Performance Based Standards Marketplace Outlook Project

Quantifying the Benefits of Performance Based Standards Vehicles - Update

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Table of Contents

List of Tables

List of Figures

Executive Summary

The Performance Based Standards (PBS) scheme has gained international focus for achieving very significant productivity and safety benefits for the Australian road freight industry.

This Operator Review for the National Transport Commission's Performance Based Standards Marketplace project has re-examined these safety, productivity and environmental benefits that are being delivered by the scheme. In all cases examined, the scheme continues to deliver great industry outcomes.

- *The scheme's uptake continues to be massive with growth over the last three years being 58% per annum compounding, raising scheme numbers from 1169 in 2013 to 4624 vehicles in 2016.*

This study confirms that safety is still being delivered by the national PBS fleet. Significant and credible insurance accident reports on PBS collisions confirmed that:

- *articulated trucks are 60% safer in avoiding major impact crashes whilst both rigid and articulated classes together are delivering 46% less major impact accidents than the existing conventional Australian trucking fleet.*
- *By 2034 it is expected that between 115 and 149 truck related fatalities will be avoided because of PBS vehicle usage.*
- *For the years 2014 to 2016, PBS operations, under the National Heavy Vehicle Regulator, are estimated to have saved 440 million kilometres in truck travel and at least 4 lives. These figures will rise geometrically over the period to 2034.*

Even under a moderate growth scenario it is expected that by 2034 PBS fleets will save 8,860 million kilometres in truck travel, and this will have three flow-on impacts:

- *Fuel saving of at least 3.2 billion litres,*
- *saving at least 8.7 million tonnes of Carbon Dioxide, and*
- *operating cost savings of at least $17.2 billion, that will benefit the customers in all sectors of the economy*
- *Just for the year 2016, it is estimated that PBS vehicles saved 94 million litres of fuel.*

The productivity benefits of PBS are averaging 24.8% gains across all commodities carried by the various PBS vehicle configurations. Specific benefits range from 15% for some volumetric commodities to 35% gains for container operations. These container benefits will be very significant for both the waterfront and for intermodal connectivity.

When the two major interstate highways, the Hume and Pacific, open to these larger and safer vehicles, this could drive the PBS population to between 15,000 to 20,000 vehicles by 2034, and this will be led by a significant increase in articulated vehicles.

Table 1 summarizes the forecast benefits from the PBS scheme to 2034, under a low, a medium and a high growth scenario. The medium scenario is quite achievable.

TABLE 1 SUMMARY PBS BENEFITS BY SCENARIO TO 2034

Year	2034	2034	2034
	Forecast Low	**Forecast Medium**	**Forecast High**
Total PBS Vehicles	9,435	15,534	20,022
Kilometre savings (B kms)	5.38	8.86	11.42
Savings to 2034 ($m)	$9,551	$17,259	$22,212
Forecast Growth% p.a.	4.0%	7.0%	8.5%
2014 Base fleet[1]	56,657	56,657	56,657
% of 2014 Base Fleet	16.6%	27.4%	35.3%
Fuel Saving (Billion litres)	1.97	3.24	4.18
Estimated 2034 Base Fleet[1]	113,610	113,610	113,610
% of 2034 Base Fleet	8.3%	13.6%	17.6%
CO_2 Savings (m tonnes)	5.2	8.7	11.2
Fatalities Savings to 2034	70	115	149

Source: Industrial Logistics Institute Surveys and assessments, 2017.
Note 1. Long term heavy truck growth rate 3.54% p.a.

The Performance Based Standards (PBS) scheme has evolved, over the almost 20 years since 1998, and has achieved many significant milestones over this time. Recently, Australia's Chief Scientist, Dr Alan Finkel, also had praise for the scheme.

"In trucking, as in all industries, prescriptive regulations become outdated when technology advances and people find a better way of achieving the same end. The end result has been good for the public and good for commerce, with safer trucks that are more cost effective to operate." Dr Alan Finkel

1. Background to this study

The performance of the PBS scheme was examined in detail in 2014, with the benefits being very significant to the Australian road transport sector, especially in the operational areas such as: safety, productivity, and the environment. As well, these benefits will flow on to the clients of road freight, the community, and all economic sectors.

When the handover to the National Heavy Vehicle Regulator (NHVR) was being established, throughout 2013, PBS was very much alive with the pace of uptake being nothing but remarkable, as presented in Table 2. Since 2013 the per annum compounding growth rate was 58% over that three year period, as the vehicle population grew by a factor of 3.9, almost quadrupling.

TABLE 2 THREE YEAR PBS TRUCK GROWTH RATE - TOTAL VEHICLES

Year	PBS Population
2016	4624
2013	1169
Compound Growth % p.a.	58%

Source: Austroads 2014, NTC/NHVR databases, 2016

This current study examines that time frame, following the legal implementation of the National Heavy Vehicle Regulator in January 2014. The report quantifies the current, and the forecast benefits that will be delivered by PBS vehicles over the next 20 year period to 2034.

It should be noted that that Table 2 excludes:

- the PBS buses, as well as
- those vehicles that have been registered in the 'local' Western Australian PBS scheme, and
- those vehicles approved through the Northern Territory permit arrangements.

2. Where PBS vehicles come from?

Performance Based Standards vehicles, and other High Productivity Vehicles that are operating on permits, are emerging almost exclusively from the 'hire and reward' sector of the road transport industry. Since 2014 some previously large ancillary operators have, or are, outsourcing their road freight operations and the outsourced sub-contractors are also taking up the PBS configurations.

TABLE 3 THE 'HIRE & REWARD' POPULATION FROM WHICH PBS VEHICLE EMERGE

Vehicle Type	Rego Code	Number at 2015
Semi-Trailer Tandem Axle Group	TS2	21834
Semi-Trailer Tri Axle Group	TS3	126026
Semi-Trailer Quad Axle Group	TS4	2591
Dog Trailer Single & Tandem Axle Group	TD12	9791
Dog Trailer Two Tandem Axle Group	TD22	4294
Dog Trailer Tandem & Tri Axle Group	TD23	625
Dog Trailer Two Tri Axle Groups	TD33	262
Lead Trailer Tandem Axle Group	TL2	2393
Lead Trailer Tri Axle Group	TL3	19560
Lead Trailer Quad Axle Group	TL4	140
3 Axle Prime Mover for Single Heavy Trailer	SP3	54525
4 Axle Prime Mover for Single Heavy Trailer	SP4	341
5 Axle Prime Mover for Single Heavy Trailer	SP5	2
3 Axle Prime Mover with 2/More Heavy Trailers (RT)	LP3	81
4 Axle Prime Mover with 2/More Heavy Trailers (RT)	LP4	33
5 Axle Prime Mover with 2/More Heavy Trailers (RT)	LP5	0
3 Axle Prime Mover with 2/More Heavy Trailers (B-D or RT)	MC3	37929
4 Axle Prime Mover with 2/More Heavy Trailers (B-D or RT)	MC4	1246
5 Axle Prime Mover with 2/More Heavy Trailers (B-D or RT)	MC5	42
3 Axle Rigid Truck Tows Heavy Trailer(S)	L3	9186
4 Axle Rigid Truck Tows Heavy Trailer(S)	L4	1501
5 Axle Rigid Truck Tows Heavy Trailer(S)	L5	34
Total Trucks only		104920
Hire and reward component trucks (54%)		**56657**
Total trailing vehicles		187516
Trailers Hire and reward (54%)		**101259**

Source: NEVDIS Data, 2015.

As well, virtually all PBS/HPV vehicles are coming from trailered combinations, generally greater than 42.5 tonnes gross vehicle mass (GVM), although some volumetric and other innovative combinations have come into the market. Table 3 presents the 'hire and reward' truck and trailer population that is the estimated base from which future PBS growth will emerge, over the 20 year forecast period to 2034.

In all, there are some 56,000 'hire and reward' trailered vehicles that the PBS fleet will continue to come from. So far, most configurations have come out of the:

- 3 axle truck with 3 axle dog trailer class that have materialized as 3 axle trucks and 4 axle dog trailer combinations, or from
- the single articulated semi-trailers that have become 20 metre or twin steer semi-trailers with and without quad axles, and from
- the B-Double classes that have evolved into Super B-Doubles, quad axles B-Doubles, and into B-Triples, as examples.

Since the PBS standards were agreed, by State and national regulators in 2006, some proposed futuristic vehicles, like the longer urban single 8x2 or 8x4, over-dimensional rigid vehicles or an even longer than 20m semi-trailers, with extendable trailers, could emerge for urban and volumetric work. However, such variants are yet to gain market traction.

It should also be noted that road train operators have expressed general unwillingness to move to PBS from their double or triple road train configurations, and so this sector has not been a high growth PBS contributor, despite some 51 special PBS A-Triples appearing on the NHVR database at this time. This sector has still been included in Table 3 as a sector from which potentially new combinations may emerge even though only a small number exist at the moment.

The growth rates, however, for road trains have been impressive ranging, with double road train growth being 9% per annum to 17% per annum for triple road trains, over the period 2007 to 2014. (See Appendix 2, Table 17). For those States, especially, Western Australia and the Northern Territory, road trains, although often technically outside the PBS performance standards, are delivering great, and ongoing, productivity to their areas of operation. However, as standard road trains are beyond the scope of this report, it should be noted that their contribution to Australia's freight task in rural and remote Australia is very significant. Also in Darwin and Perth double and triple road train combinations have direct access to the outer urban areas. Road train safety performance has been reflected in Table 7.

3. PBS data sources: Suggestions and Possibilities

When operational responsibility for the national Performance Based Standards (PBS) Program was moved to Australia's new National Heavy Vehicle Regulator (NHVR), the existing National Transport Commission's PBS approvals database was transferred to the NHVR who have continued to maintain the applications and approvals data since that time.

Operational travel and safety data for the national PBS fleet is, however, not captured by any formal or existing process. This fact was highlighted in the Austroads 2014 report into PBS benefits. So, what has changed since 2014 with regards to establishing data on the operational performance of the Australia PBS fleet? The answer is still unfortunately very little with regards getting such data regularly.

The PBS database is kept by the NHVR. It contains the applications data for vehicles by truck and trailer type and their respective Vehicle Identification Numbers (VINs). A VIN can be listed by operator, or the prime mover or trailer manufacturer. Commodity carried and operating on specific road types can also be gleaned. Cross matching PBS vehicles with elements of the National Heavy Vehicle Accreditation Scheme also becomes possible with a relational database, especially for Fatigue Management and Mass Management participation. Some loading data may also be available if the operator is in the ITS program, although approvals would have to be enacted.

3.1. Other avenues for collecting PBS operator data

This study has been highly dependent on the NHVR's data set for the PBS population by configuration, the number of PBS fleets, and the identification of those fleets in the Higher Mass Management Scheme. Safety data was accessed through insurance database sources of fleets with PBS holdings, with supplementary data coming from the operator survey. The NTARC insurance accident data is drawn from a very large statistically significant sample population of 'hire and reward', insured heavy vehicles, operating in all Australian States. Productivity data was gained through the PBS Operator Survey. This mix of initially NTC and now NHVR data sets, insurance data and operator survey data has provided a good snapshot on the state of PBS operations over the period of the scheme's transition to the new NHVR. There is no current mechanism for the collection of safety data.

However, the following suggestions have been made regarding possibilities for future PBS data collection improvements:

Kilometres travelled data:

- Distances travelled by some PBS vehicles that are participating in the Intelligent Access Program could furnish kilometre travelled data but this would have to be with the permission of the operator. However, if privacy were agreed this could yield a survey mechanism for estimating PBS kilometres by vehicle configuration. However, such a collection may only apply to fleets operating on Higher Mass Limits (HML) as vehicles operating on Concessional Mass Limits (CML) need not be in the Intelligent Access Program.
- The ABS surveys 1.8% of trucks for the national biennial Survey of Motor Vehicle Use, the SMVU. An ABS survey of 1.8% of PBS vehicles for a range of travel, commodity carried, and area of operations data, would see about 83 PBS vehicles sampled nationally. The standard errors would be massive. As well, the ABS may baulk at collecting data on some 4,500 vehicles when the total truck population in Australia is some 500,000 vehicles.
- This report has undertaken an updated Operator Survey to allow estimation of operator and kilometres travelled by specific PBS configurations.

PBS Safety data collection considerations:

- Adding a PBS logo to a truck could be a mechanism whereby a police accident report could have another entry box added to the 50+ boxes on the current police accident report forms. Advice from enforcement experts was that adding another item onto a police report may not be overly welcomed and in many cases where rollover occurs the PBS logo may not be identified as it has a 50% chance of being on the wrong side of the truck for identification. Also, enforcement agencies may not be all that familiar with the PBS scheme and this would require a further training for the officers.
- Attaching a widow sticker to the prime mover cab is another suggestion but often the prime mover may not be travelling as a PBS combination.
- Mandatory reporting of accidents involving PBS vehicles would seem excessive. For instance, if a fleet had 30 B-Doubles but one PBS 20 metre semi-trailer with a quad axle it would seem illogical that the single semi-trailer should report an incident but the other 30 vehicles would not be compelled to.
- This update report, and the previous Austroads (2014) report on PBS safety, have relied on a mixture of surveys and insurance crash data, however, these sources do

not give either a full, or even annual, update of PBS accident incidents. As clumsy as this method is it can be continued from time to time.

- As PBS vehicles, which number some 4,500 at this time, are at least statistically safer than conventional trucks, why monitor their safety instead of increasing the surveillance on the non PBS fleet? Capturing more than 'fatals' and serious injury data would be a good start, for not only PBS vehicles, but for the conventional fleet as well by specific configuration. At the moment, fatal truck accidents are split by rigid and articulated truck classes only. When PBS buses increase in number a sub-category for PBS bus 'fatals' might also be considered.
- The term 'near misses' is occasionally referred to as a collectable safety metric, However, insurance sources strongly dismiss this approach. Firstly, car or truck drivers who are at fault of a near miss will not report the incident. If a truck has an at fault near miss with a car, and it is reported, the agencies will usually not follow-up on the heavy vehicle registration. Truck drivers encountering a near miss when a car is at fault generally treat these incidents as part of the work environment and may mention it in passing to a supervisor at best. The supervisor will almost certainly not report the incident to an enforcement agency. Some industry analysts have viewed this call for 'near miss' data as a possible data source beyond the fatalities statistics. Far more useful are the insurance statistics for 'minor crashes'. These would generally be available from insurance companies if a regular resource was devoted to such retrievals on say an annual collection basis.

3.2. The PBS Operator Survey – 2017

Because of the lack of certain PBS operational data, a survey was undertaken which returned some 68 positive fleet responses. Some of these fleets were operators with large PBS/HPV holdings. The survey was begun in late December 2016 and continued to late January 2017. It was conducted by phone, most often to the company operations or fleet manager. The survey consisted of seven questions spanning the operators experience with their PBS vehicles over the last 36 months. The questions were:

1. What are your current PBS/HPV holdings?
2. What commodities are you hauling?
3. What are the average kilometres by configuration on a per/month or per annum basis?
4. What areas are your PBS vehicles operating in?

5. What productivity are you gaining over a current conventional (non PBS) vehicle? Savings in kilometres or savings in trips? (Operators seemed very knowledgeable with regards this item),
6. What forward leg and backhaul leg loadings, as a percentage, are you achieving by each PBS configuration?
7. What accidents have your PBS vehicles been involved in over the last 36 months by estimated level of claim?

Unlike the previous operator survey conducted in the Austroads 2014 study, that posed 17 questions, this survey could generally be undertaken in a very short time with the appropriate manager.

The survey was important as it allowed calculation of:

- average kilometres travelled by PBS configuration
- commodities carried by the PBS vehicles
- operator estimates of kilometres saved (productivity proxy)
- forward and backhaul loadings (important for gross tonne-kilometre estimation), and
- operator accident incidents over the last three years.

4. PBS Vehicle Safety: Updated results

PBS vehicles are avoiding major impact collisions when compared to conventional vehicles in 46% of instances. Articulated PBS vehicles are avoiding 60% of the such high impact collisions.

The findings of the previous Austroads 2014 study into High Productivity vehicle safety was done solely through an operator survey. These survey results were then compared against conventional vehicle accident severity benchmarks that were created from National Transport Insurance (NTI) data through their National Truck Accident Research Centre (NTARC). This was the first time that conventional truck accident rates had been created for a large range of specific truck configurations in Australia. These truck accident rates for conventional trucks were measured in terms of ‘major accident crash rates’ per 10,000 vehicles and per 100 million kilometres travelled. These statistics are currently available in Australia for ‘fatal’ truck accidents only, and are split into the two very generic classes of 'articulated' and 'rigid' trucks. There is no other accident data compiled by truck configuration at the national level other than through the National Truck Accident Research Centre. However, some State road transport associations do collect limited configuration accident data from their enforcement agencies.

For this 'PBS Marketplace Update' paper, extensive use was made of insurance data directly for PBS fleet vehicles across the four accident categories: minor, moderate, serious and major. The NTARC data formed 67% of the safety survey and reflected actual crash results. A supplementary operator survey was also conducted across fleets that were either not insured with NTI, or fleets where NTI could not isolate the PBS vehicles from the conventional vehicles holdings of a particular fleet. This non NTI safety survey formed a 33% subset of the safety analysis. Generally, the accident distributions for the smaller operators' survey was comparable with the larger insurance distributions, with few exceptions across the PBS configurations. A similar result found in Austroads 2014, but in that case the PBS supplementary insured accident data was compared to the larger operator survey data. Both sets exhibited the same statistical distribution in that case.

The conventional vehicle accident rates that were used in Austroads 2014, for the period 2009-2012, were updated by NTARC for this study for the years 2013-2016 inclusive. This was also true for the PBS safety benchmarks across the same period.

4.1. Survey Responses

There was good representation for both the Safety and Productivity surveys with samples of 30% and 20% respectively across the 4624 PBS vehicles operating in 1092 PBS fleets in Australia. Refer Table 4. Although fleet numbers were smaller than the vehicle survey percentages some very large fleets formed the basis in both the safety and productivity surveys

Safety Surveys	PBS Vehicles	Fleets
Insurance Data Source	948	95
Other PBS Fleets	389	63
Total	1404	158
% PBS vehicles/fleets with insurance records	67%	60%
% of PBS / HPV Population surveyed	30%	14%
Productivity Survey	PBS Vehicles	Fleets
Total	918	68
Per Cent of PBS Population	20%	6%

TABLE 4 SAMPLE SIZES FOR THE PBS SAFETY AND PRODUCTIVITY SURVEYS

Source: National Transport Insurance (pers. comm.), ILI Surveys

As the focus of this analysis was on vehicle behaviour, by configuration, the vehicle sample sizes were more than sufficient to reflect PBS behaviours at the national level. These two surveys did not focus on any particular State, or segment performance by any State or Territory.

Accident incidents for the study are classified into the four categories presented in Table 5. These definitions are used for both the PBS incidents and also for the conventional fleet benchmarks.

TABLE 5 ACCIDENT SEVERITY CATEGORIZATION

Accident definition	Minor	Moderate	Serious	Major
Claim Size ($)	< $5,000	> $5,000 < $15,000	> $15,000 < $50,000	> $50,000

Source: NTI 2015

The results of the safety survey are presented in Table 6. Of the 403 incidents, there were 64 major crashes which were examined in detail and used to derive the benchmark safety metrics presented in Table 7.

TABLE 6 PBS VEHICLE CRASH INCIDENTS BY LEVEL OF SEVERITY 2013-2016

PBS Vehicle Type	Minor	Moderate	Serious	Major
6/7AA	24	20	19	11
HR3ATD	0	0	0	1
HR4ATD	64	63	48	20
HR5ATD	8	14	8	1
HR6ATD	0	4	2	0
EB-Doubles	2	2	3	9
Super B-Doubles	1	0	0	1
A-Doubles	11	13	20	16
B-Triples	1	1	2	1
AA AB BA Triples	0	2	1	3
BAB AAB QUADS	6	0	0	1
Sub Total	117	119	103	64
Total Accidents				**403**

Sources: NTI and ILI Surveys 2017. Definitions refer Appendix 4

In most cases the PBS class of vehicles are performing better than their conventional counterparts. This is certainly true at the total articulated, and rigid truck levels. The rate per 100 million kilometres is possibly a more robust safety benchmark than the 10,000 vehicle metric, as the total pool of PBS vehicles is around 4600 vehicles. This means that at a specific vehicle level, which may have only a few hundred vehicles, the multiplicative factor could make the comparison against the same conventional vehicle highly speculative. However, as an entire population, the PBS versus the conventional fleet comparisons are credible for the 10,000 vehicle metric.

The comparison against the 100 million kilometre metric is very robust as the total calculable kilometres travelled by the surveyed PBS fleet was 855 million kilometres, which is some 8.5 times greater than the standard 100 million kilometre benchmark.

TABLE 7 AVERAGE ANNUAL MAJOR CRASH RATES FOR CONVENTIONAL VS PBS VEHICLES 2013 - 2016

Comparison Conventional Vehicle Configuration	Accident Rate per 100m km [1]	Accident Rate per 10K vehicles [1]	PBS/HPV Vehicle Configuration	PBS Accident Rate per 100m km [2]	PBS Accident Rate per 10K vehicles
HR with 3A Trailer	9.5	76.3	HR 3ATD	8.4	nsv[3]
HR with 3ATrailer			HR 4ATD	9.8	nsv[3]
HR with 3ATrailer			HR 5ATD	2.3	nsv[3]
HR with 3ATrailer			HR 6ATD	0.0	nsv[3]
TOTAL Rigid Comb	9.5	76.3	TOTAL Rigid Comb	7.8	76.0
Semi-Trailer	20.9	148.0	6/7AA Semi	9.8	nsv[3]
B-Double	9.4	145.1	EB-Double	6.5	nsv[3]
B-Double			B-Triple	4.2	nsv[3]
B-Double			A-Double	14.0	nsv[3]
Road Train 1/2	26.1	335.9	AA, AB, BA Triple	4.2	nsv[3]
B-Double	9.4	145.1	AAB BAB Quad	13.7	nsv[3]
TOTAL Articulated	15.3	171.6	TOTAL PBS Artic	6.2	153.9
TOTAL Conventional [4]	13.6	143.3	TOTAL PBS	7.3	113.9

Notes: 1. Average across 2007 – 2016. 2. Observed period 2013-2016. 3. nsv not statistically valid. 4. Reference vehicles were drawn from large population of Heavy Articulated and Heavy Rigids in combination.

Only two PBS configurations performed significantly worse than their benchmark conventional vehicle

- the A-Double, when compared against the B-Double, but not when compared against a Road Train, and
- the BAB, AAB Quad Trailer combinations when compared to a B-Double but not when compared to a Road Train.

In some cases, particular combinations performed exceptionally well against their benchmark conventional vehicle counterpart. These were:

- single 6 axle, or 7 axle twin steer, or 20 metre semi-trailers,
- B-Triples,
- A-Triple combinations (road train variants), and
- Heavy Rigid Trucks with 5 or 6 axle trailers.

Across all PBS combinations the observed safety performance measured against the conventional fleet, at least for major crashes, on a 100 million kilometre travelled basis, the PBS fleet performed 46% better than the conventional fleet. Refer Table 8.

TABLE 8 OVERVIEW OF MAJOR CRASH RATES FOR CONVENTIONAL VS PBS VEHICLES

Comparison Conventional Vehicle Configuration	Accident Rate per 100m Km[1]	Accident Rate per 10K vehicles[1]	PBS/HPV Vehicle Configuration	PBS Accident Rate per 100m Km[2]	PBS Accident Rate per 10K
Rigid Combinations	9.5	76.3	PBS Rigid	7.8	76.0
Articulated	15.3	171.6	PBS Articulated	6.2	153.9
TOTAL Conventional	13.6	143.3	TOTAL PBS	7.3	113.9
Benefit PBS Rigid over Conventional Rigid				**18%**	0.4%
Benefit PBS Articulated vs Conventional Articulated				**60%**	11%
Benefit (Major Crashes) All PBS vs all conventional vehicles				**46%**	31%

Notes: 1. Average across 2007 – 2016.
2. Observed period 2013-2016.

4.2. PBS fatal crash performance

Currently there is no classification in the 'fatals file', which is updated by the Bureau of Infrastructure Transport and Regional Economics (BITRE), for PBS vehicles. The only classification for trucks is by the Rigid and Articulated groupings without further published sub configurations. However, the key fatal safety performance metrics of:

- Rigid/Articulated trucks by 100 million kilometres travelled, and
- Rigid/Articulated trucks by 10,000 vehicles

are calculated.

TABLE 9 CONVENTIONAL VS PBS FATAL ACCIDENT RATES BY TRUCK CONFIGURATION 2009 - 2016

Truck Type	Fatalities per 100m kms (Rate as at 2014)	Fatalities per 10K vehicles (Rate as at 2015)
Rigid Trucks	0.80	2.23
Rigid PBS	0.0[1]	0.0[1]
Articulated Trucks	1.30	10.53
Articulated PBS	0.49	1.07

Source: BITRE Information Sheet 78, ILI Operator Survey. Note: 1. Suicide not counted

Table 9 reflects the comparison PBS fatal incidents survey against the conventional rigid and articulated incident metrics. It should be noted, that over the seven year period, 2009 to 2016, the PBS fatal accident rates have been well below that of conventional vehicles. One fatal incident was a suicide and is not counted in this, or in the BITRE fatal accident data sets. However, the findings of the operator surveys are indicative, although not totally conclusive in regards the fatalities with PBS vehicles. It should be noted that the insurance data used in PBS benchmarking is limited to vehicle and property asset claims by severity, and does not reflect people injuries, as this data lies within the domain of government agencies.

5. PBS Vehicle Productivity Survey: Updated results

PBS is likely to deliver a saving of 8.8 billion kilometres to 2034. This translates into productivity benefits for the PBS fleet averaging 24.8% gains across all commodity types. Specific benefits range from 15% for some volumetric commodities to 35% gains for container operations. The benefits for containers alone are very significant for both the waterfront and for intermodal connectivity.

Productivity can be measured in many ways. It has been common to see spreadsheet exercises where full trucks of different sizes move fully loaded between two points, eg, VFLC, 2009. This generally overestimates the productivity of the larger vehicle because in real life operations backhauls are not 100% full and extra trips are needed.

Using full loads one way with empty backhaul was used for productivity calculations in the ATA's Impact Analysis, 2016, however, in this report good backhaul data was available and was therefore used. Tonne kilometres per vehicle was used in BITRE, 2010, however, it would be very difficult to assign a cost to this metric on a configuration by configuration basis, although the PBS benefits in Gross tkms savings on a vehicle configuration basis were examined in Section 7 of this report.

There is also what might be called 'capacity limit productivity' where if the capacity of the truck doubles, say 25 tonne load capacity to 50 tonnes load capacity this would be a 100% productivity gain. Technically yes, but what does this mean? The operator does not save 100% of anything in reality. This method was not used here. In this study the proxy for productivity is through the 'percentage kilometres saved' by the operator by using a PBS vehicle. In the above case, a truck with a 25 tonne load capacity being replaced by a 50 tonne load capacity truck could potentially save 50% of the operators kilometres travelled. The productivity would therefore, be 50%. This study uses this method as a proxy productivity measure. As the cost per kilometre by vehicle type are known, for conventional and PBS vehicles, then the kilometres saved can be measured directly as a financial benefit.

Through the operator survey the average kilometres travelled by vehicle configuration was calculated. This was a weighted average basis which gave greater weighting to the fleets with the larger numbers of particular PBS vehicles. Say out of 100 B-Triples surveyed one fleet had 50 such vehicles then this fleet would have been given a 0.5 weighting on its responses to average kilometres travelled and for the kilometres saved by using this B-Triple vehicle. These averages are presented in Table 10 along with the kilometres performed by each PBS vehicle configuration in the survey.

TABLE 10 PRODUCTIVITY SURVEY 2017 – VEHICLE NUMBERS AND ACTIVITY

PBS Vehicle Type	Vehicle Numbers	Ave kms per vehicle	Total million kms
6/7AA	180	279210	50.26
HR3ATD	21	130710	2.74
HR4ATD	170	115310	19.60
HR5ATD	39	165200	6.44
HR6ATD	45	164440	7.40
EB-Doubles	206	379870	78.25
Super B-Doubles	36	90440	3.26
A-Doubles	80	197880	15.83
B-Triples	49	212220	10.40
AA AB BA Triples	57	227540	12.97
BAB AAB QUADS	35	187710	6.57
Total	918	232817	213.73
Total km mill 2013-2016			854.90

Source: ILI Operator Survey 2017

From a productivity consideration, and also from the operator survey, the fractional kilometre saving metric is used as the productivity gain. Each fleet interviewed had a very good idea of either:

- Trips saved per week/month/year by PBS vehicle type and length of trip
- Percentage kilometres save by vehicle type by week/month/year, or
- Previously calculated productivity

This prior knowledge by the interviewed fleets facilitated this study's productivity assessments as calculated on a 'kilometres saved' basis. These savings for each configuration are expressed as a 'factor saving' for that vehicle configuration. For example, a factor of 0.15 means that 15% of kilometres are saved, and this is the 'proxy' productivity measure for that configuration.

The operating costs for the PBS vehicles on a per kilometre basis are also presented in Table 11. The operating costs, for the comparative non PBS vehicles, are presented in Table 18, (Appendix 5). The productivity gain is calculated as the difference in the kilometres saved at conventional operating cost minus the difference in the higher PBS operating cost for the reduced distance travelled. These net savings, in 2014 nominal dollars, over the 20 year forecast period, are presented in Table 12 below.

TABLE 11 PRODUCTIVITY SURVEY – OPERATIONAL METRICS BY VEHICLE CONFIGURATION

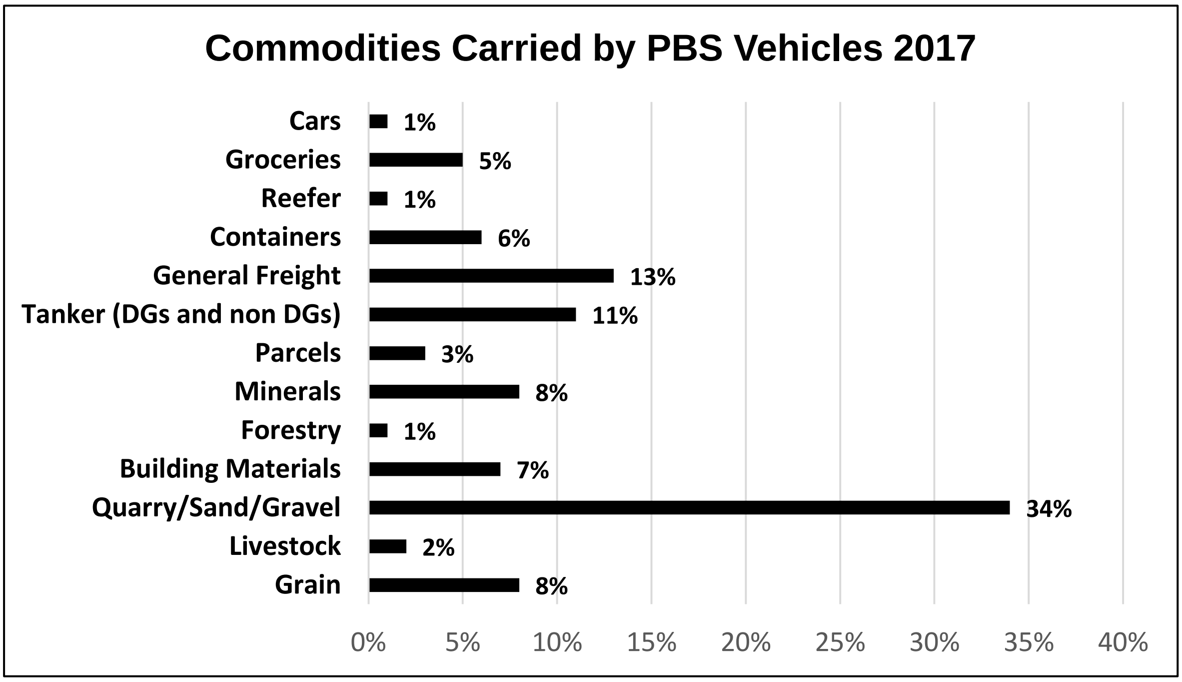
Comparison Conventional vehicle	PBS Vehicle Type	Fractional Km saving using PBS vehicle [1]	Operating cost/km [2]	Ave kms/PBS vehicle
6 Axle semi	6/7AA	0.168	1.57	279210
HR3ATD	HR3ATD	0.116	1.93	130710
HR3ATD	HR4ATD	0.197	2.05	115310
HR3ATD	HR5ATD	0.238	2.04	165200
HR3ATD	HR6ATD	0.24	2.07	164440
B-Double	EBD	0.234	1.90	379870
B-Double	SBD	0.343	3.55	90440
B-Double	AD	0.334	2.48	197880
B-Double	BT	0.312	2.39	212220
B-Double	A Triples	0.307	2.44	227540
B-Double	Quad Trailers	0.421	3.38	187710

Notes: 1. The fraction of kms saved by that PBS class. 2 PBS vehicle operating cost per km is dependent on the ave kms travelled over 12 months.

The Translog cost models were used to cost the conventional vehicle and PBS fleets. (See Appendix 5, Table 19.) These models were also used in the Austroads 2014 study.

Figure 1 presents what percentage of the fleets are carrying which particular commodity. The tippers and truck and dog trailer combinations are dominant in the PBS market currently, at 34%. General freight 13% and Tanker operations at 11%, are the next biggest commodity players. Figure 2 shows the productivity benefits for particular commodities carried by the PBS fleet. These productivity benefits range between 15% to 35% through the use of both specific or a mix of PBS configurations. For example, containers can be carried by a range of PBS vehicles, such as: Enhanced B-Doubles, Super B-Doubles, B-Triples or A-Doubles. The productivity calculation will be averaged across the gains in each of these vehicle types.

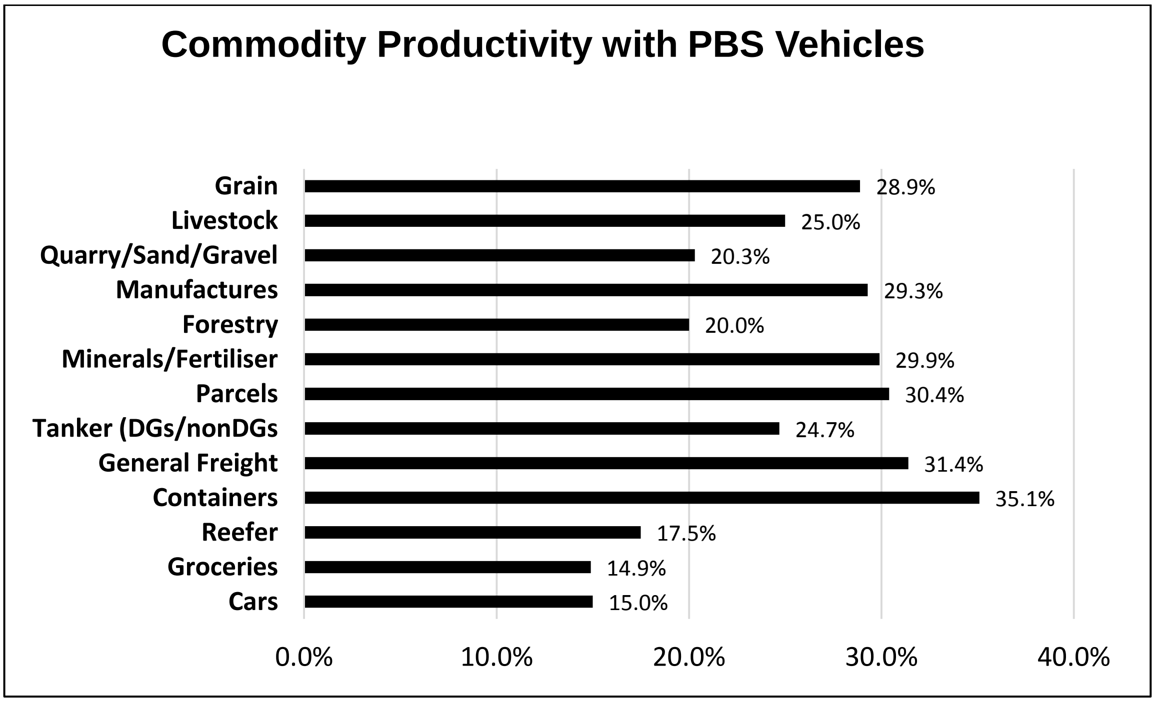
FIGURE 1 WHAT PBS VEHICLES CARRY IN AUSTRALIA, 2016



Source: Industrial Logistics Institute Operator Survey, 2017

The popular quarry/sand/soil tippers are experiencing 20.3% productivity savings across a mix of 3, 4, 5 and 6 axle trailers. The worked example of this calculation is presented in Appendix 6.

FIGURE 2 AVERAGE PRODUCTIVITY GAINS DELIVERED BY PBS VEHICLES 2013 - 2017



Source: Industrial Logistics Institute Survey, 2017

6. Forecasts - what the future holds

It is expected to 2034 that PBS will have a continuing compounding growth rate of 7% per annum, delivering a national PBS fleet of at least 15,500 vehicles. This fleet will have saved at least 115 lives, 8.8 billion kilometres and 8.7 million tonnes of CO_2.

As much as there has been staggering PBS growth rates seen since 2013, these rates will not continue for another 20 years. Such growth would see the specific hire and reward fleet almost completely substitute to PBS vehicles. In all probability, this will not happen.

The time period for the forecasts was to 2034, 20 years after the emergence of the NHVR. Three forecasts were produced: a high, a medium and a low. The growth rates were based in part from expected PBS percentage of market sales figures across four five year periods, 2014 - 2018, 2019 - 2023, etc. The medium forecast was based on selected PBS prime mover sales being just over 25% of market sales. The high forecast that that the PBS sales percentage would reach 35% of the heavy duty prime mover market by 2034. The low forecast was based on continued restricted PBS access to the Hume and Pacific highways to 2034, thus dampening the growth in articulated take-up As well, the PBS population base of 4624 in 2016 when compared to the 1169 2013 base year used in previous studies, shifted all scenario forecasts higher.

TABLE 12 PBS FORECASTS TO 2034: VEHICLE NUMBERS, AND SAVINGS BY GROWTH SCENARIOS

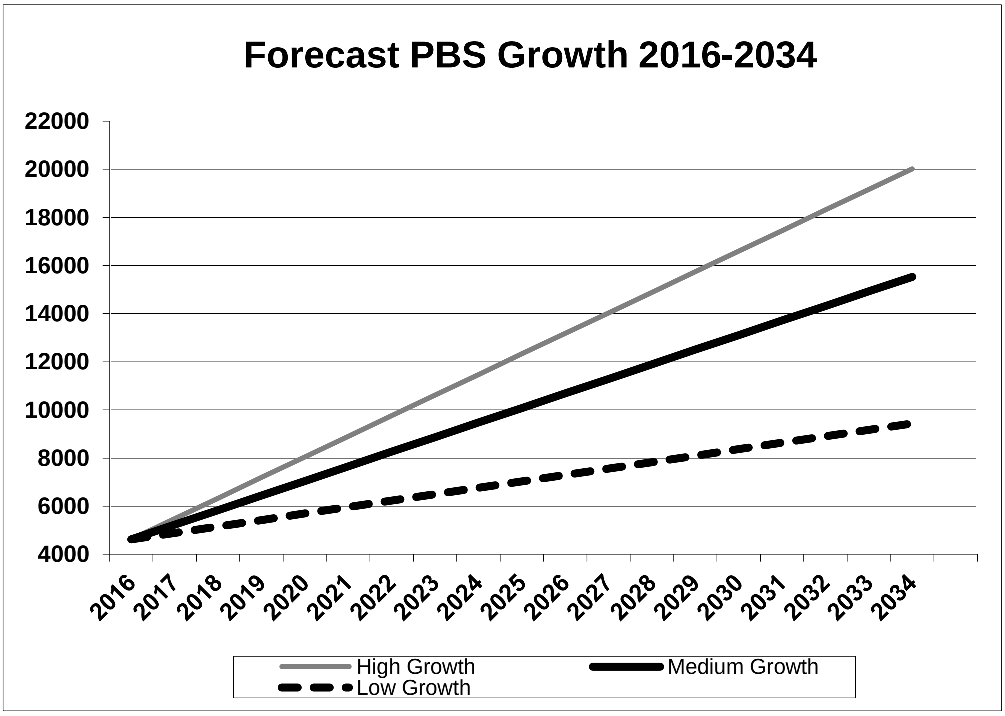
Year	2016	2034	2034	2034
	Current Numbers	Forecast Low	Forecast Medium	Forecast High
Rigid PBS	2003	4221	4791	6221
Articulated PBS	2621	5214	10744	13801
Total PBS Vehicles	4,624	9,435	15,534	20,022
Kilometre savings (B kms)	na	5.38	8.86	11.42
Savings to 2034 ($m)	na	$9,551	$17,259	$22,212
Forecast Growth% p.a.	na	4.0%	7.0%	8.5%
2015 Base fleet[1]	56,657	56,657	56,657	56,657
% of 2015 Base Fleet	8.1%	16.6%	27.4%	35.3%
Forecast 2034 Base Fleet	4,624	113,610	113.610	113,610
% of 2034 Base Fleet	4.1%	8.3%	13.6%	17.6%
Fuel Saving (Billion litres)	0.094	1.97	3.24	4.18
Fatalities Savings to 2034	na	70	115	149

ILI Forecasts 2017 Notes: 1. HV Population from which PBS can emerge, na not applicable

The PBS population forecasts and benefits are presented in Table 12 and the three scenario forecasts are graphically presented in Figure 3.

The third factor that has driven the high articulated truck growth rates for the medium and high forecasts is the potential opening of the Hume and Pacific highways in the second five year period of the forecasts, ie, the forecast five year period beginning in 2019. By this time a saturation in the tipper and other truck and dog trailer markets should be noticeable and the pent-up interstate demand in the articulated market will translate into the strong sales of articulated PBS trucks.

FIGURE 3 PBS GROWTH PROJECTIONS 2016 - 2034



7. PBS delivers savings in road freight gross tonne-kilometres

The total calculable road freight task should also take into account the tare weight of the truck as even when empty, trucks have an infrastructure impact. From an infrastructure viewpoint, gross tonne kilometres (gtkms) are vitally important. Both road and rail pricing take into account gtkms performed but from a road perspective net tkms are more often presented as the task metric. Net tkms are only part of the road freight task. Often when comparing infrastructure impacts a single larger vehicle's task is compared to the operation of a smaller vehicle. This is a flawed methodology. At least a basket of conventional vehicles with a capacity C, should be compared to a basket of PBS vehicles with the same total capacity C. This would give, on a gtkm basis, a true impact comparison.

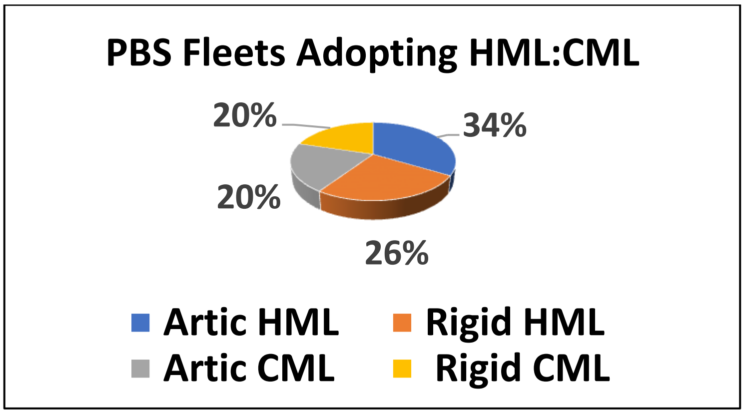
7.1. Calculation of PBS vehicles' gross tonne-kilometres

The operator survey allows estimation of three important pieces of information:

- kilometres travelled by PBS and conventional vehicles
- kilometres saved by using a PBS vehicle and
- forward and backhaul loadings.

As well as knowing what percentage of PBS fleet vehicles are using Higher Mass Limits (HML) and Concessional Mass Limits (CML), these data sets allow the calculation of gtkms for both the PBS vehicles and their conventional benchmark non PBS vehicles.

FIGURE 4 SURVEYED SPLIT OF PBS VEHICLES BY LOADING SCHEMES



Source: NHVR (Pers. comm.), Some CML (est)

It was possible from NHVR data to identify fleets in the HML scheme and it was assumed that non HML PBS operators would be in the CML scheme.

Table 13 shows the load factors by configuration from the operator survey. For modelling purposes, forward leg loads have been set to 1 (100%) and backhaul loads set to the values from the survey for the specific PBS vehicle types. The NTC's own survey found forward legs were generally loaded at 98% of capacity however, the 100% factor has been used in this analysis. This 100% factor will generate a higher PBS gtkms estimate, which delivers a slightly more conservative gtkm benefit than using the 98% forward load factor.

The forward and backhaul factors were the weighted averages of the responses by vehicle configuration from the Operator Survey. The backhaul leg, although based on weighted averages, exhibited considerably more variance than the forward leg.

TABLE 13 PBS VEHICLE LOAD AVERAGE FACTORS

PBS Vehicle	Average Forward Leg Load	Average Backhaul Leg Load
6/7AA	0.996	0.547
HR3ATD	1.000	0.303
HR4ATD	0.996	0.161
HR5ATD	0.993	0.400
HR6ATD	1.000	0.671
EB-Doubles	1.000	0.373
Super B-Doubles	1.000	0.410
A-Doubles	1.000	0.373
B-Triples	1.000	0.216
AA AB BA Triples	1.000	0.210
BAB AAB QUADS	1.000	0.110

Sources: ILI Survey 2017

The estimation of Gross tkms performed by the PBS fleet and the equivalent conventional fleet is presented in Table 14. The truck weights, loaded, unloaded under conventional, CML and HML schemes use Table 16 as the source.

The CML and HML factors are calculated from comparing the conventional benchmark load to the CML and HML loads respectively. In most cases these factors will be less than 1.0, however, a heavy tare truck under CML might carry less than a conventional light tare truck not on CML. This occurs once in Table 14. The total vehicle population of 4624 was used for this calculation, broken down by the vehicle numbers in the respective PBS configurations.

This gtkm calculation is for the calendar year 2016. It shows that on the forward and backhaul tasks, with the appropriate directional load factors, and recognizing what percentage of configurations are in HML and CML, the PBS vehicles saved Australian road infrastructure 6.2% of the Gross tkms that would have been incurred by not using the fleet of PBS vehicles.

This Gross tkm saving, is measured against the ABS SMVU (2014) detailed Gtkms totals. The saving from the current fleet of 4624 PBS vehicles is equivalent to a national saving of:

- a 1.6% saving for all Gtkms performed by all vehicles > 4.5t, or
- a 2.4% saving for the Gtkms performed from the basket of vehicles that PBS vehicles are emerging from, (Table 3).

It should also be noted that gross tkm measures could be used as one of several productivity measures but it is certainly not one that operators would use. Gross tkms do, however, get used by infrastructure pricing regulators for both rail and road operations. In this study, as with Austroads 2014, kilometres saved by vehicle type, is the preferred productivity measure. At a technical level, changes in load capacity if it is not used, does not add to productivity. However, when it is used, this capacity utilization, can manifest itself as kilometres saved which is at least measurable by survey. It should be noted that gtkms saved can be used as a productivity measure, possibly for infrastructure analysis, however, there is no attempt to compare the operator productivity with this gtkm saving. The reason for calculating a gtkm saving is to demonstrate that there is an actual measurable gtkm saving through the use of PBS vehicles.

TABLE 14 CURRENT GROSS TONNE-KILOMETRES FOR THE PBS AND CONVENTIONAL TRUCK FLEET - 2016

Benchmark Vehicle	PBS Vehicle	Kms p.a.	PBS CML Factor[1]	PBS HML Factor[1]	Forward Leg load factor	Backhaul Leg load factor	Conventional Forward and Backhaul legs Gtkms mill	PBS CML and HML Forward and Backhaul legs Gtkms mill
6AA 19m	**6 AA 20m [2]**	279,210	0.958	0.885	0.9962	0.547	9808	9578
6AA 19m	**7AA TS[3]**	279,210	0.773	0.748	1	0.547	11953	10497
HR3ATD	**HR3ATD**	130,710	1.000	0.971	1	0.303	4092	3796
HR3ATD	**HR4ATD**	115,310	1.015	0.868	0.9962	0.161	11112	11241
HR3ATD	**HR5ATD**	165,200	0.825	0.767	1	0.400	3941	3625
HR3ATD	**HR6ATD**	164,440	0.776	0.688	1	0.671	878	779
B-Double	**SBD tri Quad**	379,870	0.892	0.796	1	0.373	24208	22761
B-Double	**Super B-Double**	90,440	0.892	0.733	1	0.410	1698	1563
B-Double	**A Double 26m**	197,880	0.860	0.747	1	0.373	4210	3735
B-Double	**A Double 30m**	197,880	0.705	0.632	1	0.373	5056	4292
B-Double	**BT-triple**	212,220	0.763	0.655	1	0.216	18395	17686
B-Double	**ABT 2D, 3T**	227,540	0.661	0.607	1	0.210	872	824
B-Double	**ABT 3D, 3T**	227,540	0.632	0.569	1	0.210	915	853
B-Double	**AAB Quad**	187,710	0.507	0.440	1	0.110	1521	1386
B-Double	**BAB Quad**	187,710	0.488	0.427	1	0.110	1590	1381
Total GTKMS m							100250	93997
Saving (m GTKMS)							6253	
Saving % GTKMS							6.2%	

Source: ILI Survey Notes: 1. CML HML Factors see Section 7.1 2.6/7AA split into 2 classes.3. Twin Steer

8. Environmental Benefits

The environmental benefits of PBS accrue through fuel savings that come about through the kilometre savings by using a PBS vehicle and by not using a conventional vehicle. The PBS vehicle kilometre savings will have a direct associated fuel saving. However, these fuel savings must be adjusted as the kilometres performed by the PBS vehicle come at a higher fuel consumption rate on a per l/100kms basis. The net fuel benefit is the fuel saving of a conventional benchmark vehicle less the differential consumption rate of the PBS vehicle less the consumption rate of the conventional vehicle over the PBS distance travelled.

Under the three forecast growth scenarios to 2034, Table 15 presents the fuel and CO_2 savings for each of the PBS growth scenarios. Just for the year 2016 PBS delivered a fuel saving on 94 million litres of fuel and a quarter of a million tonnes of CO_2.

TABLE 15 PBS ENVIRONMENTAL BY SCENARIO TO 2034

Year	2016	2034	2034	2034
	Actual	Forecast Low	Forecast Medium	Forecast High
Fuel Saving (Million litres)	94	1,970	3,240	4,180
CO_2 Savings (million tonnes)	0.25	5.2	8.7	11.2

Source: ILI calculations based on kms and consumption rates

In 2014, rigid and articulated trucks in Australia consumed 7.11 billion litres of fuel for that year, SMVU 2014. For calculation purposes, if this task hypothetically remained constant for 20 years to 2034, the medium 20 year PBS scenario, would see a fuel saving of 6.1% on this national consumption figure. This is a very significant outcome in both economic and environmental terms.

9. Observations from surveys and interviews

The following is a summary of potentially useful information that might be complementary to the PBS Market Place survey conducted by the NTC in late 2016.

1. The PBS program is emerging from the 'hire and reward' (H&R) sector. This is true for in excess of 99% of fleets. A few ancillary operators (usually garden centres) use a single trailered PBS vehicle to reduce trips to soil, gravel and mulch suppliers.

2. Because PBS fleets are vastly dominated by the 'hire and reward' sector very little data reflects this split for examining the PBS/HPV sector. The best split for H&R and 'Own Business' (ancillary) for the Australian Heavy Vehicle fleet comes from the detailed ABS SMVU data cubes. Even the detailed State registration data is not particularly useful except for identifying some specialist trailers.

3. Road trains: Despite AA-triples, BA Triples and B-Triples and the BAB Quad combinations appearing in the PBS fleet, these combinations vehicles are emerging from the B-Double class. Some road trains are, however, on the NHVR database. These vehicles are generally outside the normal specifications for road trains and therefore use the PBS scheme. These 'out of spec' road trains may often have twin steer prime movers and tri axle dollies fall into this PBS A-Triple class.

4. Fleets on HML: It may be surprising but only 56% of fleets are registered for Higher Mass Limits. For this report, it is assumed that the remaining 44% is running on concessional mass limits (CML).

5. Age of tippers: Over the last three years it has been observed, especially in the PBS tipper truck and dog sector, that older vehicles are forming part of the truck and trailer combinations. In some cases, pre 1995, that is pre Australian Design Rule 70 (ADR70), PBS prime movers have been used in rigid combinations. According to one body builder some 70% of his clients' equipment is in excess of ten years old.

6. Deaths involving PBS trucks are not recorded as such in Australia. In this report, and in the previous Austroads 2014 report, some insight is gained only through the responses from operator surveys. There were 3 fatalities recorded over 7 years. Table 9 presents these findings.

ABBREVIATIONS

6/7AA	6 or 7 Axle Semi-Trailer Combination
AD	A-Double
AT	A-Triple
ATA	Australian Trucking Association
BD	B-Double
BITRE	Bureau of Infrastructure Transport and Regional Economics
BT	B-Triple
C/km	Cents per Kilometre
CML	Concessional Mass Limit
EBD	Enhanced B-Double
GCM	Gross Combination Mass
gtkms	gross tonne kilometres
GVM	Gross Vehicle Mass
H&R	Hire & Reward
HML	Higher Mass Limit
HPV	High Productivity Vehicle
HR3ADT	Rigid Truck plus 3 Axle Dog Trailer
HR4ADT	Rigid Truck plus 4 Axle Dog Trailer
HR5ADT	Rigid Truck plus 5 Axle Dog Trailer
HR6ADT	Rigid Truck plus 6 Axle Dog Trailer
IAP	Intelligent Access Program
ILI	Industrial Logistics Institute
NEVDIS	National Exchange of Vehicle and Driver Information System
NHVR	National Heavy Vehicle Regulator
NTARC	National Truck Accident Research Centre
NTC	National Transport Commission
p.a.	Per Annum
PBS	Performance Based Standards
QT	Quad Trailer Combination
SBD	Super B-Double
SMVU	Survey of Motor Vehicle Use
tkms	tonne kilometres
VIN	Vehicle Identification Number

VFLC	Victorian Freight and Logistics Council

APPENDIX 1: Vehicle Masses

Source K Cowell and Assoc, Manufacturers' and Weighbridge data

TABLE 16 TARE AND MAXIMUM LOADED WEIGHTS FOR CONVENTIONAL AND PBS VEHICLES

Comparison Conventional Vehicle	Tare weight Truck	Tare weight Trailer	PBS Type	PBS Truck tare	PBS Trailer tare	PBS GCM	PBS GCM HML	Sales Segment Category codes	% Production 2016
19m Tautliner Semi	9.5-10.5 t	8-9t	Twin Steer 20m semi	10.5-11.5t	8.5-9t	49.50t	50.50t	**HC**	<1.00%
19m Reefer Semi	9.75-10.75t	8.5-10t	20m Semi	9-10.5t	8.5-9t	42.50t	44.5t	**EH**	7.00%
19m Semi-trailer	9.5-10.5t	8-9t	Quad Semi	9-10.5t	8.5-9t	43.00t	50.5t	**DH**	2.00%
HR 3 Axle Dog	9.5-10.5t	5-6t	HR3ATD	9.5-10.5t	5-6t	48.50t	49.5t	**HC**	12.00%
HR 4 Axle Dog	10-11t	7-8t	HR4ATD 19m	10-11t	7-8t	50.50t	≤56t	**HC**	35.00%
B-Double Tautliner	10-11t	14-16t	HR4ATD 20m	10-11t	7.25-8.5t	50.50t	57.5t	**HC**	25.00%
B-Double Refrigerated	10-11t	14.5-17t	HR5ATD	10-11t	8.5-9.5t	59.50t	63t	**HC**	2.00%
B-Double Tipper	10-11t	14-16t	HR6ATD	10-11t	9.5-10.5t	63.00t	68.5t	**HC**	1.00%
B-Double	10-11t	14-16t	SBD Quad-tri	9.5-11.5t	16-17t	68.50t	73.5t	**HH**	2.50%
B-Double	10-11t	14-16t	SBD Quad Quad	9.5-11.5t	16-17t	63.00t	77.5t	**HH**	2.50%
B-Double	10-11t	14-16t	AD 26m	9.5-11.5t	14-15t	68.00t	≤74.5t	**HH**	<1.00%
B-Double	10-11t	14-16t	AD 30m	9.5-11.5t	16-17t	79.50t	≤85.5t	**HH**	<1.00%
B-Double	10-11t	14-16t	B-Triple	9.5-11.5t	22-25t	≤82.5t	≤90.5t	**HH**	<1.00%
B-Double	10-11t	14-16t	ABT 2D, 3T	9.5-11.5t	24.5-27.5t	92.50t	≤97.5t	**HH**	<1.00%
B-Double	10-11t	14-16t	ABT 3D, 3T	9.5-11.5t	25.5-28.5t	96.00t	≤102.5t	**HH**	<1.00%
B-Double	10-11t	14-16t	AAB Quad	9.5-11.5t	33-38t	119.00t	130t	**HH**	<1.00%
B-Double	10-11t	14-16t	BAB Quad	9.5-11.5t	30.5-35t	119.00t	130t	**HH**	<1.00%

APPENDIX 2: Growth Rates

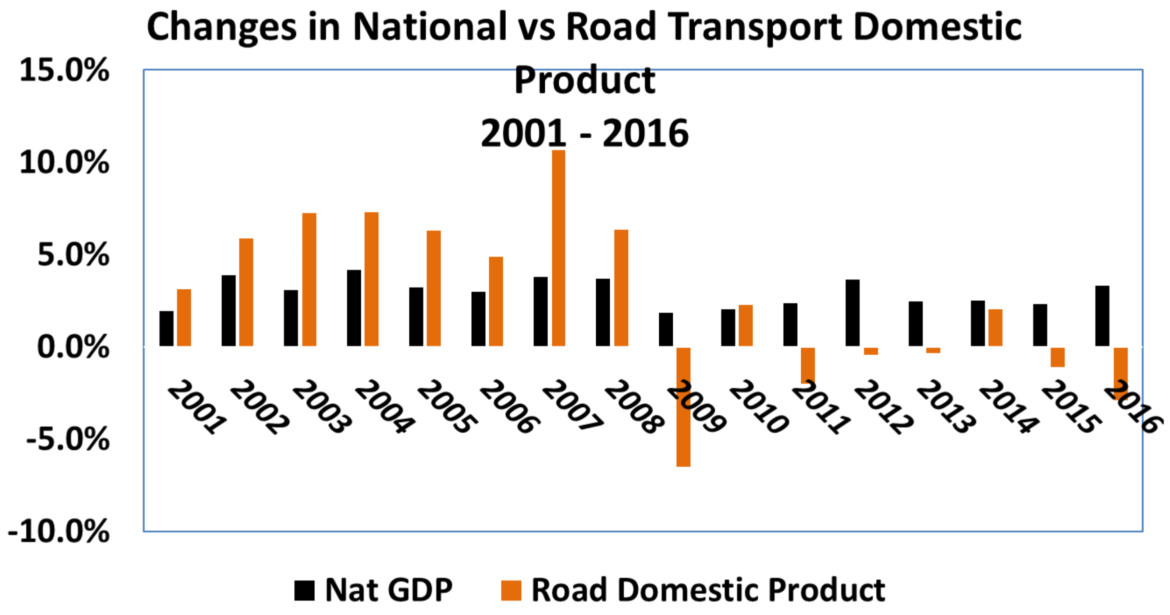
TABLE 17 VEHICLE GROWTH RATES BY VEHICLE TYPE 2007 – 2014/2015

Totals 2007	Vehicle Types	Totals 2014/15	PBS Probable	Growth Pa
39897	Rigid trucks: 2 axles: no trailer: 4.5 < GVM ≤ 7.0 t	58,854	No	4.98%
77433	Rigid trucks: 2 axles: no trailer: 7.0 t < GVM ≤ 12.0 t	110,691	No	4.57%
53402	Rigid trucks: 2 axles: no trailer: GVM > 12.0 t	59,159	No	1.29%
13442	Rigid trucks: 2 axles: with trailer: GCM ≤ 42.5 t	11,652	No	-1.77%
2625	Rigid trucks: 3 axles: no trailer: 4.5 < GVM ≤ 18.0 t	1,799	No	-4.61%
40049	Rigid trucks: 3 axles: no trailer: GVM > 18.0 t	56,099	No	4.30%
4436	Rigid trucks: 3 axles: with trailer: GCM ≤ 42.5 t	17,990	No	19.13%
591	Rigid trucks: 4 axles: no trailer: 4.5 < GVM ≤ 25.0 t	65	No	-24.11%
6080	Rigid trucks: 4 axles: no trailer: GVM > 25.0 t	12,837	Maybe/No	9.79%
52	Rigid trucks: 4 axles: with trailer: GCM ≤ 42.5 t	1,818	No	55.94%
8603	Rigid trucks: 3 axles: with trailer: GCM > 42.5t +	na		
1039	Rigid trucks: 4+ axles: with trailer: GCM > 42.5t	na	Yes	
9642	Sub Total 3 or 4 axle trucks with trailer > 42.5t	10,645		1.24%
859	Articulated trucks: single trailer: 3 axle rig	669	No	-3.08%
3488	Articulated trucks: single trailer: 4 axle rig	3,679	No	0.67%
962	Articulated trucks: single 3 axle trailer: 5 axle rig	1,226	Yes	3.08%
6335	Articulated trucks: single 2 axle trailer: 5 axle rig	6,453	No	0.23%
38217	Articulated trucks: single trailer: 6 axle rig	41,694	Yes	1.09%
1916	Articulated trucks: B-double: < 9 axle rig	3,404	Yes	7.45%
10454	Articulated trucks: B-double: ≥ 9 axle rig	21,876	Yes	9.67%
4222	Articulated trucks: Road train: 2 trailers	8,535	No	9.20%
1076	Articulated trucks: Road train: 3 trailers	3,804	No	17.10%
361	Articulated trucks: single trailer: > 6 axle rig	1,816	Yes	22.38%
na	Other trucks	25,721	No	na
164	B-Triple (est)	628	Yes	18.27%

Source: ABS SMVU detailed data cubes 2014, 2007. NTC 2015 estimates. na not applicable

APPENDIX 3: Australia's Road Freight GDP

FIGURE 5 GROSS DOMESTIC PRODUCT FOR THE ROAD FREIGHT SECTOR 2001 - 2016



Source ABS 5206.0, 2001-2016 National Accounts

Since 2006, the year that formal agreement was reached on the PBS vehicle engineering performance standards by Australian jurisdictions, there have been five years of positive road transport GDP growth, but conversely six years of negative growth, which has occurred in the last eight years. Road transport, postal and courier road activity account for 79% of this sector, the remainder accounts for buses and elements of public and road passenger transport. The weakness in the 'hire and reward' road transport sector has been seldom talked about but has impact on kilometres travelled which has road pricing implications. Road freight insurance premiums have actually reflected this environment by holding premiums for claim free operators fixed for over three years. This negative effect may have also stunted PBS growth a little.

APPENDIX 4: Vehicle Descriptions

TABLE 18 PBS VEHICLE DESCRIPTIONS

Vehicle Type	Report Abbreviation	Description
1. Single Semi-Trailer 6 or 7 axles	6/7AA	Extendable to 20m, 6 axle semi-trailer or 7 axle semi-trailers with quad axle group. Can operate on Higher Mass Limits (HML) or Concessional Mass Limits (CML). Quad axles appeared in the survey.
2. Twin Steer Semi-Trailer 19 or 20m	6/7AA	Twin steer 7 axle semi-trailer. Can operate on HML or CML. Both configurations are reflected in the survey.
2. Enhanced B-Double	EBD	B-Double with either quad axle trailer groups or length up to 30m or both. Up to 11 axles. Can be operate on CML or HML
3. Super B-Double	SBD	B-Double up to 30m with equivalent length for A and B trailers. Can operate on HML or CML.
4. A-Double	AD	An A-Double can be considered a mini Type I Road Train. It is usually less than 30m long, with 11 or 12 axles. Can operate on HML or CML
5. B-Triple	BT	Triple trailer combination, up to 36.5m. 5 axle groups, 12 to 14 axles. Can operate under HML. BB, AB and BA configurations are operational.
6. Quad Trailer Combination	QT	Articulated combination with 4 trailers. 7 axle groups, with 17 or more axles. Various configurations such as BAB or AAB variations are usual. Often referred to as a double B-Double. Combinations are over 33m and can operate on HML.
7. A-Triple	AT	Triple trailer combination, up to 36.5m. 5 axle groups, 12 to 14 axles. Can operate under HML or CML. Can use AA, BA or AB dolly configurations of 2 or 3 axles.
8. Truck and 3 Axle Dog Trailer	HR3ATD	Three-axle truck and three-axle dog trailer. 6 axles, 4 axle groups. GCM over 42.5 tonnes. Can operate under HML.
9. Truck and 4 Axle Dog Trailer	HR4ATD	Three-axle truck and four-axle dog trailer. 7 axles, 4 axle groups. GCM over 42.5 tonnes. Can operate under HML.
10. Truck and 5 Axle Dog Trailer	HR5ATD	Three-axle truck and five-axle dog trailer. 8 axles, 4 axle groups. GCM over 42.5 tonnes. Can operate under HML.
11. Truck and 6 Axle Dog Trailer	HR6ATD	Three-axle truck and six-axle dog trailer. 9 axles, 4 axle groups. GCM over 42.5 tonnes. Can operate under HML.
12. Buses 1	BC	Coach, up to 14.5m. 3 axles one being rear steerable tag axle Long distance operations
13. Buses 2	BA	Double or multi articulated bus 14.5m or longer. 3 or 4 axles. Major urban arterial road operations.
14. Buses 3	BR	Route Buses. Generally used in urban public transport systems.

Source: ILI Definitions 2014 with 2017 additions

APPENDIX 5: Operating Costs

TABLE 19 PBS AND CONVENTIONAL VEHICLE OPERATING COSTS

Vehicle type	Ave kms	C/km Non PBS[1]	C/km PBS[1]
6/7AA	279210	1.53	1.57
HR3ATD	130710	1.88	1.93
HR4ATD	115310	2.02	2.05
HR5ATD	165200	1.85	2.04
HR6ATD	164440	1.85	2.07
EBD	379870	1.72	1.90
SBD	90440	3.39	3.55
A-Double	197880	2.2	2.48
B-Triple	212220	2.06	2.39
AB, BA, AA Triple	227540	2.07	2.44
BAB, AAB Quad Trailer	187710	2.28	3.38
Other[2]	na	na	na
Bus1 Route	49000	2.45	2.50
Bus2 Double Articulated	57,500	3.95	4.00
Bus3 Coach	425000	2.03	2.07

Source:1.Translog Databases and Operating Cost Models as at Sept 2016.
2., na Not Applicable

Vehicle operating cost data is calculated from the conventional and PBS Translog truck operating cost models. The Translog conventional cost models were developed at the same time as the Austway cost model (Asman et al, 1992) and were used in the development of the TransEco cost indices in 1994.

The Translog models are recalibrated each quarter using the data updates that are applied to the Translog base data. The models are also used to update the ABS recognized TransEco Cost indices which are published quarterly. (www.transecopl.com) Also see (ABS,2000). The PBS vehicle cost models were developed in September 2012, and have been updated quarterly since then.

The conventional, non PBS benchmark vehicles, are costed against trips that are the same distance as performed by the specific PBS vehicle. Generally, the PBS vehicle costs more on a c/km basis due to higher fuel consumption, higher capital costs, and higher tyre and registration costs.

Significant data series are available for other cost inflators but not on a cent/km basis. The TransEco indices are often used to inflate costs whereas the ABS Road Producer Price Indices reflect the price changes that road freight customers pay. The two indices are different. The Translog and TransEco databases and indices are not in the public domain but are available through subscription. These two data sets were also used in the Austroads 2014 study with a September 2012 cost base. The current PBS study uses a September 2016 cost base.

APPENDIX 6: Commodity Productivity Calculation

TABLE 20 COMMODITY PRODUCTIVITY CALCULATION: EXAMPLE

Commodity	**Quarry/Sand/Soil/Gravel**		
Fleet Number	Vehicles transporting commodity	Survey Km Saving	Savings*Vehicles
1	1	0.150	0.15
2	5	0.300	1.50
3	1	0.500	0.50
4	2	0.050	0.10
5	12	0.169	2.03
6	1	0.304	0.30
7	8	0.215	1.72
8	1	0.285	0.29
9	1	0.250	0.25
10	5	0.200	1.00
11	1	0.330	0.33
12	1	0.120	0.12
13	1	0.080	0.08
14	1	0.050	0.05
15	1	0.329	0.33
16	2	0.100	0.20
Totals	**44**		**8.946**
Average Productivity			**20.33%**

Source ILI Operator Survey 2017

Table 20 gives an example of the weighted kilometre savings (productivity) for the quarry/sand/soil/gravel commodity. Across 16 fleets and 44 vehicles, which are not necessarily of the same configuration, a weighted average was calculated. In this case across all PBS configurations that carried this commodity in the operator survey, the weighted average commodity productivity benefit was 20.33%.

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