mr. Craigen, "We are very lucky to have access to this material. We believe that it is the best fuel-management material available today that works as a staff education program."

Wayne Hartle from Reimer Express Driver Training Institute, Inc. (REDTI), Winnipeg, Manitoba

"The SmartDriver program provides us with the best available program for our students. It not only teaches fuel efficiency techniques, but it also focuses on the professionalism of drivers – and that fits very well with the philosophy at REDTI."

Cyril Hawkins of Thomson Terminals Limited, Toronto, Ontario

Cyril Hawkins is a professional driver with 14 years' experience, including the past seven years at Thomson Terminals Limited. At Thomson, Cyril has always placed in the top 10 percent of drivers and consistently receives the company's full incentive bonus for fuel conservation. Last year, Cyril attended a SmartDriver session, which reinforced some of the techniques he had already been using and introduced him to some new ideas. With these new ideas, Cyril routinely beats the average fuel consumption for the Thomson fleet by about 6 percent. Based on Cyril's total travel per year, this amounts to fuel savings of more than 5000 litres annually and a reduction in carbon dioxide emissions of 13 500 kg. Cyril intends to keep saving fuel, winning those bonuses and reducing his vehicle's greenhouse gas emissions that contribute to climate change.

Caroline Fortin of J.E. Fortin Inc., Lacolle, Quebec

Ms. Fortin noticed that some of her drivers idled their vehicles by as much as 30 percent of their running time. The fleet average for idling engines was 21 percent. After attending a SmartDriver workshop for trainers, Ms. Fortin took it upon herself to train her drivers and mechanics and implement a fuel efficiency program to improve her drivers' and mechanics' skills and awareness. The employees are now aware of what impact their driving techniques have on fuel consumption and they have already reduced the idling to an average of 13 percent.


OEE
Office of Energy Efficiency
FleetSmart Program
FleetSmart Products
Take the High Road to Bigger Profits
Natural Resources Canada
Ressources naturelles Canada
Office of Energy Efficiency
Office de l'efficacité énergétique
Canada
All About FleetSmart
The FleetSmart program of Natural Resources Canada helps fleet managers improve performance and reduce operating costs through increased energy efficiency. Managers receive information on energy management in vehicle spec'ing, maintenance, driving practices and the latest new technologies to help keep fleets competitive.
FleetSmart Toolkit
This Toolkit will show you how to develop an energy management plan. It examines each of the main strategies for reducing fuel use, contains sections in which readers can insert upcoming FleetSmart information products, and tells you where you can get more information on energy efficiency and alternative transportation fuels. Success stories and case studies are also available.
FleetSmart Tool Kit
Profiles
SmartDriver for Heavy Vehicles
This training program has five components: an instructor's guide, a video, an interactive fuel-efficiency game, overheads on a CD-ROM and a booklet for trainees titled What Every SmartDriver Should Know. Together, they provide a comprehensive training course on fuel-efficient driving skills. The course is fun and easy to use for all levels of drivers – from entry level to experienced. Offer this course to your drivers and see immediate results!
Guide
Heavy Vehicle Fuel Consumption Calculator
This fuel economy calculator for heavy vehicles is a handy tool to keep in your cab to calculate your fuel consumption while you are on the road.
Owner-Operators Focus on Success
FleetSmart has published a series of success stories entitled Owner-Operators Focus on Success. Discover how these owner-operators have reduced their fuel consumption and fuel costs.
Reports
Fuel Efficiency Benchmarking in Canada's Trucking Industry
This publication reports on a national survey on highway truck fuel economy that gathered data on 42 private and for-hire fleets based in Canada.
Technical Evaluation of Automatic-Type Transmissions for the Heavy Truck Market
The FleetSmart program has commissioned a study that compares the benefits and disadvantages of automatic transmissions to those of manual transmissions.
SmartDriver for Forestry Trucks
This new training program is designed for the forest industry trucker and is modelled after the SmartDriver for Heavy Vehicles training program. There is also a CD-ROM that offers drivers the opportunity to learn from the SmartDriver training program on their own time using a personal computer. Available for PC or Macintosh. This self-directed study version is the perfect alternative for drivers who cannot attend a training session.
Idling Gets You Nowhere
Unnecessary idling is expensive and causes environmental damage. This booklet examines the question "to idle or not to idle?" A companion poster is available to help you promote awareness of idling within your fleet.
All materials are available free of charge once you are registered with FleetSmart. In order to obtain your registration form, please fax us at (613) 952-8169
or
reach us by e-mail at fleet.smart@nrcan.gc.ca
OEE
Office of Energy Efficiency
Office de l'efficacité énergétique

Appendix E IRTENZ CONFERENCE PRESENTATION 13 – 15 JULY 2004

Strategies for reducing fuel consumption

Nick Sargent
Senior Advisor Transport
EECA

Petter Baas
Managing Director
TERNZ

15 July 2004

Overview of EECA

Crown entity

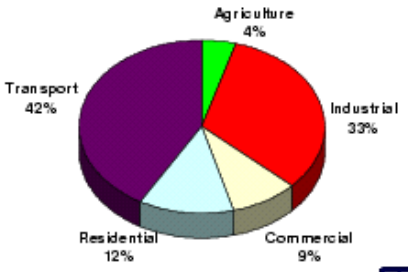
To encourage, promote and support:

- energy efficiency
- energy conservation
- use of renewable sources of energy

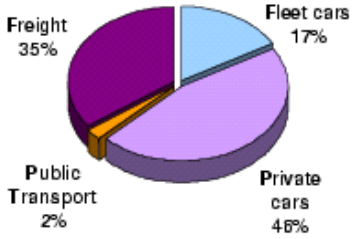
Implementation of the National Energy Efficiency Strategy (NEECS)

- 20% improvement in energy efficiency
- 30PJ of renewable energy

New Zealand's energy use



Transport energy use



Freight transport energy use

Why is government concerned about energy efficiency

Inefficient energy use is bad for the economy

Kyoto protocol target

Vehicle emissions of concern to public health and the environment

Project Outline

EECA commissioned the Heavy Vehicle Fuel Efficiency project to:

- Provide up-to-date information on the heavy vehicle fleet
- Review potential energy saving technologies and practices
- Review energy saving initiatives used overseas
- Develop a set of initiatives that Government could introduce

Emphasis on encouraging voluntary adoption

Heavy Vehicle Fuel Efficiency Project

Peter Baas
Managing Director
Transport Engineering Research New Zealand Ltd

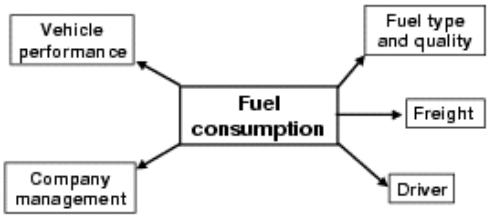
Main Points

A 10% saving in fuel could typically increase profitability by 15% to 35%

Very few operators monitor fuel consumption

If you can't measure it, you can't manage it

Factors affecting fuel consumption



Driver

Difference in fuel consumption between good and poor drivers:

- Up to 35% difference (US Technology & Maintenance Council)
- Up to 12 litres per 100km (Canadian study)

Differences due to:

- Speed
- Gear ratios (engine rpm)
- Gear change points
- Engine idling

Speed

A reduction of 8 km/h in average speed can result in a 10% - 15% fuel saving

Reduction in speed also improves safety

Cruise control provides savings of up to 6% if used properly. Lower peak speeds but little difference in trip time

Adaptive cruise control expected to be on 14% of trucks in US in 2004

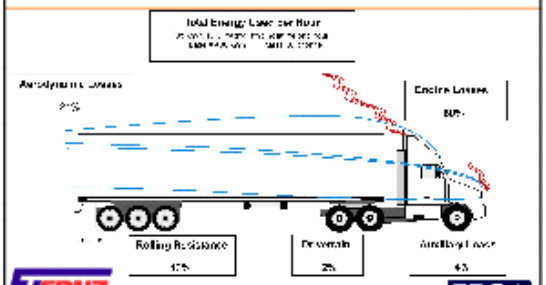
Air-conditioning

Air-conditioning increases fuel consumption by 3% to 4%

Open windows also increase fuel use

Best to use in-cab ventilation system if possible

Vehicle



Aerodynamic losses

Item	Potential Savings
Cab roof deflectors (Williams, Simmons et al. 1981)	2 - 4%
An air dam front bumper	2 - 3%
Minimising inter-vehicle gaps (OEE Canada 1998)	2 - 5%
Smooth-side trailer	2 - 4%
Side skirts on trailers (OEE Canada 1998)	3%
Bonneted versus cab over primemovers[1]	2 cents/km

[1] The HV weights and dimensions rule has meant that cab over primemovers are used in a majority of combinations

Engines and Transmissions

Matching engine size to the required task will give the best fuel economy

Semi and fully automatic transmissions now offer as good or better fuel efficiency than standard manual transmissions

Electrification of air compressor, air conditioning and hydraulic pumps can reduce fuel consumption by 18% (US CCTP 2003)

Maintenance

Poorly tuned engine can use 50% more fuel than a well tuned one

Clogged air filter can cause a 10% increase in fuel consumption

Fuel efficient driving sig reduces maintena

Maintenance intervals on fuel consumption than distance trave

Tyres

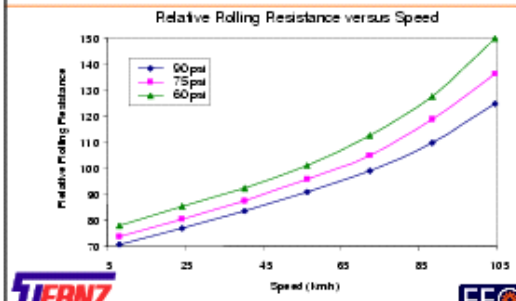
80% of tyre problems due to under-inflation

Correct tyre inflation reduces tyre wear by 15%

Flats and blowouts significantly reduced

20psi under-inflation causes 10% increase in rolling resistance and a 2% deterioration in fuel consumption

Effect of tyre pressure and speed



Industry consultation

Very few (< 1%) monitor fuel consumption on a per driver or per vehicle basis

Difficult to monitor with fuel cards

- multiple vehicles refuelled at once
- driver takes card with him
- refrigeration units etc filled when refuelling the truck
- Unaccounted fuel (UK estimates of 10%)

Consultation

Fuel efficiency seldom plays a part in purchase decisions

Difficult to influence truck purchase decisions

More important to set-up a vehicle to be low RUC than low fuel consumption, RUC typically cost 1.5 times fuel cost

Consultation

Barrier to specifying Euro 3 engines is the poor quality of NZ diesel fuel

Without mass and dimension changes will only get 8% to 10% fuel savings

Speed limiters should be set to 90 km/h

Consultation

Current driver training does not focus on fuel-efficient driving practices

Fuel challenge in NZ Trucking worked well

NRC free-cargo, a web-based load sharing and cost model programme for small operators

Main vehicle operating costs

Finance costs
Vehicle depreciation
} ***Fixed once vehicle selected***

RUC
Repairs & maintenance
Fuel
Labour
Insurance & crash repairs
} ***Variable costs***

10% saving in fuel can increase profits by up to 15% to 35%

Effect on profit

The above estimates are from overseas studies

How can you know you can't achieve similar results if you don't monitor fuel consumption?

Fuel saving is a good starting point towards "best practice"

WIN-WIN-WIN

Reduced fuel bills

Reduced maintenance costs

Reduced tyre wear

Reduced insurance premiums

Improved safety

And is good for the economy and the environment

Improving energy choices

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Appendix F ARTICLE PREPARED FOR NZ FOREST INDUSTRIES MAGAZINE

The bottom line – Fuel efficiency and profit
Harriet Palmer

"The one thing that fleet operators can do to reduce costs is to start monitoring fuel consumption, and develop ways of encouraging drivers to save fuel."

So says Peter Baas, managing director of Transport Engineering Research New Zealand (TERNZ), and joint author of a recent report for EECA (the Energy Efficiency and Conservation Agency) on strategies for reducing heavy vehicle fuel consumption.

The nature of hauling logs inevitably means the need for powerful trucks and the potential for very high fuel consumption.

"Target fuel consumption for line haul operations is around 2km per litre," says John de Pont, engineering research director at TERNZ. "In comparison, forestry vehicles probably allow 1.7km per litre on the highway, and 1.5km per litre off the highway. On average these vehicles will do anywhere between 90,000 and 130,000 km per year. They travel on difficult terrain, with a lot of low gear operation. Also, most logging is point-to-point, meaning low utilisation - typically only 50%." [50% of kilometres are travelled unladen].

TERNZ acknowledges that a whole range of factors combine to determine total fuel efficiency. While matching vehicles to task and good aerodynamic design require a more long-term approach, simple but significant factors under everyday control include good engine maintenance (a poorly tuned engine can use 50% more fuel than a well-tuned one), and maintaining correct tyre pressure.

Fuel costs are estimated to comprise 12-14% of total costs for most logging fleets, and this high fuel use means that even a small percentage saving can add up to big dollars over time. Every driver has a role to play. Monitoring of individual driver's fuel use in North America has shown that the difference between good and poor drivers' fuel consumption can be as much as 35%, or up to 12 litres of fuel per 100km. Reasons include differences in speed (an average reduction in speed of 8km/hr can reduce fuel use by 10-15%), gear ratios, gear change points, use of 'extras' such as air-conditioning, and the amount of time spent idling.

"The area where there is real scope for reducing fuel consumption is in driver training coupled with fuel monitoring" says de Pont.

And direct savings in fuel costs are just the start of the good news, it seems.

"There is a strong correlation between fuel efficient driving and maintenance costs," he continues. "What operators should be trying to do is develop a whole culture of being gentle and careful with equipment. Maintenance costs for logging trucks can be huge – typically $35,000/year."

The question of whether NZ training providers are able to deliver training in fuel efficient techniques is met with a resounding 'yes' from George Jarmulski, managing director of Master Drive. Master Drive works with drivers from some of the country's biggest logging fleets and according to Jarmulski training in fuel economy is already happening.

"We encourage operators to see training as a way to reduce overall operating costs. The training we undertake is usually structured around National Certificate modules, and we have a whole module called 'fuel economy in driving'. A driver might not necessarily recognise he is being trained in fuel economy, but it is all part of creating a professional driver."

Master Drive's operations manager, John Essex, reinforces the point.

"The number of kilometres travelled per litre of fuel is completely dependent on the skills of the driver. Much of our training is about good engine management," says Essex. "We can spend up to 14 hours in the cab with drivers, going through practical techniques – correct transmission, use of gears and so on. You might think drivers would know these things, but it's not necessarily true. Traditionally drivers were told 'there's your truck, go and drive it'. Modern trucks are very different - electronic engines, and high torque, low-revving trucks, for example, and they need different approaches to driving."

Essex also emphasises the connection between a truck that is well driven, and the reduction in fuel and maintenance costs. "If driving is done correctly, trucks work more efficiently and inevitably there is less fuel use and engine wear and tear," he says. "We find most logging operators are pro-active in wanting to save costs. Savings in fuel, repairs and maintenance usually mean that training soon pays for itself in these big fleets."

A sterling example of a large fleet operator practising what others preach in terms of fuel efficiency is Steve Murphy Logging (SML), Christchurch. The SML fleet comprises 21 logging and bulk haulage trucks, which travel a total of around 1.8 million kilometres a year. Chris Murphy is general operations manager, and he confirms that SML is serious about cost control, including fuel costs.

"Fuel makes up about 12% of our costs," says Murphy. "We have in-cab computers and carry out internal fuel reporting on a daily basis. Reporting is per driver and per truck – we have found that a 'one truck, one driver' is the way to go."

Murphy points out some of the unavoidable inefficiencies of log transport, including, in SML's case, 'a lot of stop-go stuff, and an average lead distance of 67 km, meaning drivers are often only driving for an hour at a time.' This means simply looking at fuel use does not tell the whole story of driver performance, so data is gathered daily on a range of aspects, including fuel use, tyre and maintenance costs. Monthly truck performance rating charts summarise information, and drivers who perform well benefit from a reward scheme, which, according to Murphy, gets a bit of competition going and works well in maintaining driver enthusiasm. Driver training is an integral part of SML's philosophy.

"All our drivers are trained up to National Certificate level – training is a significant cost for us, and it is not a cost you can pass on to customers. Generally we don't interfere with drivers [with high fuel consumption figures] unless we pick up on something really unusual."

Monitoring fuel use by individual drivers is the essential prerequisite to any concerted effort according to Canadian experience, but driver 'buy-in' is essential. Motivating drivers to achieve and maintain good performance is one of the challenges facing operators.

"The introduction of any type of monitoring has to be done sensitively," says de Pont. "Use of in-cab computers is common but is not absolutely necessary – there are a number of other ways of monitoring fuel use. What is important is that drivers know how they are performing. They can always benchmark against themselves, and set targets for improvement, rather than be compared against other drivers. The kudos associated with good performance has been shown to be enough to get good results in some cases, but reward schemes do work well in others."

And while EECA's interest in fuel use efficiency is driven primarily by concerns about vehicle emissions and Kyoto Protocol targets, there seems for once to be a golden opportunity for private businesses to benefit from a national initiative to 'cut back'.

"Saving money on fuel means straight line profits," says Nick Sargent, senior transport adviser at EECA. "We want the transport industry to tell us what we can do to help. While most operators do manage road user charges (RUCs), very few monitor fuel. What you can't measure, you can't manage."

Box Story

The Canadian Approach – 'Smart*Driver*' for Forestry

Saving fuel by improving driver skills has been central to fuel economy programmes already well established in the USA and Canada.

Canada is a signatory to the Kyoto Protocol, and high target reductions in GHGs are adding impetus to fuel use efficiency initiatives. A generic HGV training programme has been adapted specifically for logging fleets by FERIC (the Forest Engineering Research Institute of Canada). 'Smart*Driver* for Forestry' has resources for both drivers and trainers, including CD's, videos and manuals. The programme has three key facets – vehicle care and maintenance, better understanding of technology, and defensive driving. Trials with fleet operators who have used the training as part of developing a fuel efficiency culture within their fleets have recorded overall savings of up to 10% in fuel costs. Fleets which have been successful in increasing fuel efficiency are reported to have a number of features in common:

- A commitment from management
- Clear goals and objectives
- A fuel efficiency coordinator
- A team approach
- Driver training
- Tracking and communication of results
- Maybe an incentive programme