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# The outlook for road related revenues and road transport demand: futures thinking and scenario exploration

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## Abstract

Current information and technology advances have the future unfolding fast. Transport planners and policy analysts need to engage with a range of key drivers, trends, wildcards and uncertainties that will influence the future of transport. Technology development, information systems and the application of intelligent transport systems, for example, will influence transport demand as well as investment and expenditure needs of the future. The role of the private sector in the future will also be subject to a range of factors and government policy. In the context of these and other expected changes, demand for road services can be expected to continue to grow causing road expenditure to face substantial upward pressure from all users for increased road investment and maintenance expenditure. Therefore, there is a need to consider a broad range of policy options for future revenue streams from road transport. To achieve this, in this study a number of scenarios have been considered and the implications for road transport related revenue and future transport demand assessed. Scenarios of road transport futures were simulated by applying the Scenario Explorer$^{TM}$ software developed by ARRB Transport Research. The Scenario Explorer has been developed as an Excel/Visual Basic for Applications (VBA) tool. This tool has an 'excel engine' and a Visual Basic user interface front-end. The Scenario Explorer is intended as a top level, strategic, futures thinking tool and not as a detailed technical model. Sets of plausible road transport futures have been explored by employing a set of variables, assumptions and default values that are representative of each scenario situation.

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## Introduction

This paper is based on the work completed by ARRB Transport Research for Austroads with the purpose of achieving the following:

- Review trends in road transport related revenue;
- Review trends in road transport related demand;
- Review trends in road transport related expenditure;
- Present a scenario analysis to assess the outlook for road related revenues and road transport demand; and
- Present policy options that governments may wish to explore to address identified impacts.

The intent of the study has been to illustrate likely changes in the revenue streams and also identify future road transport demands and the consequent impact that these demands could have on road transport related expenditure pressures for governments.

While revenue derived from road transport related activities is an important source of income for Government, traffic growth is placing increasing demands on the road network in terms of wear and tear, safety, environment and urban network capacity, which ultimately result in growing asset maintenance and infrastructure requirements.

## Planning of the paper

A very brief account of information and data mostly related to historical trends and forecasts of the key variables used in the study on which this paper is based are first presented (Tsolakis, Houghton & Cox 2001). These include summaries of road transport related revenues and expenditure, the transport task and a number of important factors likely to have a marked influence on future revenues from road transport and future transport demand for roads (such as tax reform, impact of rail, new technologies and travel demand management). These summaries are followed by a brief introduction of the methodology used to develop and perform the scenario analysis employed to explore likely futures of road transport related revenue and demand. The implications of these likely futures for road revenue and demand are finally discussed, before a set of concluding remarks completes the paper.

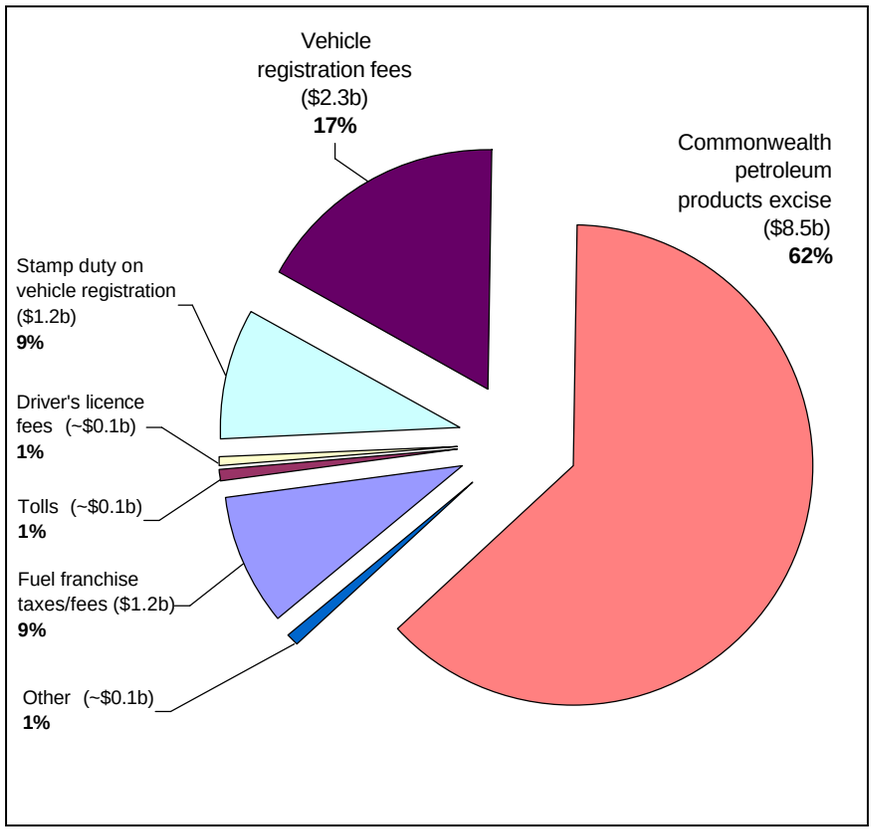
## Revenue from road transport related activities

The majority of road transport-related revenues are made up of taxes and charges levied by the Commonwealth and State Governments. These revenues were $13.75 billion in 1997-98. Commonwealth Government revenue is almost entirely made up of the excise on petrol and diesel sales. A hefty slice (over 6 per cent) of General Revenue is raised by the Commonwealth Government from fuel excise (an estimated $8.7 billion in 1998-99). State Governments also raise a significant revenue from road transport related taxes

and charges ($5.2 billion in 1997-98). Most of this revenue is from vehicle registration fees and other charges ($3.7 billion in 1997-98).

As illustrated in Figure 1, the significant proportion (62 per cent) of this revenue was from Commonwealth petroleum products excise duty. State and Territory governments raised 17 per cent of this revenue from vehicle registration fees. The other two key sources of revenue for States and Territories were from stamp duty collected on vehicle registration fees (9 per cent) and fuel franchise fees, also 9 per cent. Since 1997-98 the ability of States and Territories to levy a fuel franchise fee has been removed as a result of a High Court decision (in Ha and Lim v New South Wales on 5 August 1997). A tiny amount, in the order of 1 per cent, was revenue raised from publicly run tollways.

**Figure 1 - Government revenue from motor vehicle use, 1997-98**




*Source: BTE (1999)*

A more detailed account of taxes and charges levied by governments on motor vehicle users in Australia is presented in Table 1. Over a period of ten years (1988-89 to 1997-98), total revenue increased from $7,270.6 million to $13,749.1 million. However, the rate of growth in this total has declined significantly in recent years. The tolls from government owned and operated toll roads are also shown in Table 1. Government toll revenues have increased from $65 million in 1988-89 to $150 million in 1997-98.

## Table 1 - Selected motor vehicle taxes and charges, 1988-89 to 1998-99

| *Item* | *1988 - 89* | *1989-90* | *1990 - 91* | *1991-92* | *1992-93* | *1993-94* | *1994-95*[1] | *1995-96*[2] | *1996-97* | *1997-98* | *1998-**99*[a] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | *($ million)* | | | | | |
| **Commonwealth Government** | | | | | | | | | | | |
| Petroleum products excise[b] | 4346.4 | 4733.8 | 5221.6 | 5649.5 | 5685.7 | 6704.1 | 7440.2 | 8053.7 | 8324.9 | 8535.3 | 8661.6 |
| ACT motor vehicle taxes[c] | 38.3 | 38.3 | 21.0 | .. | .. | .. | .. | .. | .. | .. | .. |
| Federal Interstate Registration Scheme | 10.8 | 17.1 | 14.5 | 15.9 | 17.0 | 20.3 | 23.6 | 29.3 | 20.1 | 17.8 | 20.3 |
| *Subtotal* | *4395.5* | *4771.9* | *5236.1* | *5665.4* | *5702.7* | *6724.4* | *7463.8* | *8083.0* | *8345.0* | *8553.1* | *8681.9* |
| **State and Territory Governments** | | | | | | | | | | | |
| Vehicle registration fees | 1242.0 | 1342.0 | 1402.0 | 1606.0 | 1765.0 | 1901.0 | 1970.0 | 218.0 | 2146.0 | 2285.0 | na |
| Stamp duty for vehicle registration | 650.7 | 728.0 | 641.0 | 626.0 | 750.0 | 872.0 | 987.0 | 1052.0 | 1148.0 | 1260.0 | na |
| Drivers licence fees | 190.0 | 268.0 | 251.0 | 184.0 | 187.0 | 240.0 | 299.0 | 295.0 | 212.0 | 134.0 | na |
| Fuel franchise taxes-fees | 680.0 | 1016.0 | 1061.0 | 1128.0 | 1174.0 | 1346.0 | 1427.0 | 1531.0 | 1570.0 | 1251.0 | na |
| Road transport & maintenance taxes | 47.0 | 63.0 | 56.0 | 55.0 | 79.0 | 92.0 | 106.0 | 101.0 | 86.0 | 117.0 | na |
| Tolls[d] | 65.4 | 76.4 | 83.4 | 99.8 | 118.7 | 134.4 | 149.5 | 137.6 | 136.7 | 149.0 | na |
| *Subtotal* | *2875.1* | *3493.4* | *3494.4* | *3698.8* | *4073.7* | *4585.4* | *4938.5* | *5134.6* | *5298.7* | *5196.0* | *na* |
| **Total Revenue** | **7270.6** | **8265.3** | **8730.5** | **9364.2** | **9776.4** | **11309.8** | **12402.3** | **13217.6** | **13643.7** | **13749.1** | **na** |

***Notes***: This table excludes some taxes-fees on motor vehicles such as customs duty and sales tax.

a. Estimate

b. Estimated excise component attributed to motor vehicles using public roads. This figure has been re-estimated since Information Sheet 11 to provide a closer approximation to the net excise figure. It does not include the additional excise raised for the revenue replacement payments to the States under the States Grants (General Purposes) Act 1994, which replaces the State and Territory business franchise fees on petroleum. This is reported in the Commonwealth Budget Papers under State and Territory governments as a fuel franchise tax/fee.

c. Prior to the ACT becoming self-governing on 11 may 1989, monies raised via motor vehicle taxes and charges were collected by the Commonwealth government.

d. Comprises tolls collected from the Gateway Bridge and Logan Motorway in Queensland, the Sydney Harbour Bridge and Harbour Tunnel in New South Wales, and for the Waterfall/ Bulli Tollway and Sunshine Motorway up to 1994 – 95, after which the latter two ceased to be tollways.

***Source:*** BTE (1999)

Funding for road provision in Australia is primarily provided by Governments from their Consolidated or General Funds. All three levels of government (Commonwealth, State and Local) provide funding for road infrastructure. The total amount of road transport-related expenditure by the Commonwealth, State, Territory and Local Governments in 1997-98 was of the order of $7.3 billion. Over the period 1988-89 to 1997-98, Government funding of road transport-related expenditure has grown by about 4 per cent in real prices. After a 'dip' in the early 1990s, this growth has intensified in the last three years to 1997-98.

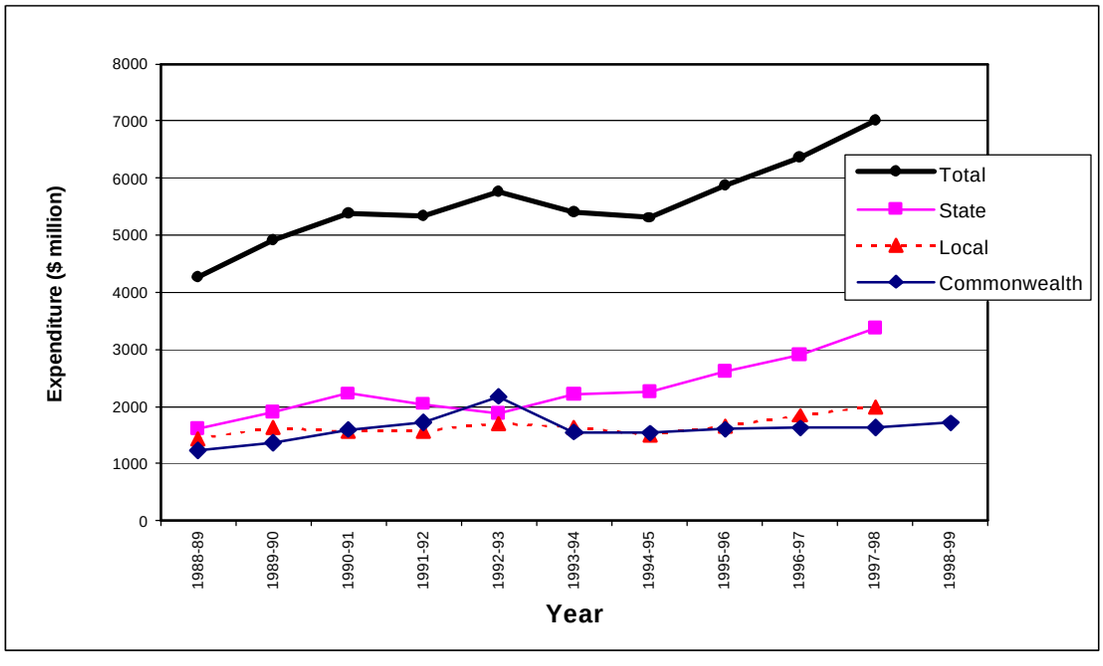
Road expenditure by the private sector is mostly related to special urban network projects (eg. major toll roads). In the 1990s, it averaged at around $0.35 billion per year.

As shown in Figure 2, funding levels between the three tiers of government in the late 1980s were comparable, but expenditure increases by the States and Territories have been the main influence on total expenditures in the last decade.

Since 1995, the mix of road transport fuel consumption has changed with the phasing out of leaded petrol and the diffusion of alternative fuels into the vehicle fleet. The continued introduction of new vehicle technologies which improve fuel efficiencies and alternative fuels (which currently do not attract excise) will have important implications for future government revenue streams.

At the same time, interest in direct charging mechanisms has emerged and is intensifying. There is mounting evidence in the literature and international practice, of a growing trend towards alternative institutional arrangements where there is a linkage between the raising and allocating of road transport related funds. This may encourage greater efficiency in the use of funds where user and community preferences are more effectively reflected in both the raising of funds and their expenditure.

**Figure 2 - Recent Government Funding of Road Infrastructure-Related**



**Expenditure**

*(Source: BTE, 1999).*

## The road transport task

Historical trends show that:

- over the past three decades, vehicle numbers have grown by about 2 per cent a year. In 1998, passenger vehicles used for both private and business purposes made up over 80 per cent of vehicle numbers.
- The growth in per capita vehicle travel has slowed in recent years because of saturation of the market for both male and female driver travel and the ageing of the population. Projections of passenger vehicle travel to 2020 indicate an increase in travel in the future of just over 1 per cent, giving a 20 per cent increase on year 2000 travel.
- Commercial vehicle travel (in million kilometres) shows similar but slower growth trends since 1990. Truck travel has remained at about the same level, although there has been a significant shift from rigid to articulated trucks. The largest growth has come from light commercial vehicles associated with the service economy, but this travel has also shown signs of slowing in the last five years.

## Major factors influencing road transport related revenue

Road transport related revenues will be influenced by the development and diffusion of new technologies into the passenger and freight vehicle fleet. Driving forces include safety, urban congestion, air quality, greenhouse gas emissions, freight vehicle productivity, and travel demand.

These forces will encourage integrated demand management strategies, the diffusion of new vehicle and fuel technologies, and the application of ITS technologies within the road transport system.

Environmental considerations increasingly play a role in a range of actions that encourage switching to alternative transport technologies or modes.

Community expectations will also continue to influence, through the political process, road transport related revenue receipts.

Studies conducted prior to the introduction of the tax reform package (ANTS) in July 2000 forecast an increase road transport demand by about 1.8 per cent, a reduction in road transport costs by 7 per cent and the inducement of some modal shift of both passengers and freight from rail to road.

The continued upward pressures on road transport demand are likely to put pressure on road transport expenditure needs. Key drivers are as follows:

- growing demand for road transport;
- other transport modes;
- private sector involvement; and
- technology development and application.

Rail is not expected to be a force capable of stemming increases in the share of road transport (in particular heavy vehicles). However, a new rail scenario involving an innovative 'blending' of road and rail technologies can lead to significant changes in the land freight transport task of the future.

The role of the private sector in the future will be subject to a range of factors and government policy. During the 1990s, the private sector contribution to road construction was around 9 per cent of arterial road construction and about 6 per cent of total road construction, based upon expenditure levels.

However, the future role of the private sector in meeting road transport demand will be subject to a range of factors including more innovative methods of private sector financing (public-private partnerships, shadow tolling, direct tolls), the level of finance available to the States and social equity concerns.

The provision of improved road links by the private sector, within major cities in response to problems of congestion, will continue to influence the demand for private car use in major cities.

Under different technology scenarios, revenues derived from fuel excise are likely to change significantly in the future because alternative fuels are not currently subject to excise.

The revenue implications for technological development depends upon the rates of diffusion of new technology into the vehicle fleet, which in turn will be influenced by the mix of policy responses to emerging social, economic and environmental driving forces.

### A synthesis of influences and policy options

Scenarios of road transport futures were simulated by applying the Scenario Explorer™ software developed by ARRB TR. In this section, a simplified approach, based on scenario analysis is used to explore some of the interactions between these driving forces[1]. The use of the scenario approach is intended as a top level, strategic thinking tool and not as a detailed technical model. The scenario explorer is based on aggregate national transport data. The data is not disaggregated by state or by urban/rural location which would be needed for more detailed analysis of selected policy options. For example, in relation to the revenue stream derived from tolling, there is currently no provision within the scenario explorer to consider options such as variable charging based on vehicle type, road type, location or time of day. Other interaction effects that are relevant, such as traffic diversion as a result of the introduction of tolling, are also not currently considered.

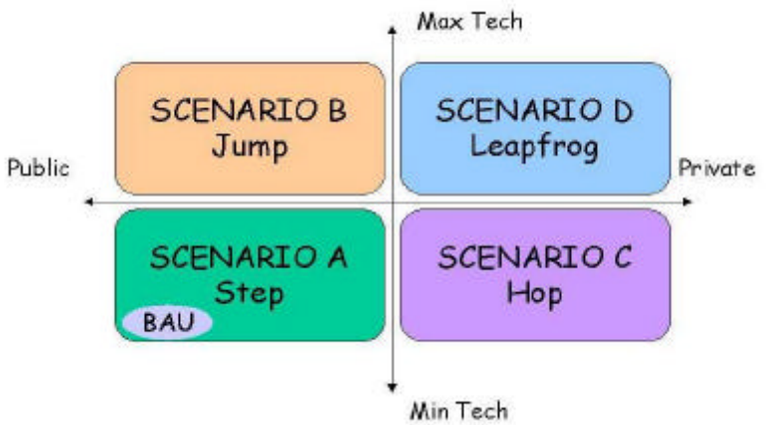
Scenarios, by their nature, cannot be fully comprehensive. Rather, they are intended to encourage the exploration of the effects of different dimensions of change and different policy options. In this way, scenarios may assist in synthesising an understanding of the longer term consequences within an area of inquiry. Although sensitivity analysis may be undertaken using the 'scenario

1 An Excel based 'scenario explorer' application has been developed for this project to enable the interactions between these technological, social and policy dimensions to be examined.

explorer' application developed for this project, this has not be attempted within the scope of the study on which this paper is based.

As noted above, there are numerous factors and interrelationships that may be relevant to a given area of inquiry. A typical scenario methodology is based on the selection of two (or more) primary scenario dimensions or axes that are used to construct different views (or outlooks) of the future. The set of axes chosen for this analysis represent dimensions of change that are relevant to this project (***a scenario space***) and include a technology dimension (reflecting different levels of ***technology diffusion*** into the vehicle fleet) and a public-private dimension, which reflects different levels of ***private sector involvement***. Figure 3 illustrates the location of the business-as-usual (BAU) scenario within the scenario space as well as four alternative scenarios based on the above scenario dimensions.

**Figure 3 - Scenario Space (showing possible trajectories from BAU)**




The scenario descriptions are based on a series of key assumptions included in the Scenario Explorer™ engine (associated spreadsheets) and are summarised in Table 2.

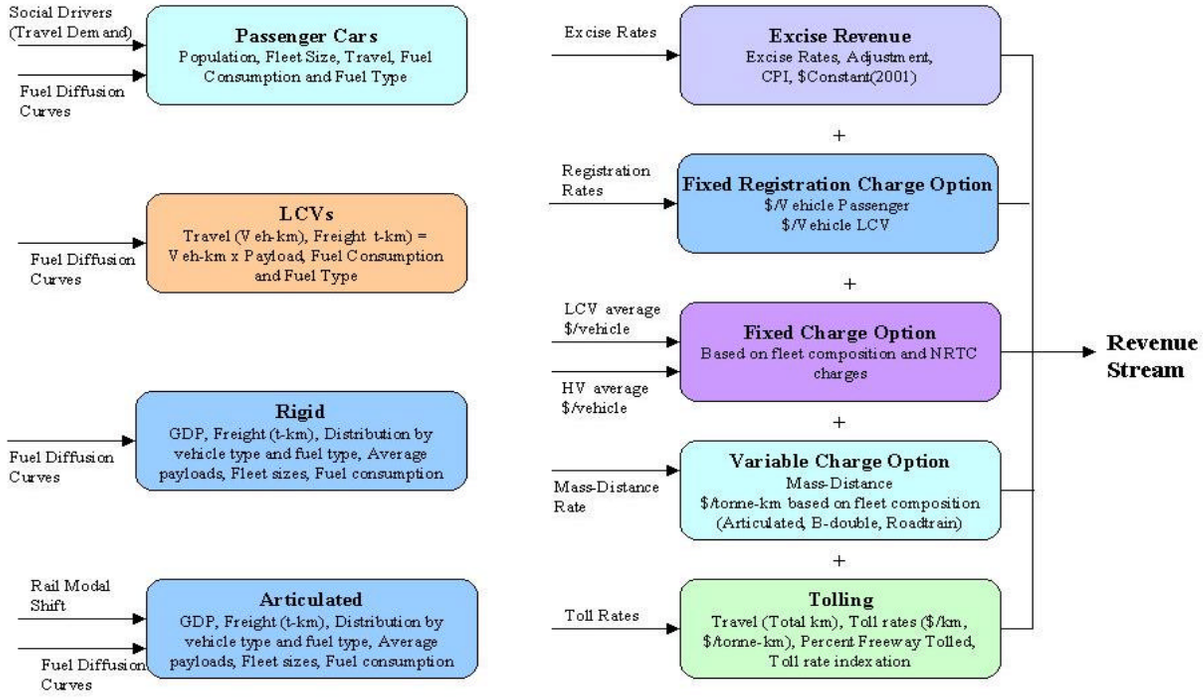
**Table 2 - Scenario Assumptions and Default Variable Values**
***(that can be altered by the user)***

| | |
|---|---|
| *Economic Variables* | |
| GDP (%pa) Growth | 3.2% |
| CPI Inflation Rate | 3.0% |
| *Passenger Cars* | |
| Passenger Car Fleet BTE Model Cars/'000 Person = $k/(1 + ae^{-bt})$ where | |
| k = 516, a = 7.65, b = 0.0896 (BTE values) | |
| k = 560, a = 10.5, b = 0.087 (ARRB TR values)[2] | |
| Average Annual Distance Travelled by Cars (km) | 14,200km |
| *Road Freight Assumptions* | |
| Rigid truck travel growth as fraction of GDP growth | 1.0 |
| LCV travel growth as fraction of GDP growth | 1.0 |
| Annual Increase in % of Diesel LCV Travel | 0.15% |
| Rigid payload increase p.a. | 2.0% |
| Articulated payload increase p.a. | 2.0% |
| Growth in articulated truck share of road freight/yr | 0.5% |
| Annual growth in LCV Payload | 2.0% |
| Annual growth in Rigid truck payload | 2.0% |
| Annual growth in articulated truck payload | 2.0% |
| Fuel efficiency improvement per annum - articulated (L/ntk) | 1.45% |
| Fuel efficiency improvement per annum - rigid (L/ntk) | 1.0% |
| Fuel efficiency improvement per annum - rail (L/ntk) | 0.7% |

The logic or flow within each scenario is based on the a number of general steps, as shown in Figure 4, which are used to examine the influence of technological, social and policy changes on the revenue stream derived from the road transport task.

[2] The ARRB TR parameter values are trial and error values selected to better match more recent data relating to the size of the passenger vehicle fleet.

**Figure 4 - Scenario Logic**




## Scenario implications

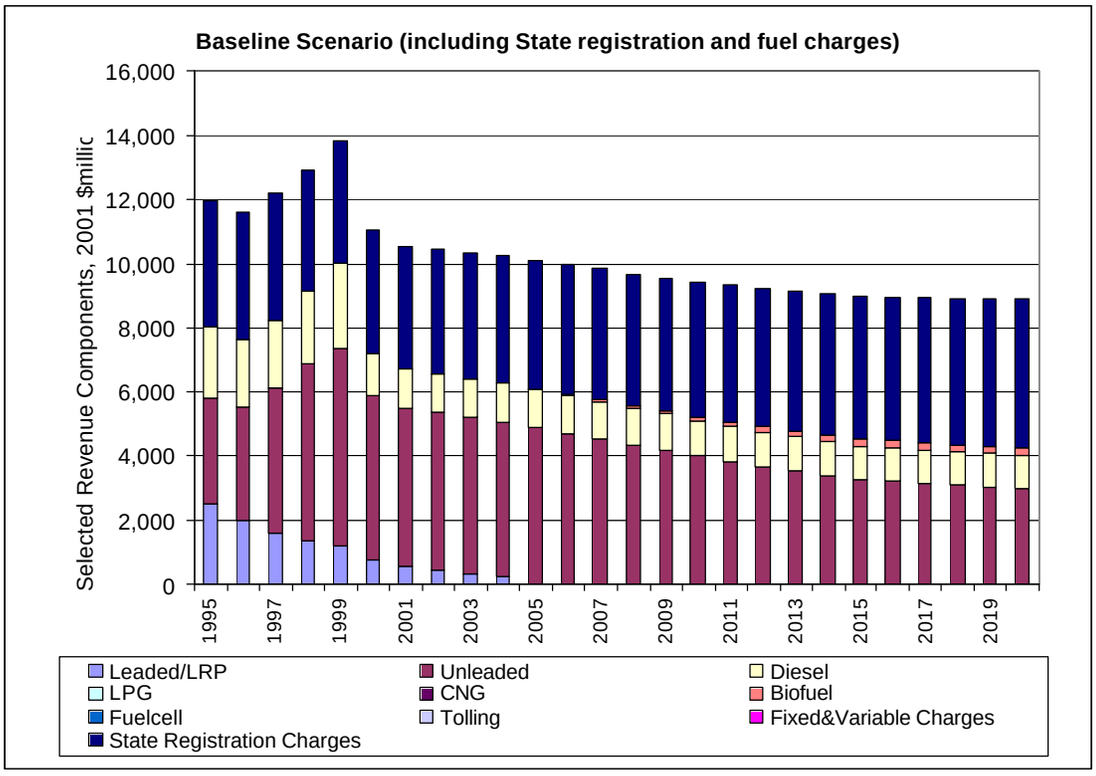
Using the Scenario Explorer™ these scenarios have been 'simulated' by employing a set of variables, assumptions and default values that are representative of each scenario situation.

## Scenario 1: *baseline*

This scenario represents BAU, which includes current expectations relating to passenger and freight task and 'typical' (or default) diffusion of new technologies into passenger and freight vehicle fleets (sets of diffusion curves are applied to describe the rate of adoption). As shown in Figure 5, the scenario output displays revenues from fuel excise by fuel type, which indicate a large reduction in the revenue stream from fuel excise (from over $6bn in 2001 to around $4bn by 2020 – (measured in constant $2001 terms). The large shift in year 2000 is due to the introduction of the GST which, inter alia, decreased fuel excise rates. (A large component of this shift was the reduction of diesel excise by 25 cents per litre). The further reduction is primarily due to diffusion of currently non-excisable fuels into the passenger fleet (primarily LPG and Fuelcell). As shown, excise from Leaded/LRP falls to zero around 2005

and the excise revenue contribution from Unleaded fuel decreases. A small contribution due to blended fuels (bio-diesel) is expected around 2010.

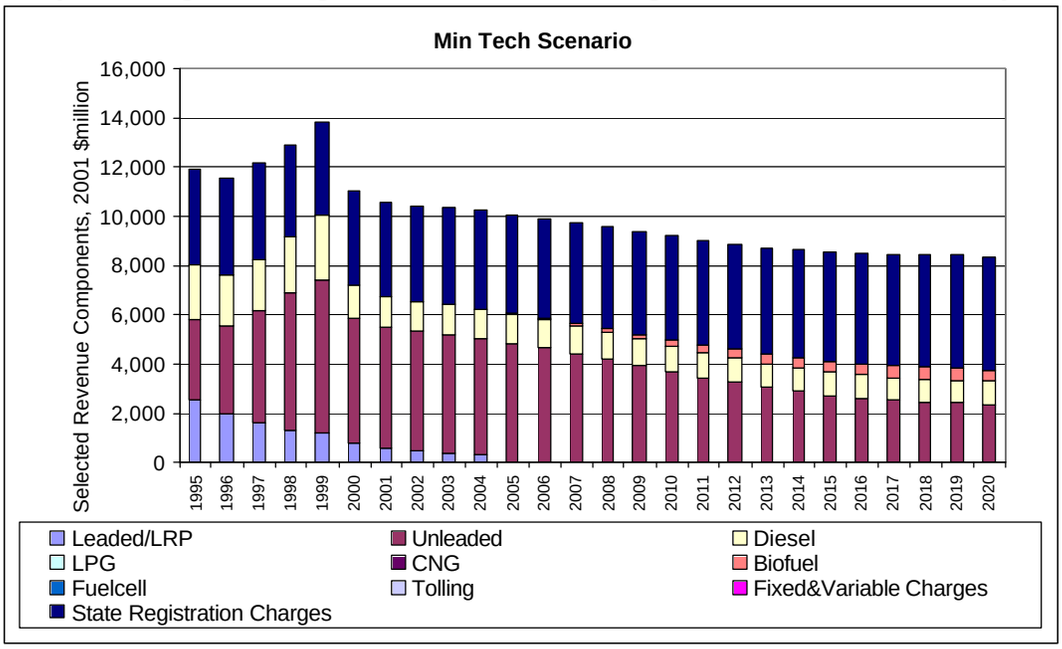
**Figure 5 - Baseline Scenario revenues (Including State registration and Fuel Charges)**




**Scenario 2: *minimum technology***

This scenario is an extension of the 'Baseline' and is described by a set of diffusion parameters that characterise the proportion of fuel types within the vehicle fleet. As shown in Figure 6, excise revenue from fuel consumption compared with the baseline scenario drops by around $400m (from $4.1bn to $3.7bn) by the year 2020 as a result of increased use of fuel types that do not currently attract excise.

**Figure 6 - 'Minimum technology' Scenario**
**(Including State registration and fuel charges revenue, All vehicles)**

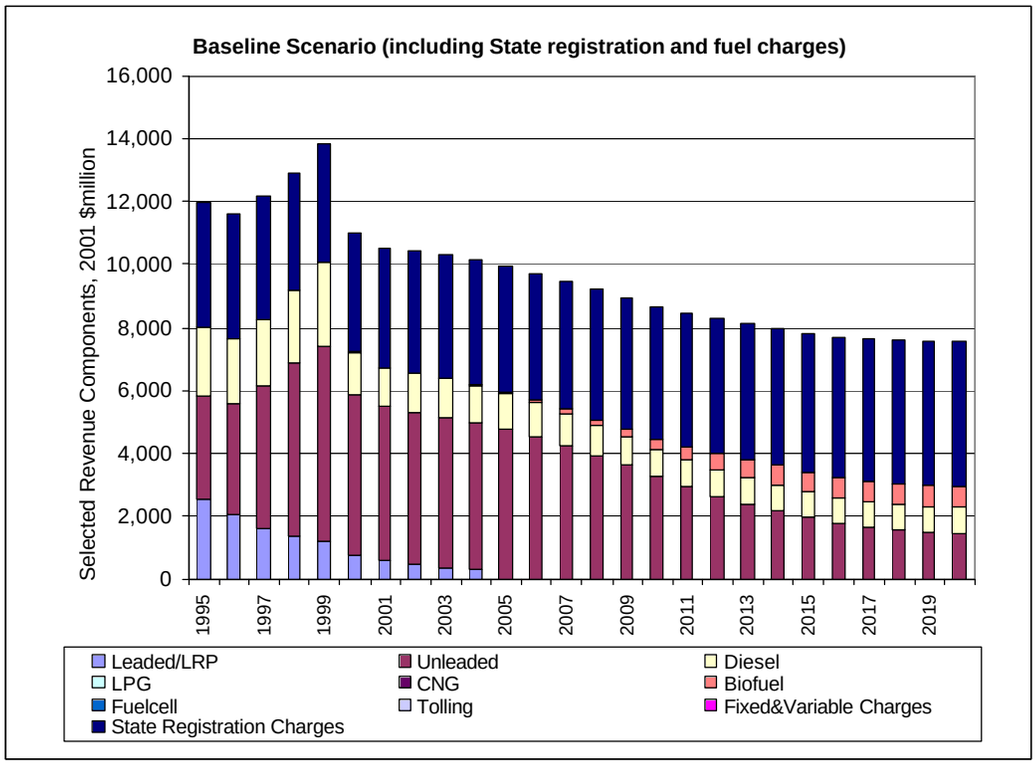


Within each scenario it is also possible to examine the excise component revenue streams by vehicle type (ie. Passenger, LCV and Articulated) separately. These results can be found in Tsolakis, Houghton & Cox (2001).

### Scenario 3: *maximum technology*

This scenario represents an aggressive penetration of new technologies into the vehicle fleet. The resulting excise revenues (by fuel type) are shown in Figure 7 (eg. the fuel excise revenue has decreased to around $2.9bn by 2020).

**Figure 7 - Maximum Technology Scenario**
**(Including existing State Registrations and Fuel Charges)**




### Combining Scenarios

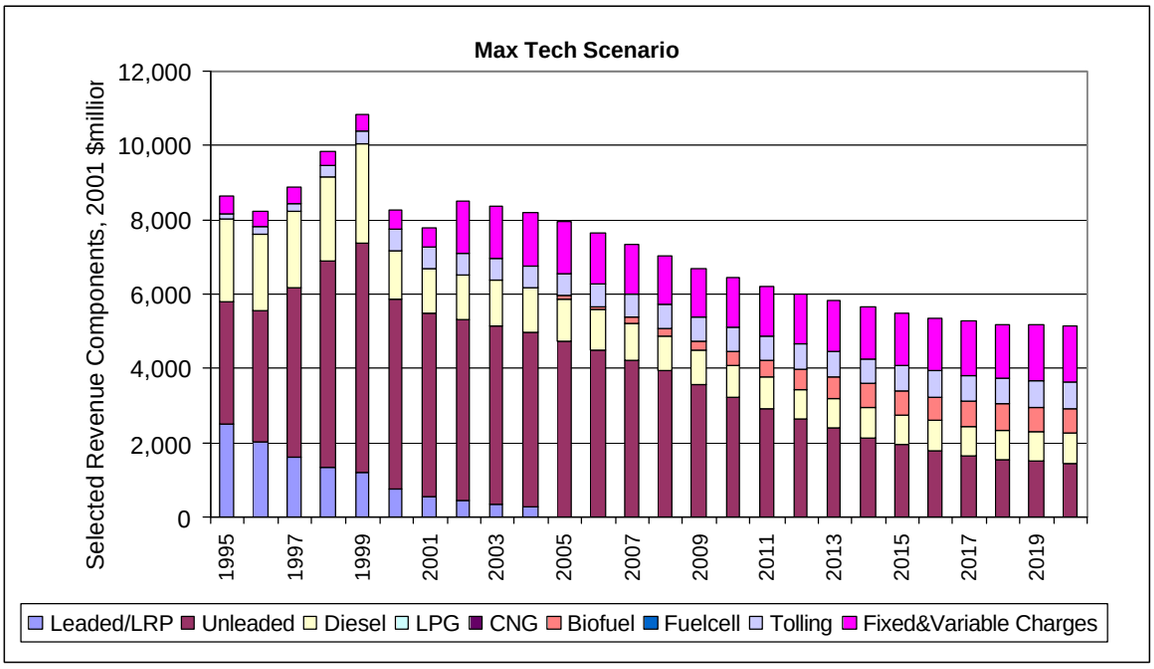
The 'scenario explorer' is able to overlay revenue streams from different scenarios. Figure 8 shows a 'maximum technology' scenario overlaid with two policy options (freeway tolling and changes to fixed and variable charges for heavy vehicles).

The main scenario variable values used are:

| | |
|---|---|
| Rigid | $0.50 per 1000 tonne-km |
| Articulated | $1.00 per 1000 tonne-km |
| Toll rates indexation | 0%pa |
| LPG/CNG Excise rates | 0 cpl, 0 cpm[3] |

As shown this policy mix results in an additional revenue of around $2bn, however, this does not counter the revenue decreases associated with the diffusion of new technologies and fuels into the fleet.

**Figure 8 - Excise, Tolling and Heavy Vehicle revenues *('Maximum technology' scenario)***




## Expenditure Envelopes

The project on which this paper is based has not examined future expenditure levels in any detail. It has, however, given consideration to future trends in road transport related demand under a number of varying assumptions. Based upon historical relationships between the level of road transport demand and the expenditure patterns of governments, it is possible to outline a range or envelope within which future expenditure may be expected to lie as a result of the pressures flowing from increasing demand. Three possible expenditure envelopes are shown in Figure 9.

## Revenue and expenditure in perspective

Using the revenue stream components projected from the scenario analysis, an example of the revenue-expenditure balance is represented in Figure 10. This Figure illustrates expected revenue components (based on the 'maximum technology' scenario). As shown, revenue-expenditure surplus is reduced to zero by year 2011 and eventually to a growing deficit of around $2bn by year 2020 (excluding GST collections). However, a break-even situation by year 2020 is estimated, if the GST portion of the revenue is accounted for in the calculations. (The reader is reminded that these are experiments using the Scenario Explorer™, which are based on a particular set of 'user controlled' assumptions and values.).

An example of the 'balance' between road revenues and expenditure that 'adds' a 3 per cent excise indexation to the Figure 10 result is presented in Figure 11. This Figure illustrates that this same maximum technology scenario experiment (see Figure 10) estimates a $2bn improvement in the 'balance' of revenue and expenditure. (Again, it is noted that the rate used to perform the indexation experiment is 'user controlled').

**Figure 9 - Expected Expenditure Levels**

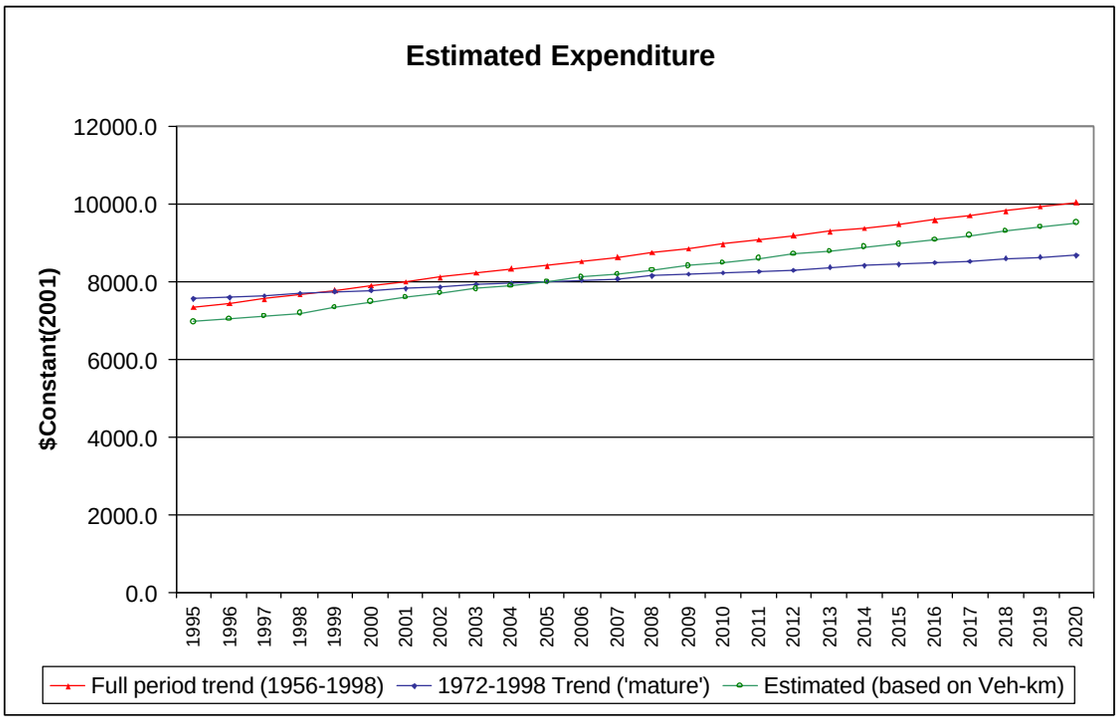



**Figure 10 – Maximum Technology Scenario**

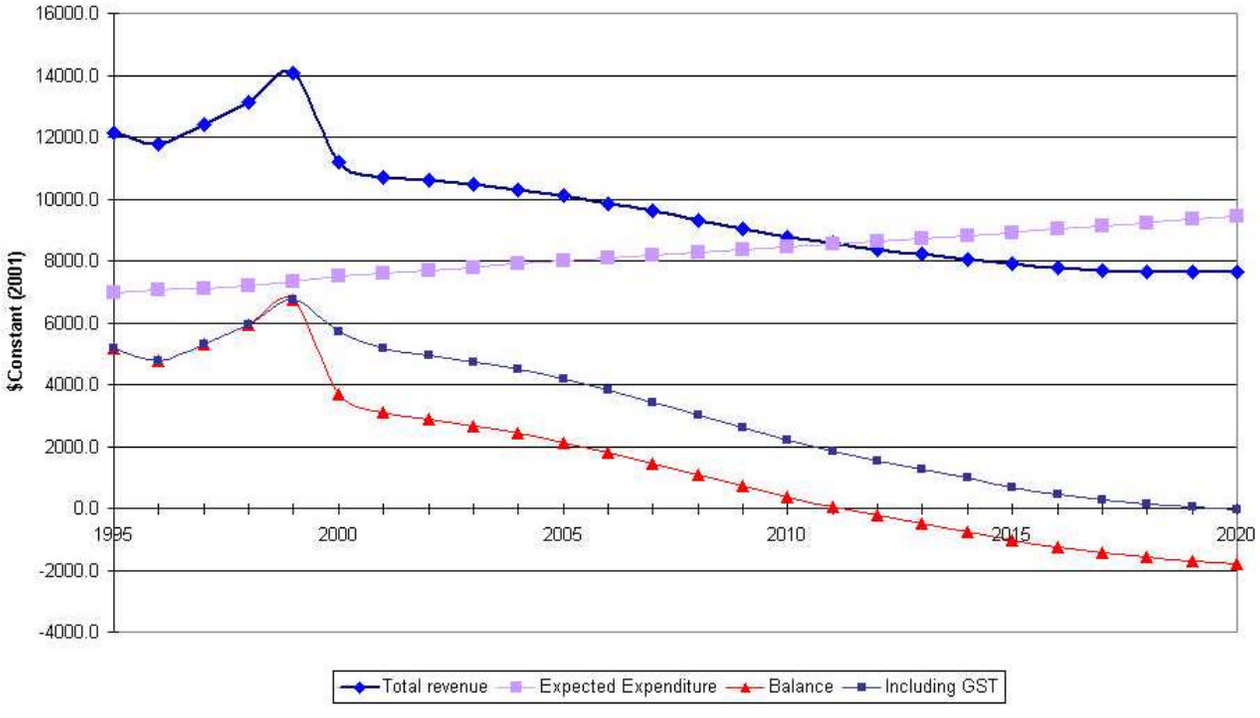
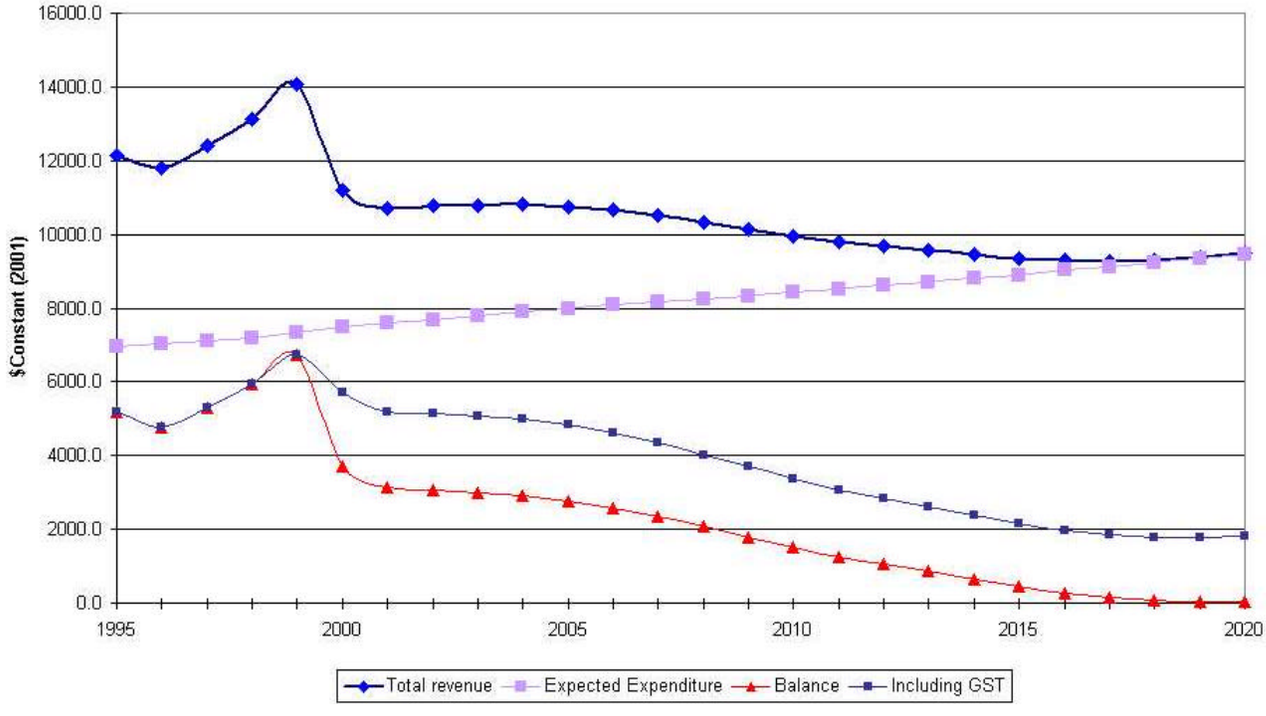


**Figure 11 – Maximum technology scenario plus excise indexation**




## Concluding remarks

A simplified scenario analysis has been used to examine the road transport related revenue implications of the effects of key drivers including technology diffusion into the vehicle fleet, new rail technology, social changes and the role of the private sector. The key points emerging from the analysis are:

- The diffusion of new technologies into the road vehicle fleet has significant implications for road transport related revenues derived from traditional sources. In particular, revenue derived from excise applied to fuel will decrease due to a range of social and technology drivers.
- In particular, the introduction of alternative fuels that do not currently attract excise will result in a reduction in the total revenue streams derived from this source. The result will be a reduction in the general revenue pool, from which, governments fund a range of service functions (including health, education, public safety and transport).
- Under the business-as-usual scenario, road related revenues (including excise, registration and other state charges, but excluding GST revenue from fuel sales) can be expected to decrease from around $10.7 billion in 2001 to around $9 billion in 2020.
- Under the 'Maximum technology' scenario, road transport related revenues (including excise, registration and other state charges, but excluding GST revenue from fuel sales) can be expected to further decrease to $7.6 billion in 2020.

- Under all scenarios, the pressure for increased road space from the continued growth in the demand for both passenger and freight travel can be expected to continue.
- The GST revenue derived from fuel consumption increases over time in real terms (as a result of increasing vehicle kilometres travelled). The GST revenue derived in the scenario explorer is based on a constant rate of GST of 10 per cent (however, this rate can be altered within the Scenario Explorer™ by the user, if desired).
- Road transport demand will continue to increase placing pressure on investment in road infrastructure. This investment will remain an important priority for governments due to the significant contribution of the road transport system to social and economic outcomes. An adequate general revenue base, that addresses the declining road transport related revenue base, will be required to enable the necessary investment in transport and other services of governments to be undertaken at a level in line with community expectations and requirements.

Overall, there is a need to consider a broad range of policy options for future revenue streams from road transport. Options in need of consideration may include, but are not limited to, the introduction of road user charging regimes which may include fixed and variable charging arrangements, freeway tolling and the replacement of excise arrangements on fuel. Demand management measures will also need to be given greater emphasis by governments as they seek to reduce the pressures for more road space from growing demand.

Finally, it needs to be reiterated that this project is not intended to recommend a policy mix that could maintain the general revenue base, rather the intent is to illustrate likely changes in the revenue streams that will lead to pressures on the road transport related revenue and road infrastructure expenditure.

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