School of Business Law and Taxation

Using Tax and Regulatory Measures to Reform Choice and Usage of Motor Vehicles for Personal Transportation in Australia for the Sustainability of Oil

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DECLARATION

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgement has been made.

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

Signature: ………………………………………….

Date: ………………………...

ABSTRACT

This thesis has been motivated by the need to preserve the scarce oil resources used by motorists for their personal transportation. The inquiry for this research was whether the government of Australia bears some responsibility for influencing Australian motorists' choice and usage of motor vehicles, in order to reduce oil consumption and preserve this scarce commodity, and whether this responsibility is being achieved within the current regulatory and tax environment.

This qualitative research has been conducted by using interpretive description and legal methodology. A tax policy solution has been suggested after investigating the problem by deconstructing prior knowledge in three areas: the status of oil reserves; the characteristics of motor vehicles that impact upon the consumption of oil; and the tax and regulatory measures that have been adopted by other countries to influence the choice and usage of passenger motor vehicles.

A critical examination of the various policy options for Australia was conducted to suggest a solution for this identified problem and this thesis proposes that the best option for Australia is to conduct a comprehensive reform of the motor vehicle taxes and charges and introduce a Luxury Energy Tax (LET) system for motor vehicles based on the precautionary principle and the polluter-pays principle.

The diagnosis of the problem and the design of a solution has been undertaken in this thesis using a step-by-step approach as follows:

1. Investigate the reported data on Australian and global oil resources.
2. Explore the need to focus on reducing oil use by passenger motor vehicles in Australia.
3. Explore the growth of passenger motor vehicle use, both globally and in Australia.
4. Explore the design and choice of passenger motor vehicles in terms of power and weight.
5. Investigate whether future car designs can resolve the oil problem.
6. Examine the current Australian regulatory and tax framework and its failure to promote oil efficiency in passenger motor vehicles.

7. Examine the regulatory and fiscal policies implemented by other countries to promote oil efficiency in passenger motor vehicles.
8. Explore specific studies on motor vehicle taxation undertaken by the Netherlands, Norway and the State of Oregon in the USA.
9. Analyse the criteria to develop a framework for Australia to promote energy-efficient passenger motor vehicles.
10. Design an interventional strategy for Australia, being a tax framework for the Luxury Energy Tax (LET).

In order to design the LET criteria, it was necessary to examine the motor vehicle characteristics that cause increased oil use and emissions and to ensure that these characteristics are taken into consideration in the design of the LET. The administration, operation and implementation of the LET system are explained in detail in this thesis. The proposed LET is then evaluated in terms of various criteria including its net revenue generation potential, the known criteria of a good tax and the ability of the tax to change behaviour. It is proposed that the revenues from the LET be directed towards building public transport infrastructure. The LET provides a new policy approach directed at resolving the problem of how passenger motor vehicles are perceived and reducing the demand for large and powerful motor vehicles that consume and diminish the limited oil resources.

This thesis identifies the opportunities that could arise through the introduction of a LET, including the design of a new micro-light LET motor vehicle and modernisation of the public transport system. The message from this thesis is that a new way of thinking is required regarding passenger vehicle transportation, and the application of this new way of thinking might bring about benefits and opportunities. This thesis also identifies that without a strong political will, these regulatory and fiscal reforms would only end up as a window-dressing exercise.

ACKNOWLEDGEMENTS AND DEDICATION

The topic of sustainability and peak oil was introduced to me by my husband as we were discussing a topic to present at a tax conference. We watched the number of motor vehicles on the road and questioned our dependency on motor vehicles for passenger transportation and whether it was necessary to drive such large and powerful motor vehicles for personal transportation. As I researched more into the topic, I realised that I had to do something more to make a difference and that taxation could be the answer.

Professor Dale Pinto was present at the tax conference and encouraged me to commence my PhD and agreed to supervise my thesis on the chosen topic. I thank Dale for not only starting me on this journey, but also for his encouragement throughout the journey and taking the time to read and comment on my work.

A search on people with interest on peak oil revealed Professor Peter Newman. I attended a seminar presented by Professor Peter Newman and after listening to Peter's presentation on what life could be like without oil made me realise that there was no turning back from this journey. Peter also agreed to supervise my thesis and I thank Peter for being a source of my inspiration and guidance.

I am also grateful to the members and directors of the Applied Law and Policy research group, for their encouragement and research support. I thank Professor Glenton Barton, for supporting my leave applications from work, without which this journey would have taken a lot longer.

The PhD journey can be a lonely endeavour. However I was fortunate to have my husband Bob to walk with me through this journey, sharing his knowledge and guiding me. I read my drafts to Bob and he would question my choices, so I could refine them. He helped me see my path through a mire of documents. I had no knowledge on motor vehicles and I thank Bob for having the patience to explain the basics of motor mechanics. Without this background understanding of the workings of a motor vehicle and the motor vehicle industry, I could not have brought the three areas of sustainability of oil, tax policy and passenger motor vehicles together in this thesis.

Finally, I acknowledge my late parents who taught me the love for life and perseverance. If not for this strong foundation rooted in love and wisdom, I could not have recognised the need to pursue on this journey to attempt to make a difference to the needs of my grandchildren and the future generations. I also thank my daughter Selina and grandchildren Joshua, Lucas and Jacob for their sacrifices whilst I undertook this arduous journey.

This thesis is dedicated to my husband, Bob Pearce, our children and grandchildren, and humanity in general.

This thesis is also dedicated to my late father and late mother for their endless love and wisdom that have made me who I am.

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LIST OF ACRONYMS

AASHTO	American Association of State Highway and Transportation Officials
ACEA	European Automobile Manufacturers' Association
ADR	Australian Design Rules
AID-EE	Active Implementation of the European Directive on Energy Efficiency
ANPR	Automatic number plate recognition
API	American Petroleum Institute
APK	Algemene Periodieke Keuring
ARF	Additional Registration Fee
ATO	Australian Taxation Office
ATW-SUV	All terrain wagon-sports utility vehicle
AVI	Audio Video Interleave
BITRE	Bureau of Infrastructure, Transport, Regional Economics
CAFC	Company Average Fuel Consumption
CAFE	Corporate Average Fuel Economy
CAT	Compressed air technology
cc	Cubic centimetres
CNG	Compressed natural gas
COE	Certificate of Entitlement
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DMV	Department of Motor Vehicles
ECU	Engine Control Unit
EIA	Energy Information Administration
EPA	Environmental Protection Agency
EROI	Energy return on investment
ESD	Ecologically sustainable development
ETAG	Electronic Tag
EU	European Union
EWG	Energy Watch Group
FHWA	Federal Highway Administration
GAO	General Accounting Office
Gb	Billion barrels
GHG	Greenhouse gas

GM	General Motors
GPS	Global positioning system
GSM	Global standard for mobile telephony
GST	Goods and Services Tax
HVO	High vehicle occupancy
IEA	International Energy Agency
IHS	Information Handling Services
JOE	Joint Operating Environment
LCT	Luxury Car Tax
LET	Luxury Energy Tax
LNG	Liquefied natural gas
LPG	Liquefied petroleum gas
Mb	Million barrels
Mbpd	Million barrels per day
MOT	Ministry of Transport
mpg	Miles per gallon
NEDC	New European driving cycle
NHTSA	National Highway Traffic Safety Administration
NOC	Network Operations Centre
NOx	Nitrogen oxide
NPRA	National Public Road Administration
OBD-II	On-Board Diagnostics-II
OBPR	Office of Best Practice Regulation
OBU	Onboard unit
ODOT	Oregon Department of Transport
OGJ	*Oil and Gas Journal*
OPEC	Organization of Petroleum Exporting Countries
OSU	Oregon State University
PARF	Preferential Additional Registration Fee
PJ	Petajoule
PM	People mover
PPP	Polluter-pays principle
PSU	Portland State University
RACQ	Royal Automobile Club of Queensland
RIS	Regulation Impact Statement

rpm	Revolutions per minute
RST	Retail Sales Tax
SUV	Sports utility vehicle
TFFC	Tax for Fuel Conservation
TPA	Technology and Policy Assessment
TPB	Theory of Planned Behaviour
URR	Ultimate recoverable reserve
VKM	Vehicle kilometres
VKT	Vehicle kilometres travelled
VMRUF	Vehicle mileage road user fee
VMT	Vehicle miles travelled
VMTCAR	Vehicle Miles Travelled Collected at Retail
WEO	World Energy Outlook
WO	*World Oil*
WOF	Warrant of Fitness

CHAPTER 1: INTRODUCTION

1.1 OVERVIEW AND PROBLEM DEFINITION

The world has a finite amount of oil resources and excessive use of a finite resource will lead to rapid depletion, especially if it is non-renewable. Global oil resources are non-renewable since the energy from oil cannot be recaptured after it has been used up. It is a well-known fact that the oil that we are accustomed to using was formed many millions of years ago.[1] The scarcity of oil was initially highlighted by the peak oil report by Hubert in the USA,[2] followed by other government and international agency reports as discussed in Chapter 2. The impact of the scarcity of oil can be observed from the energy crisis of the 1970s when the Arab members of the Organization of Petroleum Exporting Countries (OPEC) implemented an oil embargo. The embargo led to a significant increase in the price of oil and the governments of many countries imposed restrictions on motorists to economise on oil use. Petrol rationing was introduced in many countries with the distribution of ration books to motorists, leading to long queues at petrol stations.[3]

This thesis is motivated by the need to preserve the scarce oil resources used by motorists for their personal transportation. Personal observations of motor vehicles on Australian roads indicate a trend towards driving large and powerful motor vehicles. Large four-wheel drive and sport utility vehicles are increasingly common on Australian roads. Even normal motor cars appear to have increased in size when a newer model of the same type of vehicle is compared with an older model. This has brought about the inquiry in this thesis as to whether the government of Australia bears some responsibility for influencing Australian motorists' choice of motor vehicles, in order to reduce oil consumption and preserve this scarce commodity, and

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[1] Geoscience Australia and ABARE, 'Australian Energy Resource Assessment' (Assessment and Report, Australian Government Department of Resources, Energy and Tourism, 2010) Appendix F.
[2] Clifford J Wirth, 'Peak Oil: Alternatives, Renewables, and Impacts' (2008) <http://greatchange.org/ov-clifford,PeakOilAnalysisOctober6-2007.pdf> 5.
[3] David Parish, 'The 1973 – 1975 Energy Crisis and Its Impact on Transport' (Report Number 09/107, Royal Automobile Club Foundation for Motoring, October 2009).

whether this responsibility is being achieved within the current regulatory and tax environment.

The thesis first explores whether the use of available oil resources in Australia needs to be curtailed, and if so, why oil use reduction should focus on passenger motor vehicles. The answer to these questions defines the research problem requiring a solution. The solution is explored by examining the current tax and regulatory measures that are in place in Australia and determining whether the current measures have an impact upon the choice and usage of motor vehicles for personal transportation in Australia. It is argued in this thesis that the current tax and regulatory measures, including motor vehicle taxation, road user charges, excise taxes on fuel and motor vehicle regulations have not been designed with a focus on sustainability of oil or emissions control, and there is a need in Australia for specific tax measures to influence Australian people to firstly choose a personal transportation vehicle that consumes less oil, and secondly to drive less. This thesis proposes a framework within which specific tax measures can be implemented with the aim of reducing the oil use for personal transportation vehicles.

1.2 RESEARCH BACKGROUND AND CONTEXT

Over the last century the demand for large and powerful passenger vehicles has increased as they have become more than just a means of transportation. Passenger motor vehicles are often chosen as a symbol of financial success and social status, with little regard to their fuel consumption or emissions. From being a luxury in the early part of the 20^{th} century, passenger motor vehicles have become a necessity in Australia. However, if oil becomes scarcer, this necessity may once again become a luxury, disrupting the living standards and lifestyle to which Australians are accustomed, unless the Australian government takes responsibility in making appropriate policy decisions.

In September 2008, the Australian Transport Council released a public discussion paper entitled ‘Vehicle Fuel Efficiency: Potential Measures to Encourage the Uptake of More Fuel Efficient, Low Carbon Emission Vehicles'[4] and noted that engine technology in terms of fuel consumption per power output has improved substantially and there has been an improvement in fuel efficiency in the new passenger vehicle fleet. However the discussion paper states that 'potential fuel savings across the whole light vehicle fleet have been offset by increases in vehicle power, size and weight, by the strong growth in sales of four wheel drive sports utility vehicles (SUVs), and increases in the fuel consumption of light commercial vehicles.'[5] The same conclusion was also drawn by the Bureau of Infrastructure, Transport, Regional Development and Local Government (BITRE) study of the trends in new passenger vehicle fuel consumption in Australia from 1979 to 2008.[6] Studies such as these show that there is a need to reduce the power and weight of vehicles driven on Australian roads in order to conserve oil.

The trend towards driving heavy and powerful private vehicles comes at a tremendous cost to our environment in terms of depleting the limited oil resources and increasing emissions. This cost is not only borne by the people who drive vehicles, but by all humankind. The internal combustion engine was invented with the intention of conquering distance through increasing the speed by which people and goods could be transported. However, it must be questioned whether such weight and horsepower are necessary in a motor vehicle used to carry us from home to work or from one place to another. And if people wish to drive motor vehicles with such weight and power, then the next question is whether they should be deterred from making this choice through government regulations or tax policy.

The dream of a passenger motor vehicle as we know it today commenced in 1896, when Henry Ford constructed his first horseless carriage, a quadricycle. In 1903, he proclaimed that he would build a car for the great multitude, and in October 1908, he did so by producing the 'Model T'. Henry Ford consequently revolutionised the vehicle manufacturing process and by 1914, his Michigan plant could turn out a complete chassis every 93 minutes, compared with 728 minutes previously. Later,

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[4] Australian Transport Council and Environment Protection and Heritage Council Fuel Efficiency Working Group, 'Vehicle Fuel Efficiency — Potential Measures to Encourage the Uptake of More Fuel Efficient, Low Carbon Emission Vehicles' (Public Discussion Paper, Commonwealth of Australia, 2008).
[5] Ibid 16.
[6] Ibid 6–7.

the use of a constantly-moving assembly line and subdivision of labour allowed the production of Model T every 24 seconds.[7] As a result of this innovation, vehicles became affordable and facilitated greater mobility. Today, like other industrialised nations, Australia is a major consumer of vehicles.

The vehicle industry influenced Australian urbanisation policy,[8] and combined with inadequate public transport systems, the use of motor vehicles for private transportation dramatically increased from 100 cars per 1000 persons in 1945 to almost 500 cars per 1000 persons in 1971. Correspondingly, both oil use and emissions have increased, and it is now important to consider ways of reducing the reliance on oil and curbing motor vehicle emissions. Although there has been a recent trend towards increased public transport patronage and a consequent reduction in car use, both in Australia and in other countries,[9] a further increase in public transport usage in Australian cities is required to overcome motor vehicle dependence.[10]

The purpose of this research is to examine tax and other regulatory measures that the Australian government could introduce in order to reduce motor vehicle oil consumption by changing driver behaviour in the choice and usage of passenger motor vehicles. Over the last two to three decades, the need for legislative implementation of financial mechanisms to improve motor vehicle fuel efficiency in Australia has been recognised due to the extreme dependence of Australian society on motor vehicles for personal transportation. In their 1998 article, 'Legislative Implementation of Mechanisms to Improve Motor Vehicle Fuel Efficiency' published in the Melbourne University Law Review, Adrian Bradbrook and Alexandra Wawryk state that the Australian Government could introduce financial and economic measures that would encourage vehicle manufacturers to produce

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[7] Mary Bellis, *History of Transportation* (2008) About.com: Inventors <http://inventors.about.com/library/inventors/bl_history_of_transportation.htm>.

[8] See Philip Laird et al, *Back on Track: Rethinking Transport Policy in Australia and New Zealand* (University of New South Wales Press, 2001); see also Major Cities Unit, 'Our Cities: The Challenge of Change' (Background and Research Paper, Department of Infrastructure and Transport, 2010) 17–18.

[9] Garry Glazebrook, 'The Scope for Enhancing Public Transport in Australian Capital Cities' (18 June 2008) International Transport Forum <www.internationaltransportforum.org/2009/pdf/AUS_Glazebrook.pdf>.

[10] Peter Newman, Jeff Kenworthy and Garry Glazebrook, 'How to Create Exponential Decline in Car Use in Australian Cities' (2008) 45(3) *Australian Planner* 17. See also Todd Litman, 'The Future Isn't What it Used to Be' (2012) *Victoria Transport Policy Institute* <http://www.vtpi.org/future.pdf>.

more fuel-efficient vehicles and to encourage the public to purchase such vehicles.[11] The argument of this thesis is that the Australian government should introduce a new motor vehicle taxation framework in the form of a 'Luxury Energy Tax' (LET), as a partial response to the problem of oil scarcity in Australia.

There are two main reasons for the introduction of a LET. The first is that the earth has a finite amount of known oil and extractions may already have reached peak production. In 1956, US geologist M King Hubbert calculated that oil production in the US 'lower 48' states would peak in 1971. Hubbert's analysis proved correct, coming to pass in 1970, one year earlier than he had suggested.[12] After Hubbert, two senior geologists, Colin Campbell and Jean Laherrère, published a paper titled 'The End of Cheap Oil', stating that world oil fields could also peak, just as individual fields.[13]

Peak oil is often misunderstood as the point at which oil runs out, however this is not the case. Peak oil is the point where further expansion of oil production becomes impossible, because new flows are fully offset by production declines or depletion. When the oil field reaches maturity the production volumes decline. The cost of extraction far outweighs the return on volumes of oil extracted and as a result the oil field is abandoned.[14] It is difficult to extract oil from a well in the second half of the well's life because pressures are lower, water contamination is more likely and the remaining oil is found in increasingly hard to reach parts of the reservoir system.[15]

A number of reports by various governments and international agencies are discussed in Chapter 2 and they indicate that many countries, including Australia, have already reached peak production. The question of whether Australia has sufficient oil to meet demand and whether it can rely on the supply of oil from other countries is also discussed in Chapter 2, along with the reported estimated remaining proven reserves

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[11] Adrian Bradbrook and Alexandra Wawryk, 'Legislative Implementation of Financial Mechanisms to Improve Motor Vehicle Fuel efficiency' (1998) 22(3) *Melbourne Law Review* 537.
[12] Cutler Cleveland, *Nuclear Energy and the Fossil Fuels (historical)* (1 June 2010) Encyclopedia of Earth <http://www.eoearth.org/article/Nuclear_Energy_and_the_Fossil_Fuels_(historical)>. Original work is cited as Marion King Hubbert, 'Nuclear Energy and the Fossil Fuels' (Publication No 95, Shell Development Company, Exploration and Production Research Division, 8 March 1956).
[13] Colin J Campbell and Jean H Laherrère, 'The End of Cheap Oil' (1998) March *Scientific American* 79.
[14] Global Witness, 'Heads in the Sand? — Governments Ignore the Oil Supply Crunch and Threaten the Climate' (Report, Global Witness, 20 October 2009) 30.
[15] Richard Gilbert, 'Hamilton: The Electric City' (2006) *City of Hamilton* <http://richardgilbert.ca/Files/2006/Hamilton--Electric%20City%20(Web).pdf> 9.

of oil forecast by various government and international agencies. The Australian government considers that Australia has limited crude oil resources and only enough to last 10 years.[16] It also states that world oil reserves were estimated at some 1400 billion barrels[17] at the end of 2008. This is equivalent to around 42 years of supply at current production rates.[18]

The Energy Watch Group's 2008 report estimates that the world oil proved reserves amount to approximately 1255 billion barrels. The estimated world consumption in 2005 was 30.3 billion barrels, increasing every year.[19] The Energy Information Administration (EIA), a US government agency, has projected that oil will continue to be a major source of energy in the coming decades, with consumption of about 118 million barrels per day by 2030, totalling about 43 billion barrels per year.[20] This could mean that within the next 30 to 50 years, there may not be enough supplies to satisfy the demand for oil.

As already mentioned, the impact on life of an insufficient oil supply can be gleaned by looking back at the time of the oil embargo in 1973 when OPEC stopped exports of oil to the US and other western nations. The embargo produced chaos in many countries and governments targeted motorists to reduce oil consumption, imposing oil rationing and reduction in speed limits in order to conserve oil.[21] This strongly suggests that Australia should make changes to societal behaviour in order to promote the recognition that oil is non-renewable and its supply is not guaranteed; its use should be curtailed by implementing appropriate government policies.

It is submitted that the first place to start is by cutting down on passenger motor vehicle oil use by encouraging people to drive less, and to drive lighter and less powerful vehicles. This is the second reason for the need to introduce a LET in Australia, and is further discussed in Chapter 3 of this research. In Australia, 34 per

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16 Geoscience Australia and ABARE, above n 1, 4.
17 One barrel is equivalent to 42 US gallons or 159 litres.
18 Geoscience Australia and ABARE, above n 1, 41.
19 Jörg Schindler and Werner Zittel, 'Crude Oil — The Supply Outlook' (Report, Energy Watch Group, 2008) <http://www.energywatchgroup.org/fileadmin/global/pdf/2008-02_EWG_Oil_Report_updated.pdf>.
20 US Government Accountability Office, 'Report to Congressional Requesters: Crude Oil: Uncertainty about Future Oil Supply Makes it Important to Develop a Strategy for Addressing a Peak and Decline in Oil Production' (Report No GAO-07-283, 2007) <http://www.gao.gov/new.items/d07283.pdf>.
21 David Parish, 'The 1973–1975 Energy Crisis and its Impact on Transport' (Report Number 09/107, Royal Automobile Club Foundation for Motoring, October 2009) 4–6.

cent of the national fuel energy consumption is from petroleum products and the largest industry consumer of energy is transportation.[22] Between 70 to 80 per cent of the energy consumption by the transportation sector in Australia is related to road transport vehicles, and passenger vehicles accounted for 77.2 per cent of all vehicles registered in Australia at 31 March 2008.[23]

In Australia, there were 15.3 million motor vehicles registered at 31 March 2008, of which 11.8 million were passenger vehicles. The average age of passenger vehicles in Australia was 9.7 years at 31 March 2008.[24] Thus more than a decade of planning would be required to achieve a significant improvement in overall fuel efficiency. This suggests that the introduction of laws and regulations such as a LET should occur sooner rather than later.

The introduction of a LET will also assist in reducing greenhouse gas (GHG) emissions. Many scientists are warning that without a reduction of GHG emissions, it will be impossible to avoid irreparable damage to the planet's habitability for human civilisation. A climate crisis demands immediate action to sharply reduce carbon dioxide emissions worldwide, in order to turn down the earth's thermostat and avert a catastrophe.[25] Most developed countries have adopted the Kyoto recommendations in reducing GHG emissions. By implementing the Kyoto recommendations, Australia has accepted the challenge of reducing GHG emissions, and to achieve this, the Australian government has recently introduced a carbon pricing mechanism in the *Clean Energy Act 2011* (Cth) and related legislation. However, fuels used for personal transportation have been excluded from the mechanism.[26] Thus the LET proposed in this thesis aims to help reduce GHG emissions arising from the use of transportation fuels in passenger motor vehicles.

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[22] Australian Bureau of Agricultural and Resource Economics and Sciences, 'Energy in Australia 2010' (Report, Department of Resources Energy and Tourism, 16 April 2010) 12–15.
[23] Australian Bureau of Statistics, *Motor Vehicle Census, Australia, 31 Mar 2009* (Catalogue No 9309.0, 31 March 2009).
[24] Ibid.
[25] Al Gore, 'Former Vice President Gore Gives a Major Policy Address at the NYU School of Law' (Speech delivered at New York University School of Law, New York, 18 September 2006)
[26] Explanatory Memorandum, Clean Energy Bill 2011 (Cth) 12.

The Australian government's report on transport emission projections[27] states that passenger cars are the largest source of emissions in the transport sector, accounting for almost half of the transport emissions in 2009. The increase in emissions reportedly relates to total passenger vehicle kilometres travelled and the fuel efficiency of the vehicle fleet.[28] The report also states that the size and technology of future new cars is highly uncertain, as it depends on consumer choices.[29] In response to these comments, the Australian government has revealed its intention to introduce mandatory carbon dioxide emission standards that will apply to new light vehicles from 2015, and a discussion paper was released in 2011 to elicit views from interested parties on key issues that would need to be addressed in the development of the standards.[30]

There are other reasons for introducing a LET, including enhancements to urban amenity, encouragement of a more active lifestyle, health benefits arising from traffic reduction, decreasing the incidence of automobile accidents, and economic benefits arising from reduced car dependence, but this thesis will focus on oil scarcity. It will be argued that it is necessary to consider a LET to change people's behaviour and their perception of large vehicles, and to encourage people to drive vehicles that use less fuel and to drive less, thereby conserving oil and reducing emissions. The issue of climate change is well covered in the literature and is a major focus of public policy. However the looming global scarcity of oil is not so well covered. Thus this thesis will focus on the rationale of oil scarcity as the basis for considering a LET on vehicles.

There are two ways of dealing with change. One is through voluntary measures to raise awareness, and improve availability of information and support for people to try alternative modes of transportation instead of driving their vehicles. The other is a strict compulsory approach, which could include appropriate tax measures. The current approach adopted by the Australian government is the voluntary approach, which is reflected in projects such as TravelSmart, in all states in Australia. For

[27] Department of Climate Change and Energy Efficiency, 'Transport Emission Projections 2010' (Report, Commonwealth of Australia, 2010) 2.
[28] Ibid 9.
[29] Ibid 11.
[30] Department of Infrastructure and Transport, 'Light Vehicle CO_2 Emission Standards for Australia: Key Issues' (Discussion Paper, Commonwealth of Australia, 2011).

example, in Western Australia, TravelSmart Household is a personalised travel service to help the community make better use of available travel options by replacing car trips with walking, cycling or using public transport.[31]

This thesis explores why compulsory means such as taxation may be a more effective tool to change the way personal transportation is perceived. The imposition of a specific tax can also address the problematic issue of transport demand management.[32] As early as the 1920s, economists applied road pricing to deal with the external costs of transportation, such as congestion, accidents, risk, noise and emissions.[33] Many countries use taxation as a means to address transport demand management.

Singapore has a vehicle quota system that was implemented on 1 May 1990, and which restricts the number of vehicles on Singaporean roads.[34] The Dutch government approved a plan to replace their transportation taxes with a system that charges drivers based on how much they drive. With technology known as Mobimiles, charges were to be tallied for each car and billed at regular intervals.[35] In 2003, the Greater London Council in England introduced a congestion charge for driving on certain roads in London.[36] Since 2000, the Swiss government has required all Swiss trucks to install an onboard unit (OBU) and imposes road usage fees using GPS technology.

Taxation, combined with other regulatory rules, can be effective in changing behaviour. An example is smoking, where the government is passing a message to the community by banning smoking in public places and imposing excise duties on

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[31] Australian Greenhouse Office, *TravelSmart Snapshots* (2005) Department of the Environment and Heritage <http://www.environment.gov.au/settlements/transport/publications/travelsmart-snapshots.html>.
[32] Transport demand management consists of a group of factors generating the total volume of travel and includes the travel undertaken, the trip length, the mode used and vehicle occupancy. See Stephen Potter, 'Sustainability, Energy Conservation and Personal Transport' in Warren J (ed), *Managing Transport Energy* (Oxford University Press, 2007) 9.
[33] See A C Pigou, *The Economics of Welfare* (Macmillan, 1920) in F H Knight, 'Some Fallacies in the Interpretation of Social Cost' (1924) 38 *Quarterly Journal of Economics* 582.
[34] Lew Yii Der and Leong Wai Yan, 'Managing Congestion in Singapore — A Behavioural Economics Perspective' (2009) May *Journeys*17.
[35] Ministry of Transport, Public Works and Water Management, 'A Different Way of Paying for Road Use Impacts on Traffic, Environment & Safety, Technology, Organisation, Enforcement and Costs Management Summaries' (Management Summaries, Ministry of Transport, Public Works and Water Management, March 2005) 20.
[36] Transport of London, *Congestion Charge, How it Works* <http://www.tfl.gov.uk/roadusers/congestioncharging/6718.aspx>.

cigarettes. By introducing the *Clean Energy Act 2011* (Cth), the Australian government is showing its support of behaviour-changing taxation, and economists have urged governments to make more use of the taxation of 'bads', such as pollution, traffic congestion and anti-social consumption, as opposed to 'goods'.[37] It has been argued that if consumers can be convinced of the link between environmental disaster and non-renewable energy sources, drivers of heavy and fuel-guzzling vehicles will be shunned and fuel taxes will be viewed as an acceptable 'evil'.[38]

This thesis submits that there is a need for a tax that will promote a change in driver behaviour towards using lighter and less powerful vehicles, therefore reducing emissions and reducing dependence on foreign oil. A specific motor vehicle tax framework to reduce the consumption of oil may be an option, as canvassed by Pigou.[39] The introduction of a LET may influence people both to choose personal transportation vehicles that consume less fuel, and to drive less. Most consumers only change their behaviour when there is a financial incentive to do so.

In this thesis a case is made for the introduction of tax measures in order to lead to a new way of thinking about oil management. The tax would relate to vehicles and their use, and not where the vehicles are manufactured. A new way of thinking is required as it takes millions of years for our planet to produce oil, but it takes an instant to burn it, and once burnt, it is irrecoverable. The tax measures proposed in this thesis are therefore evaluated not only for their revenue-raising capacity, but also the savings in oil they can achieve. They are also evaluated for the potential for change in human behaviour using theories such as the theory of planned behaviour,[40] and are examined in light of the generally accepted tax policy principles first enunciated by Adam Smith in 1776: that a tax should be certain and simple to

[37] Alan Mitchell, 'Trouble Taxing Bad Behaviour', *Australian Financial Review* (Melbourne), 17 October 2011, 23.
[38] Roberta F Mann and Mona L Hymel, 'Getting Into the Act: Enticing the Consumer to Become "Green" Through Tax Incentives' (2006) 36 *Environmental Law Reporter* 10419.
[39] Arthur C Pigou, *The Economics of Welfare* (Macmillan and Co, 1920) in John Freebairn, 'Environmental Taxation and its Possible Application in Australia' (Paper prepared for the Treasury, Canberra, May 2009).
[40] See Icek Ajzen, 'The Theory of Planned Behavior' (1991) 50 *Organizational Behavior and Human Decision Processes* 179.

understand, it should be convenient and economical to collect, and it and should take into account the taxpayers' ability to pay the tax.[41]

1.3 RESEARCH QUESTIONS AND RESEARCH OBJECTIVES

The aim of this research is to establish that there is a need to change current Australian policy in order to influence the choice of passenger motor vehicles necessary to affect oil sustainability. Once this need is established, then the approach adopted is to examine the tax policies and legal options used by other countries to promote energy efficiency in passenger motor vehicles. The thesis proposes a tax framework for Australia that not only takes into account the inbuilt factors in vehicles which cause excessive fuel use, ie the weight, the engine capacity, the power output and emissions produced, but also the distance driven.

The core research questions are:

1. Is there a need to reform the design, choice and usage of passenger motor vehicles in Australia in order to sustain the limited oil resources?
2. What are the realistic tax measures that can be implemented and what criteria should the design of tax framework take into account to reform the choice and usage of motor vehicles for personal transportation in Australia in order to reduce the consumption of oil?

To answer these questions, four objectives provide the framework for this thesis:

1. To investigate the reported Australian and global oil resources.
2. To explore the need to focus on reducing passenger motor vehicle oil use in Australia.

[41] Asprey Committee, Commonwealth of Australia, *Full Report of the Commonwealth Committee on Taxation* (1975). Also see Peter D Groenewegen, *Public Finance in Australia* (Prentice-Hall of Australia, 3rd ed, 1984).

3. To examine tax policies and legal options used by other countries that promote passenger motor vehicle energy efficiency and influence the choice of personal transportation.
4. To address the Australian tax policy reform and other regulatory reforms required to reduce the use of oil in passenger motor vehicles and propose a framework by utilising lessons learnt from other countries.

1.4 RESEARCH DESIGN AND METHODS

This part articulates the research design and methodology which has been adopted to answer the research questions of the thesis.

1.4.1 Research Framework

The research framework or paradigm to answer the research questions and objectives for this thesis is non-positivism or interpretivism using inductive legal reasoning.

A research framework or 'paradigm' as advocated by Guba and Lincoln is a system of philosophical beliefs or worldviews that leads and governs an investigation or individuals, respecting their position in the world and the range of possible relationships to it and its parts.[42] Therefore the research paradigm shapes the entire research process and provides valuable directions, principles concerning the approach, methods and techniques for conducting research within its philosophical setting.[43] The traditional view has been that the framework adopted reflects the beliefs of the researcher in terms of ontology (how the researcher views the world) and epistemology (the researcher's belief of how knowledge is created).[44]

The literature on research methodology evidences extensive and constant debate concerning the best approach for carrying out research. McKerchar notes that the

[42] Egon Guba and Yvonna S Lincoln, 'Competing Paradigms in Qualitative Research' in Norman K Denzin and Yvonna S Lincoln (eds), *The Sage Handbook of Qualitative Research* (Sage Publications, 2nd ed, 1994) 163.
[43] Ibid.
[44] Margaret McKerchar, *Design and Conduct of Research in Tax, Law and Accounting* (Thomson Reuters, 2010) 71.

substantial body of existing literature on the design and conduct of research states that two leading research paradigms are generally acknowledged by research methodologists in social science and other disciplines. These are the positivist paradigm and the interpretive or phenomenology paradigm.[45]

The positivist paradigm is rooted in natural science with an emphasis on experimental scientific observation to explain and test cause and effect relationships of an event. By contrast, the interpretive paradigm is founded on the humanities with an emphasis on holistic and qualitative information to provide rich insights into components of a social phenomenon.[46] The interpretive theorist sees the social world as possessing an uncertain ontological status and the truth is socially construed.[47] Therefore, according to Hassard, the best way to understand the social world is from the point of view of the investigated participant.[48] The interpretive approach endeavours to understand meanings of particular situations,[49] and under this approach, the researcher acquires a rich and empathetic understanding of social life aspects and experiences.[50]

The research for this thesis falls within the interpretive paradigm, being socio-legal research that is reform-oriented. Whilst positivism can provide the theoretical underpinning for doctrinal legal research which is the 'black letter law' research, McKerchar notes that the positivist paradigm is not appropriate for socio-legal research which requires an understanding of people's behaviour. The current research is non-doctrinal about law and not a study in law, in that the law is sought to provide a solution to a problem related to the sustainability of oil and people's choice of motor vehicles for personal transportation. The current study is broad and requires both inductive and deductive reasoning to construe possible explanations and derive

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[45] Ibid 70.
[46] Torsten Husen, 'Research Paradigms in Education' in John P Keeves (ed), *Educational Research, Methodology and Measurement: An International Handbook* (Pergamon Press, 1988) 17.
[47] Gregory Ticehurst and Anthony Veal, '*Business Research Methods: A Managerial Approach'* (Pearson Education, 2000).
[48]John Hassard, '*Sociology and Organisation Theory: Positivism, Paradigms and Postmodernity'* (Cambridge University Press, 1993).
[49]Thomas Schwandt, 'Constructivist, Interpretivist Approaches to Human Inquiry' in Norman K Denzin and Yvonna S Lincoln (eds), *The Sage Handbook of Qualitative Research* (Sage Publications, 2nd ed, 1994) 163.
[50] John K Smith and Lous Heshusius, 'Closing Down the Conversation: The End of the Quantitative-Qualitative Debate Among Educational Inquiries' (1986) 15(1) *Educational Researcher* 4.

conclusions in order to resolve the research questions and the research objectives stated above.

1.4.2 Methodology

The choice of research framework influences the choice of methodology. Methodology is the middle ground between philosophical discussion on theoretical frameworks and discussion on the methods. The methodology used for this research is a combination of qualitative interpretative description and reform-oriented legal research.

a. Interpretive Description

Interpretive description is a qualitative research approach developed by Sally Thorne, Reimer Kirkham and MacDonald-Emes in 1997, and has been mainly used in nursing science. Since interpretive description is a relatively new theoretical framework, its foundation is discussed here with an explanation of why it is suitable for this research.

The theoretical or philosophical underpinnings for interpretive description are firmly aligned with interpretive naturalist orientations such as those delineated by Lincoln and Guba, which include:

- There are multiple construed realities that can be studied only holistically. Thus, reality is complex, contextual, construed and ultimately subjective.
- The inquirer and the 'object' of inquiry interact to influence one another; indeed, the knower and known are inseparable.
- No a priori theory could possibly encompass the multiple realities that are likely to be encountered; rather, the theory must emerge or be grounded in the data.[51]

[51] Sally Thorne, Sheryl Reimer Kirkham and Katherine O'Flynn-Magee, 'The Analytic Challenge in Interpretive Description' (2004) 3(1) *International Journal of Qualitative Methods* 5.

Interpretive description is an articulation of a qualitative approach to description with an interpretive or explanatory flavour. It offers the potential to deconstruct the angle of vision upon which prior knowledge has been erected to generate new insights that shape new inquiries and applications.[52]Thorne states that in interpretive description, findings reflect an interpretive manoeuvre within which the researcher considers what the pieces might mean, individually and in relation to one another, including the sequence of presentation that the researcher uses that leads the eventual reader toward a kind of knowing that was not possible prior to the study.[53] The new organised structures in themselves may not advance knowledge. However, when the organising structures are given subjective interpretation and experience and they reveal new possibilities in the relationship between subjective experience and conceptual knowledge, then they will have achieved their essential purpose.[54]

The research in this thesis offers the potential for deconstructing prior knowledge in three areas, these being the status of oil reserves; the characteristics of motor vehicles that impact upon the consumption of oil; and the tax and regulatory measures which may be adopted by countries to influence the choice of passenger motor vehicles. These three areas when viewed independently do not create new knowledge. However, putting the knowledge in these areas together gives rise to a new inquiry and a need to investigate a solution through tax and regulatory reform.

The core elements of interpretive description are interpretation, analysis and description. Interpretation is a process and a product of mulling over. According to Wolcott, 'When you emphasize description, you want your reader to see what you saw. When you emphasize analysis, you want your reader to know what you know. When you emphasize interpretation, you want your reader to understand what you think you yourself have understood.'[55] Interpretive description accomplishes all three in different ratios and for different purposes. The decisions that the researcher makes and the groundings to achieve that aim creates the foundation for the manner in which the analytic process will transform data to become the written report.[56] The

[52] Sally Thorne, *Interpretive Description* (Left Coast Press, 2008) 35.
[53] Ibid.
[54] Ibid 175.
[55] Harry F Wolcott, *Transforming Qualitative Data: Description, Analysis, and Interpretation* (Sage Publications, 1992) 412. See Thorne, above n 52, 163.
[56] Thorne, above n 52, 163.

current research applies all three core elements of interpretive description in answering the research questions and the research objectives.

Interpretive description requires working with data conceptually. Concepts are mental devices for organising ideas so that the idea can be communicated to build knowledge. There are four sequential cognitive processes that are required in conceptualising data in interpretive description. These are: comprehending; synthesising; theorising and recontextualising.[57] A good thematic description or summary can then show the reader how elements within the larger phenomenon can be ordered and organised to reveal new ideas.[58] The cognitive processes are applied to this thesis as discussed under methods and techniques below.

Interpretive description is a meaning-making activity, directed towards the purpose of rendering a new, enriched or expanded way of making sense of some problem or issue. In order to retain its quality, it must retain that sense of direction throughout the process so that the claims it has generated are consistent with the steps that comprised the generation. This thesis aims to achieve the sense of direction necessary to resolving the research questions.

Although interpretative description is new and has a health profession focus, it can readily be adapted to the current research due to its focus on sustainability which is also new and demands a new kind of methodology. Moreover, there are obvious similarities between this research and the research conducted in the nursing environment, although they are in two different fields. An example of health research where interpretive description has been used is in health care communication issues in multiple sclerosis, especially from the period of the onset of symptoms to the point of diagnosis and treatment.[59] Interpretive description was used to answer compelling, complex and contextually embedded questions relevant to nursing practice. It allowed the researcher to articulate a meaningful account of the knowledge with the aim of providing a backdrop for assessment, planning and interventional strategies.[60] The patterns and themes are ordered into a story or professional narrative in order to

[57] Ibid 165–66.
[58] Ibid 173.
[59] Sally Thorne et al, ‘Health Care Communication Issues in Multiple Sclerosis: An Interpretive Description’ (2004) 14(1) *Qualitative Health Research* 5.
[60] Thorne, Kirkham and O’Flynn-Magee, above n 51, 6.

influence the choices in the construction of the research product and taking into consideration the needs of the audience.

Interpretive description is suitable for the current study as it assists in diagnosing not a medical problem, but the problems arising from the limited supply of oil for personal transportation. The research questions are aimed at identifying the symptoms and consequences if no action is taken. Using interpretive description in this study has made it possible to obtain a meaningful account of the knowledge of oil resources, the impact of oil use on motor vehicles used for personal transportation, and an assessment of the current regulatory and tax environment. This knowledge has provided the backdrop for assessment, planning and interventional strategies. The questions in the current study are quite complex and broad. The diagnosis of the problem and design of the solution using interpretive description has been a step-by-step approach as follows:

1. To investigate the reported Australian and global oil resources.
2. To explore the need to focus on reducing oil use by passenger motor vehicles in Australia.
3. To explore the growth of passenger motor vehicle use, both globally and in Australia.
4. To explore the design and choice of passenger motor vehicles in terms of power and weight.
5. To investigate whether future car designs can resolve the oil problem.
6. To examine the current Australian regulatory and tax framework and its deficiency in promoting oil efficiency in passenger motor vehicles.
7. To examine the regulatory and fiscal policies implemented by other countries to promote oil efficiency in passenger motor vehicles.
8. To explore specific studies on motor vehicle taxation undertaken by the Netherlands, Norway and Oregon.
9. To analyse the criteria to develop a framework for Australia to promote energy-efficient passenger motor vehicles.
10. To design an interventional strategy for Australia, being a tax framework for the Luxury Energy Tax (LET).

b. Legal Research

In conjunction with interpretive description, legal research methodology has also been employed for this study. McKerchar notes that there is increasing evidence of researchers drawing from more than one paradigm or using more than one strategy of inquiry from within the same methodology. This can assist researchers who are driven by the purpose of the question and not necessarily bound by any one paradigm.[61]

The Pearce Committee identified two typologies of legal research: doctrinal or non-doctrinal, and further divided non-doctrinal research into reform-oriented and theoretical research.[62] Doctrinal research is based on the 'black-letter' or literal analysis of legal rules and principles, relying on a deductive form of legal reasoning. Non-doctrinal research is concerned with people, social values and social institutions.[63] The legal research employed for this thesis is non-doctrinal as opposed to doctrinal research. Doctrinal research is not appropriate for this research as its scope is usually narrow and excludes any policy or societal implications, whereas this thesis is premised on the societal implications associated with the sustainability of oil, the implications of peak oil and the oil crisis from an international perspective, and the need to use motor vehicles for personal transportation. This research is reform-oriented, identifies the gap in the current laws in Australia and proposes a framework based on the desirable characteristics of a tax structure, taking into consideration the legal options used by other countries to promote energy efficiency of passenger motor vehicles and influence the choice of personal transportation.

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[61] Margaret A McKerchar, 'Philosophical Paradigms, Inquiry Strategies and Knowledge Claims: Applying the Principles of Research Design and Conduct to Taxation' (2008) 6(1) *eJournal of Tax Research* 14.

[62] Dennis Pearce, Enid Campbell and Don Harding, *Australian Law Schools: A Discipline Assessment for the Commonwealth Tertiary Education Commission* (AGPS, 1987). See McKerchar, above n 61, 5.

[63] McKerchar, above n 61, 13.

c. Methods and Techniques

The epistemological foundation of interpretive description allows for the use of established qualitative data collection and analysis. This research has used an iterative process of collecting information mainly from published documents, meaning that the collection and analysis of data has been rhythmic, intertwined and repetitive and the interpretation is inductive.

The first step focused on establishing the existing knowledge, and was achieved by gathering information within the context of the research purpose. Based on the scope of the research questions, some primary source documents and mainly secondary source documents were gathered. The primary source materials included those relevant to the current laws of Australia, such as cases and legislation sourced from the Australasian Legal Information Institute.[64] The secondary source materials were obtained from a variety of textbooks, scholarly journal articles, government reports, institutional reports, records of discussions at round table conferences and government statistics. Australian and foreign libraries, government organisations, institutional organisations and research bodies were used to obtain the secondary source documents. Documents from foreign countries such as the Netherlands and Norway needed translation into English, which was done using the facility available through Microsoft Word.

The next step was to sample and code the documents. Documents that were relevant to the research questions were then grouped according to the question of inquiry.

The following step involved reading, analysing, interpreting and summarising. This process was carried out methodically and in detail so that an interpretation of the document could be summarised. Initial reflections were carried out on the key parts of information in each document. The materials were worked through to identify similarities and differences. Commonalities were established and differences were grouped creating a basic level of generalisation. The generalisations were then linked together, compared and analysed to extract the meaning and message in order to answer each research question and draw conclusions. The researcher's analytic

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[64] See Australasian Legal Information Institute (12 June 2012) <www.austlii.edu.au>.

process was applied to bring out construed truths, and the data was then recontextualised and the information converted into findings.

Opportunities for triangulating the data obtained from documents came largely through round table conference reports, verbal advice and feedback from participants of various conferences on environmental tax and transportation.

The methods and techniques used fall within both the interpretive description and the legal methodology that has been adopted in this research. The usual range of data collection methods that are not normally considered in 'academic' research is encouraged by interpretive description. Thorne notes that this flexibility encourages data and research to be looked at from a broader epistemological perspective and asserts that 'staying overlong in the microscopic view of the trees has the tendency to blur one's perspective on the forest, and so it becomes important to move in and out of the detail.'[65] Thorne further states that the data analysis needs to 'trigger your innate curiosity, and to follow the many lines of fascinating inquiry that your inductive processes illuminate.'[66] Interpretive description not only requires immersion and intimate knowledge of the data, but a constant reflection on the data is required to develop new insights that allow the redevelopment of responses.[67]

McKerchar also notes that collecting data sequentially allows the findings from one strategy to inform another.[68] This research identifies a problem in humanities and recommends a solution through tax policy.

d. Ethical Considerations

This research has been conducted according to the Curtin University of Technology ethical guidelines. The checklist found in the Form C Application for Approval of Research with Low Risk (Ethical Requirements) Guidelines was completed in order to identify any considerations that may arise and require ethical approval. The conduct of this research did not require any ethical approval

[65] Thorne, Kirkham and O'Flynn-Magee, above n 51, 14.
[66] Thorne, above n 52, 155.
[67] Thorne, Kirkham and O'Flynn-Magee, above n 51, 13.
[68] McKerchar, above n 61, 15.

from the Human Research Ethics Committee at Curtin University of Technology. The research also satisfies the School of Business Law and Taxation guidelines for conducting research.

1.5 COVERAGE AND SCOPE

The scope and coverage of this thesis extends to the need to change current Australian tax policy measures in order to influence the way drivers choose their motor vehicles for personal transportation, in order to address the issues of oil sustainability and climate change. Climate change is only addressed to the extent that a reduction in the use of oil has an effect on it. Climate change policy, including the proposed carbon reduction scheme, is not examined in this research. Rather, the research assesses whether the sustainability of oil is a factor that currently influences the choice of motor vehicles for personal transportation in Australia and whether the current regulatory and tax policy in Australia bear any influence on drivers who make that choice.

The thesis does not explore other alternative ideas to reduce energy use, such as tradeable energy quotas. The purpose of tradeable energy quotas is premised on fair entitlement to energy by using a form of rationing system and simply and efficiently measuring all emissions from energy use within a national economy. Thus tradeable energy quotas target fuels and electricity. This thesis only deals with the sustainability of oil used by motor vehicles for personal transportation and therefore tradeable energy quotas have not been examined in this thesis.

The focus of this research is from a policy perspective and does not include economic financial modelling within its scope. Further, this research only focuses on personal transportation in passenger motor vehicles, ie a car designed to carry passengers, and not commercial motor vehicles used for business or freight transportation, for three reasons. Firstly, it can be argued that personal transportation can be reduced without having a direct impact on the production of goods and services. Secondly, businesses are likely to pass on their costs and therefore are less likely to change their behaviour. Thirdly, between 70 and 80 per cent of the energy consumption by the transportation sector in Australia is related to road transport vehicles, and passenger vehicles accounted for 77.2 per cent of all vehicles registered in Australia at 31 March 2008.[69]

1.6 THESIS STRUCTURE AND ORGANISATION

This thesis comprises eight chapters within the context of the core research questions and objectives. The core research questions are:

1 Is there a need to reform the design, choice and usage of passenger motor vehicles in Australia in order to sustain the limited oil resources?

2 What are the realistic tax measures that can be implemented and what criteria should the design of a tax framework take into account to reform the choice and usage of motor vehicles for personal transportation in Australia in order to reduce oil consumption?

To answer these questions, four objectives provide the framework for this thesis:

1. To investigate the reported Australian and global oil resources.
2. To explore the need to focus on reducing the use of oil in passenger motor vehicles in Australia.
3. To examine tax policies and legal options used by other countries that promote passenger motor vehicle energy efficiency and influence the choice of personal transportation.
4. To address the Australian tax policy reform and other regulatory reforms required to reduce the use of oil in passenger motor vehicles and propose a framework by utilising lessons learnt from other countries.

Chapter 1 presents the rationale for the research and defines the research problem. The chapter articulates and justifies the research paradigm, the methodology and the data collection methods and techniques used for this thesis, together with any ethical considerations. It also identifies the purpose and scope of the research.

[69] Australian Bureau of Statistics, above n 23.

Chapter 2 provides an analysis within which part of the first research question is framed, ie the sustainability of oil and the implications of peak oil and the oil crisis from an international perspective. This chapter deals with the first research objective: To investigate the reported Australian and global oil resources by examining reported data on known or proven oil reserves, the rate of depletion and evidence of a peak in oil supply, from both the Australian and global perspectives. The concerns of the global community and implications of peak oil are also stated in order to assess the need to reduce the use of oil in passenger motor vehicles.

Chapter 3 also provides an analysis within which part of the first research question and the second research objective are framed, ie the need to reform the choice and usage of passenger motor vehicles in Australia. This chapter explores the growth of motor vehicle use, both globally and in Australia, and the reliance on motor vehicles for personal transportation. It also examines the design and choice of motor vehicles used for personal transportation to determine whether this is sustainable or a change is required. Future motor vehicle designs and their limitations are also discussed in this chapter.

Chapter 4 addresses the third research objective: To examine tax policies and legal options used by other countries that promote passenger motor vehicle energy efficiency and influence the choice of personal transportation. The review pertaining to the role of the law in providing regulatory and fiscal measures to reduce the use of oil in passenger motor vehicles also prepares the answer for the second research question: What are the realistic tax measures that can be implemented and what criteria should the design of a tax framework take into account to reform the choice and usage of motor vehicles for personal transportation in Australia in order to reduce oil consumption?

This chapter examines the fuel economy standards, consumer awareness programs, fiscal measures and demand management programs that have been implemented in various countries around the world. It provides the background literature against which the need to change current tax and regulatory arrangements in Australia is examined, in order to impact on the design, choice and usage of motor vehicles in Australia to reduce oil consumption.

In order to satisfy the fourth research objective of addressing the Australian tax policy reform and other regulatory reforms required to reduce the use of oil in passenger motor vehicles and propose a framework for an all-encompassing LET design in Chapter 6, a case study of the motor vehicle taxes and road user charges proposed or implemented in the following selected countries is undertaken in Chapter 5: Norway; the Netherlands; and the United States of America (specifically, the state of Oregon). These countries were chosen as they have conducted parliamentary-approved studies that involve innovative ways of taxing their motor vehicles and road user charges. Examining the innovative thinking applied in these studies enables lessons to be drawn for Australia in bringing about a change in motor vehicle taxation in order to reduce oil consumption and change the perception of a passenger motor vehicle used for transportation.

Chapter 6 draws lessons from the findings presented in Chapters 2 to 5, and explores the various policy options that Australia can adopt and their likely outcomes. This thesis proposes that in addition to setting the fuel economy and CO_2 emission standards, the Australian government should regulate consumer preferences for passenger motor vehicle transportation through appropriately designed motor vehicle taxes such as the LET. Chapter 6 proposes a LET framework that answers the second research question: What criteria should the design of a tax framework take into account to reform the choice and usage of motor vehicles for personal transportation in Australia in order to reduce oil consumption? The LET framework is then explored in this chapter in terms of core environmental tax principles, in particular the ‘Precautionary Principle’ and the ‘Polluter Pay Principle’, and its design, operation, administration and implementation.

The LET system described in Chapter 6 is evaluated in Chapter 7 under the following categories: The net revenue generation potential; the expected savings in the usage of oil as a result of implementing the LET; general evaluation in terms of collection, fee calculation, technology, cost of state-wide implementation, auditing, fee rate structure, phase-in-period, systemic precision, adaptability to congestion pricing, public acceptance, convenience and protection of privacy; the known criteria of a good tax; and the ability of the LET to change behaviour. In order to evaluate the net revenue generation potential and the savings in oil usage, a detailed exercise is undertaken in this chapter by examining the current Australian passenger motor vehicle fleet, extracting the characteristics of the motor vehicles that impact on the consumption of oil and forecasting the change in the fleet as a result of implementing the LET.

Chapter 8 provides conclusions, identifies problems associated with the introduction of the proposed framework of a LET, discusses the limitations of the research and suggests areas for further possible research.

CHAPTER 2: SUSTAINABILITY OF OIL

2.1 INTRODUCTION

This chapter provides the background and context within which the aim and objectives of this thesis are framed, ie the sustainability of oil and the choice and usage of motor vehicles for personal transportation. This chapter addresses the first two research objectives stated in part 1.3, which are as follows:

OBJECTIVE (i): To investigate the reported Australian and global oil resources.

OBJECTIVE (ii): To explore the need to focus on reducing the use of oil in passenger motor vehicles in Australia.

This chapter also addresses the first core research question stated in part 1.3 which is to determine whether there is a need to reform the choice and usage of passenger motor vehicles in Australia. The main reason is the sustainability of oil and Australia's increasing reliance on imported oil.

Australia's need for oil cannot be studied in isolation. This is due to the fact that if Australia does not have enough oil for its own needs, it will need to import oil from another country. Whether another country will be able to supply Australia with the required oil can only be ascertained by examining the global supply and demand for oil.

The global oil position is explored in part 2.2 by examining reported data on known or proven global oil reserves, the rate of depletion and evidence of a peak in oil supply. The concerns of the global community are also summarised from reports produced by various government and international organisations.

Part 2.3 analyses the implications of peak oil and the global oil crisis gathered from global evidence and points to a need for government action.

Part 2.4 explores the Australian position on oil and the extent of its reliance on imported oil. An analysis of Australian government reports indicates that passenger vehicles consume the majority of oil in Australia and from this an inference can be drawn that there is a need to focus on reducing the use of oil in passenger motor vehicles.

2.2 GLOBAL OIL POSITION

Before examining the global oil position it is necessary to first understand the terminologies used in the global literature concerning oil.

2.2.1 What is Oil?

Oil is a liquid fossil fuel which scientists believe was formed between 100 and 300 million years ago during the Palaeozoic and Mesozoic era by natural processes.[70] It is thought to have been formed from living organisms that died millions of years ago, and through heat and pressure were turned into oil and gas, trapped within source rocks.[71] Oil that took so long to form can be used up in an instant in driving a passenger motor vehicle, and once used, it is irrecoverable.

The discovery of oil can be traced back to 1846 when Dr Abraham Gesner managed to extract oil and other petroleum products, including kerosene, from albertite rocks. In the 1850s Ignacy Lukasiewich found a way to distil seep oil into products, and constructed the first real oil refinery. However the modern oil era began in Oil Creek in Pennsylvania with boreholes sunk by Colonel Drake. By the 1880s, Standard Oil controlled nearly all of America’s refining capacity.

Before examining the various ways oils are defined, it is important to understand the oil supply chain. The oil supply chain starts with exploration. Using reflection seismic technology, geoscientists identify areas where hydrocarbons may be trapped

[70] Geoscience Australia and ABARE, above n 1, 344.
[71] US Energy Information Administration, *Oil (Petroleum)* <http://www.eia.gov/kids/energy.cfm?page=oil_home-basics>.

in suitable rocks. Once these areas are located, then drilling is carried out to test whether the structure contains both oil and gas. If the area contains an economically recoverable resource, then a decision is made on whether to proceed with the development and production phase. The development phase involves the construction of infrastructure including wells, production facilities, processing facilities, and storage and transportation facilities. The production phase includes extracting oil from the reservoir and removing impurities.[72]

Oil is generally classified as conventional or unconventional. Conventional oil is crude oil that is technically producible from reservoirs through a well bore, and excludes mined deposits (tar sands and oil shales) and created liquids (gas-to-liquids and coal oil).[73] Crude oil is a naturally occurring liquid consisting mainly of hydrocarbons derived from the thermal and chemical alteration of organic matter buried in sedimentary basins. Crude oils vary in appearance, chemical composition and viscosity. Light crude oils have low density and viscosity whereas heavy crude oils have high density and viscosity.[74]

Conventional crude oil is crude oil with a viscosity above 17° API,[75] heavy oil with viscosity between 10° and 17° API, all deep sea oil at any depth, polar oil, and condensate. Non-conventional oil is natural gas liquid, extra heavy oil below 10° API, synthetic crude oil, bitumen from tar sands and oil shale. Conventional oil is typically the highest quality light oil which flows from the reservoirs with comparative ease, whereas unconventional oils are heavy and require greater capital and energy to recover them.

Condensate is a liquid mixture of heavier hydrocarbons found in oil fields with associated gas. It is gas in the reservoir, but condenses to form a liquid when produced and brought to the surface.[76]

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[72] Geoscience Australia and ABARE, above n 1, 45.
[73] John Wood, Gary Long and David Morehouse, 'Long-Term World Oil Supply Scenarios: The Future Is Neither Bleak or Rosy as Some Assert' (Report prepared for US Energy Information Administration, 2004) <www.eia.doe.gov>.
[74] Geoscience Australia and ABARE, above n 1, 43.
[75] Degrees API is the specific gravity or density of oil expressed in terms of a scale devised by the American Petroleum Institute.
[76] Geoscience Australia and ABARE, above n 1, 43.

Liquefied petroleum gas (LPG) is a mixture of lighter hydrocarbons and is normally a gas at the surface. It is usually stored and transported as a liquid under pressure. LPG has lower energy content per volume than condensate and crude oils.[77]

Crude oil and condensate are not used in their raw or unprocessed form. Rather, they are processed in a refinery to produce refined petroleum products used as fuels, such as LPG, gasoline for aviation and automotives, automotive diesel oil, industrial diesel oil, fuel oil and kerosene, and refined products for non-fuel applications such as bitumen.[78]

Oil is typically measured on a volumetric basis in either barrels or cubic metres. One barrel is equivalent to 42 US gallons or 159 litres. One million barrels is abbreviated Mb and one billion barrels is abbreviated Gb. One million barrels per day is abbreviated Mbpd.

In examining oil production data, it is necessary to understand the difference between 'oil resources' and 'oil reserves'. The term 'resource' describes the amount of oil in the ground while 'reserve' describes the amount of oil expected to be extracted. A large reserve of oil does not mean that it is possible to increase the flow rate to satisfy an increase in demand. The physical, chemical and geological attributes of a field become the limiting factors for extraction from a resource. When a resource reaches its peak of production,[79] the extraction reaches a phase where regardless of additional expenditure and effort, the volume of output declines.[80] The next section carries out an assessment of reported data to ascertain the global reserve of oil and evidence of a near-term peak in oil supply.

In this thesis, 'oil' refers to conventional crude oil as described above, including the refined petroleum products extracted from conventional crude oil.

[77] Ibid.
[78] Ibid.
[79] See discussion on peak oil in the section titled 'Peaking of Global Oil Production'.
[80] Global Witness, above n 14, 24.

2.2.2 An Assessment of Global Reserves and Evidence of a Near-Term Peak in Oil Supply

The process by which oil is made in source rocks and its extraction from oil fields is well understood by geologists. Therefore the areas with potential hydrocarbon accumulations are well known and there are unlikely to be huge surprises in the future as the world has already been sufficiently explored.[81]

In November 2010, the European Union energy expert Guenther Oettinger expressed a fear that the global consumption of oil is going to increase and confirmed that the global availability of oil had already peaked.[82] It is necessary to examine the global position of oil, as Australia does not have enough oil for its own needs, and relies on oil imported from other countries. Whether other countries will continue to be able to supply Australia with the required oil can only be ascertained by examining the global supply and demand for oil.

On the supply side, reports from various government organisations and international agencies provide data on global reserve estimates. These reserves have to be extracted from the ground and the extraction rate depends upon whether the oil fields have reached their peak, hence the term 'peak oil'. An analysis of the studies and reports below indicates that there is no uniform estimate of the global oil reserve. In addition, some studies forecast a near-term peak and subsequent terminal decline in the production of conventional oil, whereas others argue that liquid fuel production will be sufficient to meet global demand well into the 21st century. Despite the differences in the forecasts of global reserves and the peak oil position as summarised below, the commentaries and views of various government reports, business leaders and industry experts indicate that the era of cheap oil is almost over, and any forecasts that delay the peak beyond 2030 are based upon optimistic assumptions.

[81] Schindler and Zittel, above n 19, 20.
[82] C Dunmore, 'Global Oil Availability has Peaked - EU Energy Chief', *Reuters* (online), 10 November 2010 <http://www.reuters.com/article/idUSBRU01112520101110> .

A literature review carried out by the Low Carbon Mobility Centre at Oxford University in the UK reveals three sources for oil reserve data:[83]

1. Data available in the public domain originates from surveys conducted by *Oil and Gas Journal* (OGJ), *World Oil* (WO) and the OPEC Secretariat. The data from these sources is not subject to independent audits and has been reported to give more optimistic estimates in comparison with independent parties that assess reporting methodology.
2. Information agencies such as the International Energy Agency (IEA), Energy Information Administration (EIA) and *BP Statistical Review* reproduce data referred from reporting agencies, with small amendments.
3. Independent authors and academic institutions such as Uppsala University also report oil data, sometimes purchased from scouting companies such as the Information Handling Services (IHS) who sell data on individual fields; independent authors consider this data to be the most accurate.

a. An Assessment of the Global Reserves of Oil

In order to determine the quantity of the world's oil reserves, it is necessary to examine the definition of reserves. Although a distinction was made above between the terms oil resource and oil reserve, there is no universal definition of oil reserves and the concept of oil reserves is generally not well understood. In general, 'oil reserve' can be defined as an estimate of the amount of oil in a reservoir that can be extracted at an assumed cost. There are three categories of reserves: proven, probable and possible reserves.[84]

Proven oil reserves are those which are producible using current technology at current prices and having a 90 per cent certainty of being produced. Proven reserves are further sub-divided into 'proven developed' and 'proven undeveloped' reserves. Proven developed reserves can be produced from existing wells with minimal additional investment or operating expense, compared with proven undeveloped

[83] Nick Owen, Oliver Inderwildi and David King, 'The Status of Conventional World Oil Reserves — Hype or Cause for Concern?' (2010) 38 *Energy Policy* 4743.
[84] Schindler and Zittel, above n 19, 25.

reserves which require additional capital investment to bring the oil to the surface. Probable reserves are those having a 50 per cent certainty of being produced using current and likely technology at current prices. Possible reserves are those having a 10 per cent certainty of being produced. The 'ultimate recoverable reserve' (URR) includes a total recoverable reserve and would include proven, probable and possible reserves.

As there is no universal agreement on the definition of an oil reserve or a universally applied method of reserve reporting, there are differences in published reserve data. Reserve estimation has been described as gauging how much extractable oil resides in complex rock formations that exist typically one to three miles below the surface of the ground. This estimation has been described as being similar to a blindfolded person trying to judge what a whole elephant looks like from touching it in just a few places.[85] Differences between reserve estimates can arise from the use of different methodologies, or differences in judgement, politics and self-interest considerations. Moreover, reserve estimates are revised periodically as a reservoir is developed and new information is obtained. Reserve estimation is not an exact science like counting the cars in a parking lot, but an assessment using an array of methodologies and a great deal of judgement.[86] Thus different estimators may calculate different reserves from the same data, as shown in Table 2.1.

TABLE 2.1: Forecasts of 'Proved' Global Oil Reserves

Author	**Date of Forecast**	**Proved Oil Reserves (Gb)**
OGJ	Jan 2009	1342
WO	Year end 2007	1184
IEA	2008	1241
BP Statistical Review	June 2009	1258
Independent authors	Various	903

Source: Low Carbon Mobility Centre, UK reported in Nick Owen, Oliver Inderwildi and David King, 'The Status of Conventional World Oil Reserves – Hype or Cause for Concern?' (2010) 38 *Energy Policy* 4743, 4744.

[85] Robert Hirsch, Roger Bezdek and Robert Wendling, 'Peaking of World Oil Production: Impacts, Mitigation, & Risk Management' (2005) <http://www.netl.doe.gov/publications/others/pdf/oil_peaking_netl.pdf> 12.
[86] Ibid 11–12.

The forecasts noted in Table 2.1 above from OGJ, WO and BP Statistical Review include tar sands. It has been reported that if the tar sands were removed from the above estimates, the OGJ reserve forecast would be 882Gb, the WO forecast would be 892Gb and the BP Statistical Review forecast would be 830Gb.[87]

Other organisations such as the EIA and the Energy Watch Group (EWG) have also reported on the status of the world's oil reserves. The EIA belongs to the US Department of Energy and it publishes many energy statistics, as well as annual reports entitled 'International Energy Outlook'. 'International Energy Outlook 2010' was released in July 2010 and presents international energy projections through to 2035. The report stated that as of January 2010, proved world oil reserves including the Canadian oil sands, as reported by the *Oil and Gas Journal*, were estimated at 1354Gb, of which 56 per cent are located in the Middle East.[88] Peak Oil experts have asserted that the Middle East exporting countries artificially raised estimates of their reserves even though there were no new discoveries, on the basis that the reserves were previously underreported for financial and political reasons.[89]

The EWG is an international network of scientists and parliamentarians, initiated by a member of German Parliament, in collaboration with other parliamentarians from both Germany and abroad. A report titled 'Crude Oil – The Supply Outlook' was released by the EWG in 2008 on the future availability of crude oil up to 2030. The methodology used was the proved plus probable discoveries and production patterns. The report stated that the peak of discoveries took place in the 1960s,[90] and that the current reserves amounted to 854Gb. By comparison, the industry database IHS estimated that the remaining world oil supplies were 1255Gb. Table 2.2 shows the oil reserves, production and consumption reported by the EWG and IHS.

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[87] Owen, Inderwildi and King, above n 83, 4747.
[88] Energy Information Administration, 'International Energy Outlook' (Report No DOE/EIA-0484(2010), Energy Information Administration, 27 July 2010) <http://www.eia.gov/forecasts/archive/ieo10/index.html> 37.
[89] Schindler and Zittel, above n 19, 30.
[90] Schindler and Zittel, above n 19, 7.

TABLE 2.2: Oil Reserves and Annual Oil Production in Different Regions and Key Countries

Region	Remaining Reserves 2008		Production 2005		Consumption 2005
	EWG [Gb]	IHS [Gb]	Onshore [Gb/yr]	Offshore Gb/yr]	Gb/yr
OECD North America	**84**	**67.6**	**3.20**	**1.71**	**9.13**
Canada	17	15.3	0.89	0.12	0.82
USA	41	31.9	1.93	0.59	7.59
Mexico	26	20.4	0.36	1.00	0.72
OECD Europe	**25.5**	**23.5**	**0.1**	**1.94**	**5.72**
Norway	11	11.6	0	1.13	0.08
UK	8	7.8	0.01	0.7	0.65
OECD Pacific	**2.5**	**5.1**	**0.025**	**0.18**	**3.18**
Australia	2.4	4.8	0.02	0.17	0.31
Transition Economics	**154**	**190.6**	**4.1**	**0.18**	**2.02**
Russian Federation	105	128	3.4	0.13	1.00
Azerbaijan	9.2	14	0.01	0.15	0.04
Kazakhstan	33	39	0.47	0	0.08
China	**27**	**25.5**	**1.1**	**0.22**	**2.55**
South Asia	**5.5**	**5.9**	**0.11**	**0.16**	**0.96**
East Asia	**16.5**	**24.1**	**0.3**	**0.65**	**1.75**
Indonesia	6.8	8.6	0.27	0.11	0.43
Latin America	**52.5**	**129**	**2.0**	**0.61**	**1.74**
Brazil	13.2	24	0.075	0.55	0.75
Venezuela	21.9	89	1.17	0	0.20
Middle East	**362**	**678.5**	**6.97**	**1.97**	**2.09**
Kuwait	35	51	0.96	0	0.11
Iran	43.5	134	1.19	0.24	0.59
Iraq	41	99	0.67	0	
Saudi Arabia	181	286	2.85	0.86	0.69

Region	Remaining Reserves 2008		Production 2005		Consumption 2005
	EWG [Gb]	IHS [Gb]	Onshore [Gb/yr]	Offshore Gb/yr]	Gb/yr
UAE	39	57	0.46	0.45	0.14
Africa	**125**	**104.9**	**2.03**	**1.53**	**1.01**
Algeria	14	13.5	0.72	0	0.09
Angola	19	14.5	0.01	0.45	
Libya	33	27	0.61	0.02	
Nigeria	42	36	0.39	0.52	
World	**854**	**1255**	**19.94**	**9.15**	**30.3**

Source: Jörg Schindler and Werner Zittel, 'Crude Oil — The Supply Outlook' (Report, Energy Watch Group, 2008) <http://www.energywatchgroup.org/fileadmin/global/pdf/2008-02_EWG_Oil_Report_updated.pdf>.

Table 2.2 shows that countries with the most oil reserves are in the Middle East and transitional economies. Although the difference between the EWG and the IHS estimates of oil reserves is 401Gb, this only amounts to 14 more years of supply based on a global demand of 30.3Gb per year. Fourteen years difference is not much when compared with the number of years it took for the oil to be formed. Based on the global consumption of 30.3Gb per year in 2005 and without any significant new discoveries and changes in consumption, the current oil reserves would last somewhere between 28 years to 42 years. This timeframe indicates that countries should be preserving oil for necessities and developing alternative energy sources.

The next question to consider is whether the forecasted global oil reserves can be extracted at a rate that will satisfy the demand for the next 28 to 42 years. This depends upon whether the fields have reached peak production, which is discussed next.

b. Peaking of Global Oil Production

As mentioned in Chapter 1, peak oil is the point at which further expansion of oil production becomes impossible, because new flows are fully offset by production declines or depletion. In a typical production profile for a single field, production rises quickly to a peak and then subsides at a depletion rate which varies from field to field. Peak production is typically established when 25 to 30 per cent of the reserves are extracted. The last 25 to 30 per cent of the reserves are extremely difficult to extract, so the reserve position at peak is not very comforting.[91]

In short, peaking means that the rate of world oil production cannot increase. It means that production will decrease with time after peaking occurs.[92] Global oil will have reached peak when all new projects coming on stream fail to offset the annual decline from older fields. The timing of the global peak is normally judged by taking into consideration shrinking discoveries, the rate of depletion, the adequacy of investment and the rate of global demand.

Hubbert published his peak oil analysis in 1956 when he indicated that the US conventional oil production would resemble a bell-shaped curve, reaching a peak and then declining. Hubbert's theory proved remarkably accurate and is called the peak oil theory. It has been widely accepted as a technique for assessing production volumes as the production rate starts to decline before reserves approach their peak. Using Hubbert's theory of peak oil, the global peak can be ascertained as the point at which about 50 per cent of the world's URRs have been consumed. Thus, peak oil can be estimated by examining the known quantities of URR and the volume of oil consumed so far.

A report produced in 2009 by the Technology and Policy Assessment (TPA) function of the UK Energy Research Centre, entitled 'Global Oil Depletion: An Assessment of the Evidence for a Near-Term Peak in Global Oil Production' states that the depletion of oil resources and the peak oil debate is contentious, whereby the pessimists forecast an imminent peak, and the optimists believe that rising prices will stimulate new discoveries and new methods of recovery, and therefore there will be sufficient oil to meet global demand well into the 21st century.[93]

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[91] Industry Taskforce on Peak Oil & Energy Security, 'The Oil Crunch: A Wake-Up Call for the UK Economy' (Second report of the UK Industry Taskforce on Peak Oil & Energy Security (ITPOES), 10 February 2010) 11.

[92] Hirsch, Bezdek and Wendling, above n 85, 12.

[93] Steve Sorrell et al, 'Global Oil Depletion: An Assessment of the Evidence for a Near-Term Peak in Global Oil Production' (Report produced by the Technology and Policy Assessment function of the

The TPA reported on selected forecasts of the date of global peak, based on their URR estimate and the decline rate, as shown in the Table 2.3 below.

TABLE 2.3: Selected Forecasts of Global Peak, URR and Post-Peak Decline Rates

Category	**Reporting Agency**	**Date of Global Peak**	**URR (Gb)**	**Post Peak Decline Rates per Year**
International organisations	IEA	No peak[94] Conventional oil plateau by 2030	3577	6.7%
	OPEC	No peak	3345	4 to 5%
National organisations	BGR*	2020	2979	Not given
Oil companies	Shell	2020	Not given	Not given
	Meling	2020	3149	2.6%
	Total	2020	Not given	0.2%
Consultancies	Energyfiles	2017	2685	2 to 3%
	LBST**	2006	1840	3.5 to 4%
	Peak Oil Consulting	2011–2013	Not given	2 to 2.3%
Universities	Campbell	2008	1900 to 2425	2.1%
	University of Uppsala	2008–2018	Not given	6 to 16%
	Miller	2013 -2017	2800	3.3%

Source: Steve Sorrell et al, 'Global Oil Depletion: An Assessment of the Evidence for a Near-Term Peak in Global Oil Production' (Report produced by the Technology and Policy Assessment function of the UK Energy research Centre, August 2009).

*BGR: Bundesanstait Geowissenschaften und Rohstoffe being the German Federal Institute for Geoscience and Natural Resources

**LBST: Ludwig-Bolkow-Systemtechnik GmbH

UK Energy research Centre, August 2009) 1. The pessimists included: Colin Campbell, *The Coming Oil Crisis* (Multi-Science Publishing & Petroconsultants, 1997); Kenneth S Deffeyes, *Beyond Oil:The View from Hubbert's Peak* (Hill and Wang, 2005); and Schindler and Zittel, above n 19. The optimists included Adelman, CERA, Mills and Odell.

[94] Faith Birol, Chief Economist of the IEA, said in an interview that the global oil peak occurred in 2006. See ABC, 'Oil Crunch', *Catalyst*, 28 April 2011 (Jonica Newby, interview with Faith Birol).

In summary, the TPA Report's findings are as follows:

- Global cumulative production of conventional oil stood at 1128Gb in 2007, with annual production of 29.5Gb. Since 1995, global production has grown at an average of 1.5 per cent per year, with 60 per cent of cumulative production occurring since 1980.[95]
- Most of the world's conventional oil was discovered between 1946 and 1980 and since that time annual production has exceeded annual discoveries.
- Although there are around 70 000 producing oil fields in the world, approximately 25 fields account for a quarter of global production, 100 fields account for half of production and up to 500 fields account for two-thirds of cumulative discoveries. Most of these 'giant' fields are relatively old, most of the rest will begin to decline within the next decade or so and few new giant fields are expected to be found. The remaining reserves at these fields, their future production profiles and the potential for enhanced recovery and reserve growth are therefore of critical importance.[96]
- The oil industry must continually invest to replace the decline in production from existing fields. The production-weighted global average rate of decline from post-peak fields is at least 6.5 per cent per year, while the corresponding rate of decline from all currently-producing fields is at least 4 per cent per year. This implies that at least 3Mbd of new capacity must be added each year, simply to maintain production at current levels.[97]
- More than two-thirds of current crude oil production capacity may need to be replaced by 2030, simply to prevent production from falling.[98]
- Estimates of the global URR for conventional oil vary widely in their definitions, methods, assumptions and results. Contemporary estimates now fall within the range 2000–4300Gb, compared to cumulative production through to 2007 of 1128Gb.[99]
- For a wide range of assumptions about the global URR and the shape of the future production cycle, a peak in production can be estimated to occur

[95] Steve Sorrell et al, above n 93, 170.
[96] Ibid 168.
[97] Ibid.
[98] Ibid 169.
[99] Ibid 137.

before 2031. In most models, increasing the global URR by a billion barrels delays the peak by only a few days. Delaying the peak beyond 2030 requires optimistic assumptions about the size of the recoverable resource and the rate at which it is developed.[100]

- Forecasts that delay the peak of conventional oil production until after 2030 rest upon several assumptions that are at best optimistic and at worst implausible.[101]
- A peak in conventional oil supply will only be associated with a peak in liquid fuels supply if 'non-conventional' sources are unable to substitute in a sufficiently timely fashion.
- The risk of a peak in conventional oil production deserves urgent and serious consideration.[102]

There are many national and international reports that show concern about the global oil position and advocate that governments of each country should take policy action to reduce the demand for oil, especially in the transportation sector, as summarised below.

c. *The Energy Watch Group (EWG)*

The Energy Watch Group's report, 'Crude Oil – The Supply Outlook 2008', concluded that the world oil production peaked in 2006 and that by 2020 and 2030 the global oil supply will be dramatically lower. This will create a supply gap which will not be satisfied by other forms of energy.[103]

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[100] Ibid.
[101] Ibid 165.
[102] Ibid 171.
[103] Schindler and Zittel, above n 19, 16.

d. The US Joint Forces Command: The Joint Operating Environment (JOE) Report 2010

The US Joint Forces Command's 'Joint Operating Environment' (JOE) is an independent report and does not constitute the US government policy. It has a military and security focus as opposed to emerging opportunities. The report claims that oil and gas will make up 60 per cent of the global energy mix in the 2030s. The central problem in the coming decade will not be a shortage of oil reserves, but a shortage of refining capacity. By 2030, the demand for oil will increase to 118Mbpd.[104] The report states that in order to meet the rising demand, OPEC will have to increase its output from 30Mbpd to at least 50Mbpd and no OPEC nations except Saudi Arabia are investing in new technologies and recovery methods to achieve such a growth.[105]

The US JOE report also states that a severe energy crunch is inevitable without a massive expansion of production and refining capacity. The effect of the supply crunch would result in reduction of growth for both developing and developed countries and could lead to harsh economic adjustments.[106] By 2012, surplus oil production capacity could disappear and by 2015, the shortfall in output could be about 10Mbpd.[107]

e. The International Energy Agency (IEA)

The World Energy Outlook (WEO) 2010 produced by the IEA focused on climate change and emphasised the removal of fossil-fuel consumption subsidies which totalled USD312 billion in 2009. The report claimed that the removal of these subsidies would make a big contribution to energy security and environmental goals, and confirmed that fossil fuels, in particular oil, coal and natural gas will remain the dominant energy sources in 2035. The report also stated that emerging economies led

[104] US Joint Forces Command, 'The Joint Operating Environment (JOE)' (Distribution Statement, 18 February 2010) 24.
[105] Ibid 26.
[106] Ibid 28.
[107] Ibid 29.

by China and India will drive global demand higher, mainly due to rising use of transport fuel.[108]

For the first time, the WEO 2010 report projected that crude oil output would reach an undulating plateau of around 68 to 69Mbpd and may not regain its all-time peak of 70Mbpd in 2006. The report states that global oil production will peak one day. The IEA 450 Scenario projections predict peak oil production at 86Mbpd just before 2020. The message from the report is that if governments act vigorously to encourage more efficient use of oil and the development of alternatives, this may reduce the demand for oil and the peak would not be caused by a resource constraint. However, if governments do not act, then demand will continue to increase and supply costs of oil will rise, leading to vulnerability to supply disruptions. The report also stated that unconventional oil is abundant, but more costly.[109]

The IEA reports were contradicted by their chief economist, Faith Birol, in an interview reported on the ABC television program *Catalyst*, on the oil crunch reported on 28 April 2011. Dr Birol said in that interview, 'When we look at the oil markets the news is not very bright. We think that the crude oil production has already peaked in 2006.'[110]

f. The UK Government Department of Energy & Climate Change

In August 2009, the UK Government Department of Energy & Climate Change released a report entitled 'Energy Security: A National Challenge in a Changing World'. The report is referred to as the 'Wicks Report', as Malcolm Wick, MP for Croydon, was appointed by the UK Prime Minister as a special representative on international energy.

The report states that despite the promising outlook for new technologies to provide more of the world's energy needs, the demand for fossil fuel is likely to grow over the next decade and remain a significant part of the global energy mix in the longer term. There are clear risks that global supply will not be able to satisfy the demand,

[108] International Energy Agency, 'World Energy Outlook 2010' (OECD/IEA 2010) 4.
[109] Ibid 4-7.
[110] ABC, above n 94.

one reason being that many resource-rich countries restrict the involvement of foreign companies in producing oil, which may result in lack of sufficient investment to increase production. This no doubt will have an impact on the price of oil.[111]

The report states that in order to support the UK's energy security, the approach should be to first minimise energy use, diversify the energy mix and then take action to minimise residual risks arising from the UK's continual use of oil and gas and growing import dependence.[112] The UK government sees energy security as physical security, ie avoiding involuntary disruption of supply, price security, and geopolitical security, ie dependence on particular nations.[113]

The UK government report projects a growth in the world population from 6.5 billion in 2009 to 8.2 billion by 2030, with 35 per cent of this growth coming from China and India. The demand for cars in emerging countries and the difficulty in replacing oil for transport use with alternatives means that oil will remain the largest fuel in the global fuel mix. Around three quarters of the projected increase in demand for oil worldwide is expected to come from the transport sector. The report notes that the transport sector is least responsive to price changes in the short term, ie the demand is inelastic.[114]

The Wicks report states that a future increase in global demand for oil is likely to be met by the Organisation of Petroleum Exporting Countries (OPEC). However, oil production has already peaked in most non-OPEC countries and the production in OPEC countries will peak before 2030.[115]

g. The UK Industry Taskforce on Peak Oil & Energy Security

The UK Industry Taskforce on Peak Oil & Energy Security also released a report in February 2010 entitled 'The Oil Crunch: A Wake-Up Call for the UK Economy'. Their message to the government and businesses is clear, which is to act now. The

[111] Malcolm Wicks, 'Energy Security: A National Challenge in a Changing World' (Report for the Department of Energy and Climate, 2009) 3–4.
[112] Ibid 6.
[113] Ibid 8.
[114] Ibid 27.
[115] Ibid 29.

message is that there will be an oil crunch in the next five years and as the world reaches maximum oil extraction rates, ie peak oil, the era of cheap oil is over. The UK government should set coherent policies to help the UK adapt, as virtually every sector of the UK economy is still dependent on oil. The transport sector is dependent on fossil fuels and older combustion technologies.[116]

h. Global Witness

Global Witness is an international non-governmental organisation established in 1993. One of the goals of Global Witness is to expose corrupt exploitation of natural resources. In October 2009, Global Witness produced a report titled 'Heads in the Sand? — Governments Ignore the Oil Supply Crunch and Threaten the Climate', which provides an overview of the energy crisis and explores the problems with securing sufficient oil supply for the growing demand, declining discovery rate, insufficient new projects and oil field depletion. The report states that governments and multi-lateral and international agencies have failed to recognise the scale of the global oil crunch and most governments are unprepared for the consequences. There is concern about the lack of international discussion about the nature and scale of the problem. The report also states that the oil supply is not assured as generally presumed, and criticises the IEA for holding an overconfident view that future supply will meet growing demand. It also says that the IEA's view is based on the understanding that a massive investment of up to USD450 billion annually for the next 22 years will ensure the supply. However the report claims that it is not possible for the world to spend its way to an oil supply solution.[117]

The main recommendation of the Global Witness report is for individual governments to officially recognise the scale and imminence of an oil crunch. Individual governments have an overwhelming responsibility to their present and future citizens to take urgent action. Finally, the report states that business-as-usual is not possible and therefore a radically increased pace of change is required.[118]

[116] Industry Taskforce on Peak Oil & Energy Security, above n 91, 4.
[117] Global Witness, above n 14, 5.
[118] Ibid 53.

The Global Witness report lists the countries where oil production has peaked as follows: Argentina, Australia, Brunei, Columbia, Congo-Brazzaville, Denmark, Egypt, Gabon, Indonesia, Mexico, Norway, Oman, Papua New Guinea, Peru, Romania, Syria, Trinidad & Tobago, Tunisia, United Kingdom, USA, Uzbekistan, Vietnam and Yemen. Countries where oil production has peaked for political reasons include Iran, Nigeria and Venezuela. Countries on a production plateau are Algeria, Ecuador, India, Iraq, Malaysia and Russia. Iraq's output has stagnated, but with stability and investment, it could be increased. The key countries that the world is relying on for oil are Angola, Azerbaijan, Brazil, Canada, China, Kazakhstan, Kuwait, Libya, Qatar/UAE, and Saudi Arabia.[119]

i. Alternative View

Although the majority of the national and international reports show concern about the global oil position, there are some economists who believe that the world will never run out of oil as the reduction in the supply of oil will also shift or reduce the demand and therefore there will always be oil in the ground. People will adjust their behaviour by using unconventional oil or other energy sources.[120]

Unconventional oil can be recovered through a variety of processes, for example deep water oil extraction and production from tar sands. However the cost of oil recovery using these processes is more costly than conventional oil. Synthetic crude oil can also be extracted from oil shale and synthetic diesel can be produced from gas or coal. However the energy returned from energy invested (EROI) by using these technologies is relatively low.

Despite this alternative view, it should be noted that concern about peak oil centres around the amount of cheap energy that has been available from oil. The EROI from conventional oil is high, and life without cheap energy will have ramifications. The next part explores the implications of reduced energy as a result of peak oil and the oil crisis.

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[119] Ibid 32.
[120] Mike Moffatt, *Peak Oil – Are Economists Collectively Stupid?* (2012) About.com Economics <http://economics.about.com/od/theoilsupply/a/stupideconomist.htm>.

2.3 Implications of Peak Oil and the Oil Crisis: An International Perspective

The implications of peak oil and the oil crisis predicted by the international community strongly suggests that action is required to reduce demand by adopting behaviour change programs and diversify liquid fuel mix by implementing alternative energy carriers where appropriate.[121] However, exploration takes time, and the implementation of new technologies takes even longer. Some critics argue that higher oil prices will have no effect on the economy since price mechanisms will cause a smooth transition to alternative energy resources such as coal, natural gas or nuclear. Hirsh has examined the possibility of switching to alternative sources of fuel and he concludes that the non-renewable energy alternatives will also be subject to peak at some time in the future. On the other hand, renewable energy alternatives from the sun or wind require energy storage which will add further costs compared with the EROI for oil.[122]

Adapting behaviour in order to reduce the demand for oil, and implementing alternative energy sources takes time. History has demonstrated that humans are slow to change. If we examine American history and the abolition of the slave trade, the southern US states were plunged into a deep crisis and it took a century for the southern states to recover and catch up with the northern states. By comparison, developing alternative energy technologies is likely to be even harder under the more challenging circumstances of a global energy crunch. It is likely that when oil becomes scarce, there may be slow and painful processes of social and technological adjustments that could last for a century or more. The unavoidable consequence could be famine, disease, and mass exodus. Countries that are likely to survive better are those that are prepared to adapt to community-based values and a return to a subsistence lifestyle.[123]

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[121] Owen, Inderwildi and King, above n 83, 4743–49.
[122] Ugo Bardi, 'Peak Oil: The Four Stages of a New Idea' (2009) 34 *Energy* 323.
[123] Jorg Friedrichs, 'Global Energy Crunch: How Different Parts of the World Would React to a Peak Oil Scenario' (2010) 38 *Energy Policy* 4562.

Although it cannot be predicted with certainty when the production of oil will peak, the peaking of oil will cause a unique challenge. Massive mitigation more than a decade before peaking is required to prevent disruption to life as we know it today. It has been noted that previous energy transitions were gradual and evolutionary, whereas oil peaking will be abrupt and revolutionary.[124] In order to prevent economic and social chaos, this thesis argues that government intervention will be required, especially with regard to passenger transportation.

It has been reported in the US that from the time oil peaking occurs or is recognised, it may take as long as 15 years until on-road fleet fuel efficiency is achieved in a realistic manner and only aggressive vehicle fuel efficiency standards legislation may reduce consumption of fuel.[125] This thesis argues that in addition to fuel efficiency standards, taxation may be required as a tool to effectively reduce the consumption of oil in passenger motor vehicles.

Dr Robert Falkner from the London School of Economics has recently reported that the transport sector in the UK is most exposed to the effects of global oil supply constraints and price shocks, as the transport sector is highly dependent on petrol, diesel and kerosene.[126] This is equally true for Australia as the vulnerability of the transport sector has important knock-on effects throughout the economy due to the wide range of businesses relying on a highly integrated transport system. Many businesses have frequent deliveries of stock with just-in-time business models. About 95 per cent of all products in shops are delivered using oil. Oil is essential for the production of pharmaceuticals and agrochemicals. About 99 per cent of food production uses oil.[127]

The Global Witness report states that the ramifications of a global oil shortage are likely to affect almost every aspect of life, and if not handled properly, it could become a multidimensional problem affecting economic growth, social progress and political security around the world.[128]

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[124] Hirsch, Bezdek and Wendling, above n 85, 64.
[125] Ibid 76.
[126] Industry Taskforce on Peak Oil & Energy Security, above n 91, 27.
[127] Global Witness, above n 14, 13.
[128] See for example discussions in *New Scientist*: Debora MacKenzie, 'Why the Demise of Civilisation may be Inevitable' (2008) 2650 *New Scientist* 32; Debora MacKenzie, 'Will a Pandemic

The economic impact of an oil supply crunch is likely to be far reaching and complex. Energy expert Robert Hirsch analysed the relationship between GDP and oil use on a global basis and his analysis shows that the global GDP to oil use ratio stands at approximately 0.6 to 0.8 to 1. This means that for every one per cent loss of available oil supply, global GDP could fall by 0.6 to 0.8 per cent.[129]

The oil supply crunch is likely to have an impact on world population which is forecast to increase to 8 billion by the 2030s. Of this increase, 95 per cent will occur in developing countries.[130] The Australian population is expected to increase from 21.6 million in 2008 to 28.5 million by 2030.[131] Population growth affects the size and pattern of energy demand, as an increase in population requires an increase in energy use. Oil provides the energy needed to grow and distribute food, which has an impact on the rate of mortality as food is made available where needed. In 18th century Europe, food was only transported about 15 kilometres.[132] Today, motor vehicles and trains transport food within a country and aeroplanes can transport fresh food around the world.

The question the world faces is no longer whether to reduce energy consumption, but how. The answer lies with the policymakers, whether they choose to manage energy intelligently or not. Transport systems requiring energy intensive vehicles will wither, impacting on energy-dependent food systems with possible consequences in terms of unemployment and even famine. However if policymakers manage the energy downturn intelligently, an acceptable quality of life could be maintained.[133]

In addition, private citizens should be encouraged through government policies to adjust their lifestyles, and governments should provide support for oil conservation

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Bring Down Civilisation?' (2008) 2650 *New Scientist* 28; 'Countdown to Crisis: Eight Days that Shook Britain,' *BBC News Online*, 14th September 2000 <http://news.bbc.co.uk/2/hi/uk_news/924574.stm>, from Global Witness, above n 14, 13. Also see Clint Smith, 'The Next Oil Shock' (New Zealand, Parliamentary Library Research Paper, October 2010).

[129] Global Witness, above n 14, 18.

[130] US Joint Forces Command, above n 104, 12.

[131] See Australian Bureau of Statistics, *Population Projections, Australia* (Catalogue No 3222.0, 4 September 2008) and Australian Bureau of Statistics, *Australian Demographic Statistics* (Catalogue No 3101.0, March 2009), reported in Geoscience Australia and ABARE, above n 1, 26.

[132] Graham Zable, *Population and Energy* (2002) Minnesotans For Sustainability <http://www.mnforsustain.org/pop_population_and_energy_zable.g.htm>.

[133] Richard Heinberg, 'Searching for A Miracle "Net Energy" Limits & The Fate of Industrial Society' (A Joint Project of the International Forum on Globalization and the Post Carbon Institute, September 2009) 65.

measures that help them do so. The scale of the problem is likely to be immense and some degree of international coordination and cooperation will also likely be required. Peak oil presents many challenges to modern society, but with a strong commitment from governments, countries can prepare for the eventual end of the oil age.[134]

Having examined the global position, the next section explores Australia's energy position and the need to focus on passenger motor vehicles in order to maintain Australia's energy security, particularly for oil.

2.4 AUSTRALIAN OIL POSITION

Similar to the global position, Australia's oil resources are in decline with remaining crude oil resources estimated at 1 January 2009 to be 8414 petajoules (PJ)[135] which is equivalent to 1431Mb. This includes 6950PJ of economic demonstrated resources and 1464PJ of sub-economic demonstrated resources.[136] Australia also has 16 170PJ or 2750Mb of condensate and 6210PJ or 1475Mb of LPG.[137] The economic demonstrated resources have further declined during the course of writing this thesis to 5685PJ at 31 December 2010.[138] The reason for this is that Australia's crude oil resources are being depleted at a faster rate than they are being replenished by discovery. As a result, Australia is increasingly relying on imports to meet its demand for crude oil.[139] Crude oil exploration in Australia has not repeated the early success of the 1960s when the first offshore exploration discovered the giant Gippsland Basin.[140]

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[134] Jonah Ralston, *Peak Oil: The Eventual End of the Oil Age* (Directed Research Project, Master of Arts in International Affairs, Washington University in St. Louis, 2008) 25.
[135] One joule is defined as the amount of work done by a force of one Newton moving an object through a distance of one meter. One joule is the equivalent of one watt of power dissipated for one second. One petajoule is the heat energy content of about 43 000 tonnes of coal or 29 million litres of petrol.
[136] Geoscience Australia and ABARE, above n 1, 51.
[137] Ibid 4.
[138] Department of Resources, Energy and Tourism, 'Energy in Australia 2012' (ABARE, Canberra, 2012) 11.
[139] Geoscience Australia and ABARE, above n 1, 20.
[140] Ibid 41.

Australia's crude oil production was equivalent to 69 per cent of refinery feedstock in 2007–08 and imported 31 per cent of its crude oil requirement. In 2008–09, Australia imported 24 303 million litres of refinery feedstock (crude oil and condensate) and exported 16 588 million litres of refinery feedstock.[141] Australia also imported 18 276 million litres of refined petroleum products in 2008–09 and exported 1134 million litres of refined petroleum products in the same year. In terms of the value of Australian trade in petroleum in 2008–09, Australia exported AUD8755 million of crude oil and other refinery feedstock and imported AUD14 721 million of crude oil and other refinery feedstock in that same year.[142] In terms of refined products, in 2008–09, Australia exported AUD785 million of refined products and imported AUD15 297 million of refined products in that same year.[143]

The majority of Australia's crude oil and condensate comes from the Carnarvon Basin in north-west Australia and the Gippsland Basin in the Bass Strait. The production from the Carnarvon Basin currently accounts for 63 per cent of Australia's production of crude oil, condensate and LPG, whereas the Gippsland Basin accounts for 20 per cent of the production of crude oil, condensate and LPG.[144] Australia's net imports of oil and oil products represented 45 per cent of consumption in 2007–08.[145] Australia's primary oil production peaked in 2000–01 at 1546PJ (276Mb) and has been declining at five per cent per year to 1059PJ or 187Mb per year in 2007–08.

In Australia, the total conventional oil production (including crude oil, condensate and LPG) is increasingly from offshore oilfields with deeper oil accumulations and fields that contain smaller reserves compared with those developed in the past. It should be noted that oilfields that are located offshore generally reach peak production in a shorter time than reserves that are located onshore. Moreover, the production costs of offshore fields are greater than onshore fields.[146]

Since Australia does not produce enough oil for its own use and has to rely on imported oil from other countries, the government of Australia needs to question

[141] Australian Bureau of Agricultural and Resource Economics and Sciences, above n 22, 53–4.
[142] Ibid 55.
[143] Ibid.
[144] Ibid 51.
[145] Geoscience Australia and ABARE, above n 1, 42.
[146] Geoscience Australia and ABARE, above n 1, 72.

Australia's oil security and the need to develop policies that would bring about reduced reliance on global oil reserves that are constantly being depleted and may become very expensive. In order to assess the Australian government's energy management policy, it is first necessary to examine the extent of the liquid fuel problem in Australia.

According to the Department of Resources Energy and Tourism, Australia is the world's ninth largest energy producer accounting for around 2.4 per cent of the world's energy production.[147] It has 38.2 per cent of the total world resource of uranium, 18.5 per cent of the total world resource of coal, 1.4 per cent of the total world resource of gas and only 0.3 per cent of the total world resource of oil.[148]

As regards energy consumption, in the year 2007–08, Australia's primary energy consumption was 5772PJ, of which 40 per cent was coal, 34 per cent was oil and 22 per cent was gas.[149] Of the 5772PJ of energy consumed in 2007–08, only 3917PJ was available for disposal as 1856PJ was required for conversion of energy to usable form.[150] Table 2.4 shows that road transport was the largest consumer of energy in Australia in the years 2007–08 and 2009–10.[151]

TABLE 2.4: Energy Consumption in Australia

	2007–08 PJ	**2009–10 PJ**
Agriculture	92.6	96.0
Mining	449.7	339.7
Food, beverages, textiles	212.1	111.9
Wood, paper and printing	75.1	76.6
Chemical	202.3	227.7
Iron and Steel	117.4	69.9
Non-ferrous metals	461.5	384.6
Other industry	150.4	140.7

147 Department of Resources, Energy and Tourism, above n 138, 1.
148 Ibid 4.
149 Ibid 13.
150 Ibid 17.
151 Ibid 16.

	2007–08 PJ	**2009–10 PJ**
Construction	26.4	25.4
Road transport	1027.5	1064.9
Rail transport	37.5	45.7
Air transport	226.3	245.5
Water transport	70.6	60.1
Commercial services	278.9	309.1
Residential	425.7	440.1
Lubes, bitumen, solvents	62.9	65.8
Total	3916.9	3702.8

Source: Australian Government Department of Resources Energy and Tourism, *Energy in Australia* (2010 and 2012).

The energy used in Australian road transport comes mainly from automotive gasoline and automotive diesel oil as demonstrated in Table 2.5 below.[152]

TABLE 2.5: Australian Consumption of Petroleum Products 2008–09

	Million litres
LPG	3996
Automotive gasoline	18 734
Avgas	96
Turbine fuel	6173
Kerosene	25
Heating oil	7
Automotive diesel oil	18 587
Industrial diesel fuel	16
Fuel oil	1423
Lubes and greases	437
Bitumen	809
Other	311
Total	**50 614**

Source: Australian Government Department of Resources Energy and Tourism (2010)

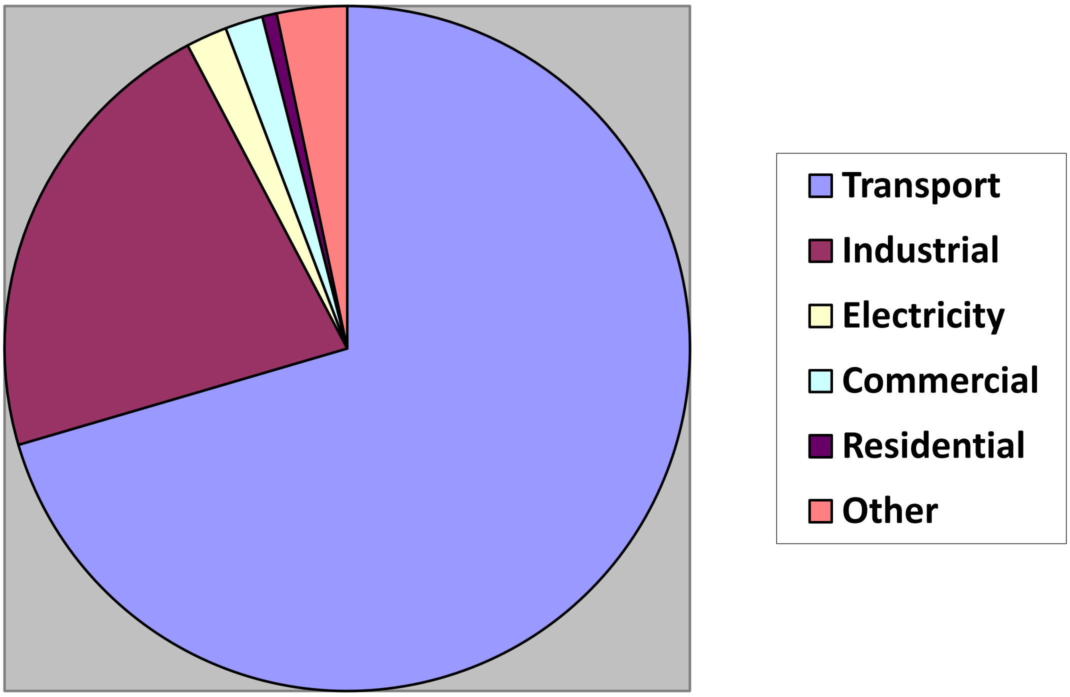
[152] Ibid 18.

Of the consumption of 50 614 million litres of petroleum products, 78 per cent or 39 546 million litres came from the petroleum refining industry in Australia. However, the Australian refineries consumed 38 808 million litres of crude oil and condensate, of which 80 per cent was imported.[153] This is partly because the Australian crude oil is generally light and getting lighter and the Australian refineries require the heavier crude oils. This means that Australia is very dependent on imported crude and petroleum products (oil). In 2010–11, Australia imported 31 768 million litres of crude oil and over 16 000 million litres of refined transport fuels.[154]

In terms of oil consumption, the transport sector is the largest consumer of oil products in Australia. In 2007–08, the transport sector accounted for around 70 per cent of the total use of oil, compared with 50 per cent in the 1970s as shown in Figure 2.1 below.[155]

[153] Ibid 57.
[154] Department of Resources, Energy and Tourism, 'Strategic Framework for Alternative Transport Fuels' (December 2011) 16.
[155] Geoscience Australia and ABARE, above n 1, 63.

FIGURE 2.1: Australian Oil and LPG Domestic Consumption 2007–08



Source: ABARE, Australian energy statistics.

Within the transport sector, road transport is the largest consumer of oil representing 74 per cent of the total energy consumption in the transport sector.[156] A further examination of fuel consumption within the road transport sector reveals that passenger motor vehicles consumed 60.9 per cent of all Australian road fuel consumption in 2007–08 as demonstrated in Table 2.6 below.[157]

[156] Department of Resources, Energy and Tourism, above n 138, 63.
[157] Department of Resources, Energy and Tourism, 'Energy in Australia 2011' (ABARE, 2011) 68.

TABLE 2.6: Australian Road Fuel Consumption by Type of Vehicles 2006–07

	Percentage
Passenger vehicles	60.9
Buses	2.3
Motorcycles	0.4
Light commercial vehicles	15.7
Other trucks	0.2
Articulated trucks	12.5
Rigid Trucks	7.9
Total	**100**

Source: Department of Resources, Energy and Tourism, *Energy in Australia 2011* (ABARE, 2011)

Since passenger vehicles in Australia consume the majority of oil used for road transport, it is necessary to investigate how the consumption of oil can be reduced in passenger motor vehicles. As part of this investigation, it is necessary to understand the types of motor vehicles that Australians drive, where they drive and the number of vehicle kilometres (VKM) they accumulate in a year. It is also necessary to examine the growth of the motor vehicle industry, the design and characteristics of the motor vehicles that people choose for personal transportation, and the impact their choices have on the consumption of oil. Following such an examination, a critical analysis of appropriate regulatory and fiscal policies can be conducted in order to find ways to bring about a reduction in the consumption of oil in passenger motor vehicles.

The growth of motor vehicle use is discussed in Chapter 3. History shows that motor vehicles were seen as a means of conquering distance and increasing the speed by which people and goods could be moved. The ingredients that made it possible for the vehicle population to grow were the invention of the assembly line, the abundance of cheap oil, appropriate marketing techniques and appropriate government regulations. The next chapter analyses data on passenger motor vehicles that will set parameters for the policy review in Chapter 4, ie an analysis of the existing regulatory and fiscal measures that address the use of oil in passenger motor vehicles.

2.5 CONCLUSION

This chapter addressed the first research question and the first two research objectives stated in part 1.3.

The first objective was the investigation of the reported Australian and global oil resources. The investigation reveals that the countries with the most oil reserves are in the Middle East and transitional economies, ie the Russian Federation. The oil position is well summarised in the reports, for instance that a peak in production can be expected to occur before 2031; increasing the global URR by a billion barrels delays the peak by only a few days, and delaying the peak beyond 2030 requires optimistic assumptions about the size of the recoverable resource and the rate at which it is developed. Many organisations have forecast global peak oil to occur before 2020. Peak oil does not mean oil running out, but a point where further expansion of oil production becomes impossible, because new flows are fully offset by production declines or depletion. Many national and international reports show concern about the global oil position and advocate that governments should take policy action to reduce the demand for oil, especially in the transportation sector.

This chapter also addressed the second research objective, to explore whether there is a need to focus on reducing the use of oil in passenger motor vehicles in Australia. Australian government reports indicate that Australia's oil resources are in decline as crude oil resources are being depleted at a faster rate than they are being replenished by discovery, and as a result, Australia is increasingly relying on imported oil. Since passenger vehicles in Australia consume the most oil, that is the focus of investigation for this research. Chapter 3 analyses passenger motor vehicles in terms of their growth in number and size, driver usage and choice, and dependency on oil. Chapter 3 also explores future car designs and their limitations.

CHAPTER 3: ANALYSIS OF PASSENGER MOTOR VEHICLES — GROWTH, USAGE, DESIGN AND CHOICE

3.1 INTRODUCTION

This chapter addresses the second research objective: To explore the need to focus on reducing the use of oil in passenger motor vehicles in Australia. An analysis of passenger motor vehicles is undertaken in this chapter in terms of their growth in number and size, their usage and design, their choice by motorists, and their impact on the consumption of oil.

Part 3.2 explores the increase in passenger motor vehicles, both globally and in Australia, and illustrates how the passenger motor vehicle industry has grown over the last 100 years. Australians mainly rely on passenger motor vehicles for transportation and this is examined in part 3.3. Part 3.4 explores the design and choice of passenger motor vehicles and addresses the question of whether a large and powerful passenger vehicle is necessary when a smaller, lighter vehicle can provide the necessary transportation with reduced oil consumption. Part 3.5 investigates whether future car designs can resolve the oil problem, followed by a conclusion in part 3.6.

3.2 GROWTH OF PASSENGER MOTOR VEHICLES

The growth of the motor vehicle industry over the last 100 years has been dependent upon the plentiful supply of oil, a resource which has taken millions of years to form. The history of motor vehicles dates back to 1886 when Karl Benz invented the first gasoline motor vehicle and fitted it with a four-stroke engine.[158] Henry Ford

[158] Jean-Pierre Bardou et al, *The Motor Vehicle Revolution: The Impact of an Industry* (James M Laux trans, University of North Carolina Press, 1982) [trans of: *La Révolution Automobile* (first published 1977)] 5.

revolutionised the motor industry in the United States in 1908 by introducing a low-priced model 'T'. The model T was very successful, with 15 458 781 cars having been produced after ten years. The success of the model T was due to its simple, sturdy design and a high power-to-weight ratio, which meant that drivers could obtain power without pushing the engine to its limit.[159] The year 1908 marked the founding of General Motors (GM) as the holding company for many merged firms in the car industry.

Manufacturers in the 1900s were keen to reduce the weight of cars in order to increase their performance, and began using special steels for crucial parts such as gears and valves. These steel alloys contained carbon, nickel, chromium, tungsten and manganese. The focus on new production methods led to larger volumes of cars being produced. There was a shift in focus from sale to production. Ford's invention of a constant moving assembly line between 1907 and 1909 was a major evolutionary step in the mass production of cars. By April 1914, the constant moving assembly line reduced the time required for chassis assembly from 840 minutes to 93 minutes. The increased production output due to the assembly line meant that the price of cars was reduced. This put pressure on other manufacturers around the world, especially in Europe.

By 1914, the first phase of the motor vehicle revolution was complete. The First World War did not halt the growth of car manufacturing. In 1914, America produced 548 139 passenger cars, and by 1917, there was an increase of over 218 per cent in production to 1 745 792 cars.[160] The heaviest demand was for lower priced cars, and in 1916 the price of the Model T dropped to USD360. In 1918, manufacturers improved their cars by installing heaters and closing up the bodies. The four-wheel hydraulic brakes were also introduced in 1918.[161] In the early years, cars were considered a luxury and there was resistance to them due to the fear of motor vehicles running into horses and people. In October 1917, the War Industries Board in the United States classified car manufacturing as a 'non-essential' industry, and in 1918 the US imposed a luxury tax on cars. Similar taxes were also imposed by

[159] Ibid 54.
[160] Ibid 84.
[161] Ibid 88.

Britain. However, this did not deter the demand for cars and their production. By 1920, there was a total of 8 132 000 registered cars in the US.[162]

The growth pattern of motor vehicle manufacturing in Australia was similar to that in America and Europe. Australia commenced the manufacturing of cars in 1897, when the first petrol car was invented by Harry Tarrant in Melbourne. Tarrant was later joined by Howard Lewis, a bicycle maker, and together they produced another car with a six horsepower engine. This car became known as the Tarrant,[163] and over the years it underwent a number of design improvements and adjustments using both Australian-made and imported components.[164] Locally designed engines, gearboxes and rear axles were combined with imported radiators, magnetos and carburettors.[165]

Australia was already importing cars in the early 1900s from the UK and America. By 1917, 15 000 cars were imported into Australia, of which 10 000 were Model T Fords and 2300 Dodges, 1500 Buicks and 1200 others.[166] In order to protect local manufacturing, the Australian government introduced customs duty on imported vehicle bodies. In 1913 about 2000 car bodies were produced locally and 4900 imported.

The demand for vehicles increased after the First World War, as better roads were constructed and vehicles became more reliable. In 1920–21, there was one vehicle to 55 people. By 1929–30, there was one vehicle to 11 people. The Second World War brought a shortage of petrol which was rationed for civilian use. Imports were restricted during the Second World War and greater reliance was placed on the local car industry.[167] The first Australian Holden was manufactured in 1948 and became a popular family car, followed by Ford, Chrysler and Volkswagen. The Japanese cars came onto the scene in the 1960s, and the large American cars and expensive European cars could not compete with the Japanese as the Japanese cars were cheaper, simpler and reliable.

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[162] Ibid 90.

[163] An automobile engine produced by Tarrant Motor & Engineering Co and dating back to 1908 is housed in the Powerhouse Museum in Sydney, Australia.

[164] Sir Brian Inglis, 'Transport' in *Technology in Australia 1788–1988* (Australian Academy of Technological Sciences and Engineering using the Web Academic Resource Publisher, revised 2001), 479.

[165] Ibid.

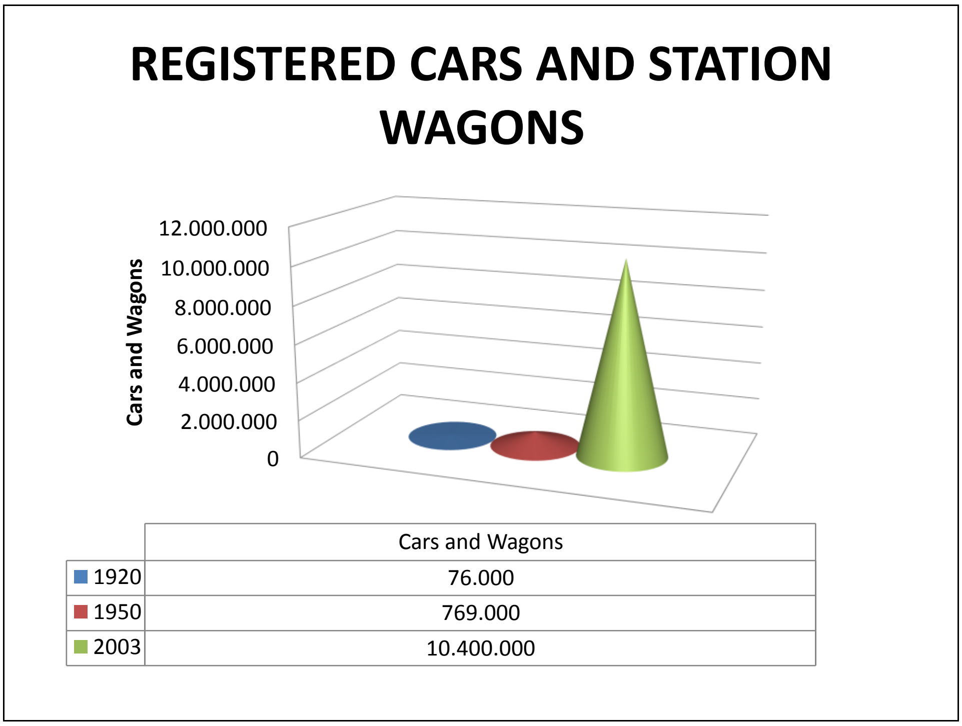
[166] Ibid 480.

[167] Ibid 485.

The number of passenger vehicles registered per 1000 population increased in Australia from 250 in 1965 to 465 in 1995.[168] In 2008, there were 555 passenger vehicles per 1000 population compared with 719 total motor vehicles per 1000 population.[169] Thus in 2008, registered passenger motor vehicles formed 77 per cent of total registered motor vehicles. Of the 11 803 536 registered passenger vehicles in 2008, 6.2 million were made up of three makes: Toyota (19.4 per cent); Holden (17.6 per cent) or Ford (15.2 per cent per cent).[170]

The historical increase in the number of registered cars on Australian roads is shown in Figure 3.1.

FIGURE 3.1: Registered Cars and Station Wagons



Source: Australian Bureau of Statistics, 'Use of Urban Public Transport in Australia' in *Year Book Australia, 2005*[171]

[168] Australian Bureau of Statistics, *Australian Social Trends, 1996* (Catalogue No 4102.0, 24 June 1996) 159–70.
[169] Australian Bureau of Statistics, above n 23, 10.
[170] Australian Bureau of Statistics, above n 23, 14.
[171] Australian Bureau of Statistics, 'Use of Urban Public Transport in Australia' in *Year Book Australia, 2005* (Catalogue No 1301.0, 21 January 2005).

Not only did the number of passenger vehicles increase, but Australians also increasingly began relying on passenger motor vehicles as their main means of transport, as discussed in the next part.

3.3 USAGE OF PASSENGER MOTOR VEHICLES FOR TRANSPORTATION

Australians increasingly began relying on passenger motor vehicles for transportation. In 1995, private road vehicles represented 93 per cent of city passenger transport.[172] In March 2009, 92 per cent of Australian households kept at least one registered motor vehicle at home. The proportion of households with two or more registered vehicles increased from 51 per cent in 2006 to 56 per cent in 2009.[173] In 2009, 80 per cent of people in Australia used private motor vehicles to travel to work or full-time study, 14 per cent took public transport, four per cent walked and two per cent cycled. Ninety-four per cent of people who used a private motor vehicle to travel to work or full-time study did so as a driver or rider and only six per cent travelled as a passenger. The most common reasons for Australians not using public transport are: lack of service at right or convenient time; convenience, comfort and privacy; travel time too long; and own vehicle needed.[174]

A Senate inquiry on the investment of Commonwealth and State funds in public passenger transport infrastructure and services reported in August 2009 that metropolitan travel passenger-kilometres consist of about 85–90 per cent by car, 10 per cent by public transport and the rest by cycling and walking. The most prominent comment in the submissions was the need for improvements to public transport service and for encouragement of public transport use. A number of recommendations were made which included that the government should investigate

[172] Ibid.
[173] Australian Bureau of Statistics, *Year Book Australia, 2009–10* (Catalogue No 1301.0, 4 June 2010) 84.
[174] Ibid 85.

tax incentive options for public transport and that it should support behavioural change programs.[175]

The 'State of Australian Cities' (2010) report by Infrastructure Australia states that the level of car dependency in Australian cities has increased at a faster rate than population growth, creating traffic congestion problems that are projected to cost AUD20.4 billion by 2020.[176] However more recent trends since the early 2000s show a peak in motor vehicle use in most developed countries.[177]

Since the end of the Second World War, Australian cities have grown, with an increase in suburbs. The government policies that have shaped our cities are housing and land, transportation and taxation. A rapid increase in motor vehicle ownership has encouraged the improvement and spread of the road system, thereby influencing urban land use. The increased dependency on passenger motor vehicles for transportation has increased oil consumption, other associated costs such as land use for roads and parking, policing, accidents, noise, pollution and costs associated with congestion.

Registered passenger motor vehicles consumed 30 047 million litres of fuel in the 12 months ended 31 October 2007, of which 62.8 per cent was petrol and 31.2 per cent was diesel.[178]

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[175] Senate Rural and Regional Affairs and Transport Committee, Parliament of Australia, 'Executive Summary and Recommendations' in *Investment of Commonwealth and State Funds in Public Passenger Transport Infrastructure and Services* (2009) <http://www.aph.gov.au/Parliamentary_Business/Committees/Custom_Contents/SenateCommittees/rratctte/publictransport/report> .

[176] Major Cities Unit, 'State of Australian Cities 2010' (Report, Infrastructure Australia, 2010) <http://www.infrastructureaustralia.gov.au/publications/files/MCU_SOAC.pdf>.

[177] Litman, above n 10, 6.

[178] Australian Bureau of Statistics, *Survey of Motor Vehicle Use, Australia, 12 Months Ended 31 October 2007* (Catalogue No 9208.0, 28 August 2008).

TABLE 3.1: Type of Fuel Used by Passenger Vehicles

	2003	**2008**
Leaded	1 666 750	620 228
Unleaded	8 177 794	10 384 655
Diesel	295 697	505 340
LPG/other	225 700	293 313
Total	10 365 941	11 803 536

Source: Australian Bureau of Statistics, *Motor Vehicle Census, Australia, 31 Mar 2008* (Catalogue No 9309.0, 14 January 2009).

It is not just the increase in the use of passenger motor vehicles that needs to be controlled to conserve oil and reduce other associated costs, but also the design of the vehicles. It is worth noting that even though the engines powering our vehicles have become more efficient at extracting energy from liquid fuels, this has not resulted in an energy saving. The reason for this is that manufacturers have increased the power output of the motor vehicles as a selling point to attract customers, because customers are demanding larger and more powerful motor vehicles. The next part examines the current design of motor vehicles and the types of vehicles that Australians are choosing.

3.4 DESIGN AND CHOICE OF PASSENGER MOTOR VEHICLES

As the number of registered passenger motor vehicles has increased, it is necessary to examine the design criteria for passenger motor vehicles and their impact on oil consumption. To this end, the specifications of the Holden family car models from 1948 to 2008 were studied and the following data was collected:

- Year the model was introduced;
- Engine size in litres;
- Engine power output in kilowatts (kW);
- Weight of the car in kilograms (kg);

- Vehicle’s power-to-weight ratio;
- Vehicle performance in terms of the time taken in seconds to reach a speed of 100km per hour.

The results are summarised in Table 3.2.

TABLE 3.2: Holden Family Car Model Specifications, 1948 to 2008

Car Model	Year Introduced	Engine Size (litre)	Power in kW	Weight kg	Power-to-Weight Ratio kW per tonne	Performance 0–100km/h in seconds
Holden 48-215 (FX)	Nov 1948	2.15	45	1012	44.46	20
Holden FJ	Oct 1953	2.15	45	1012	44.46	20
Holden FE	July 1956	2.15	53	1080	49.07	20.4
Holden FC	May 1958	2.15	53	1084	48.89	19.5
Holden FB	Jan 1960	2.26	56	1122	49.91	20.8
Holden EK	May 1961	2.26	56	1121	49.95	20.8
Holden EJ	July 1962	2.26	56	1130	49.56	18
Holden EH	Aug 1963	2.45	75	1185	63.29	
Holden HD	Feb 1965	2.45	86	1216	70.72	13.2
Holden HR	Apr 1966	2.45	86	1217	70.66	15.3
Holden HK	Jan 1968	2.65	85	1300	65.38	15.2
Holden HT	May 1969	2.65	85	1300	65.38	10.1
Holden HG	July 1970	2.65	85	1300	65.38	12.8
Holden HQ	July 1971	3.3	101	1338	75.48	13.1
Holden HJ	July 1974	3.3	96	1338	71.75	13.1
Holden HX	July 1976	3.3	82	1330	61.65	16.4
Holden HZ	Oct 1977	3.3	81	1342	60.35	16.8
Holden WB	1980	3.3	81	1220	66.39	
Holden VB	Oct 1978	3.3	71	1220	58.20	16.4
Holden VC	Mar 1980	2.85	76	1158	65.63	13.9
Holden VH	Oct 1981	2.85	76	1152	65.97	10.2
Holden VK	Feb 1984	3.3	86	1250	68.80	
Holden VL	Mar 1986	3.0	114	1250	91.20	7.04
Holden VN	Aug 1988	3.8	125	1226	101.96	8.1

Car Model	Year Introduced	Engine Size (litre)	Power in kW	Weight kg	Power-to-Weight Ratio kW per tonne	Performance 0–100km/h in seconds
Holden VP	Sept 1991	3.8	125	1332	93.84	8.1
Holden VR	July 1993	3.8	130	1362	95.44	
Holden VS	Apr 1995	3.8	145	1385	104.69	8.9
Holden VT	Aug 1997	3.8	147	1512	97.22	9.1
Holden VX	Sept 2000	3.8	147	1519	96.77	9.1
Holden VY	Oct 2002	3.8	152	1522	98.55	9.0
Holden VZ	Aug 2004	3.6	180	1700	105.88	8.6
Holden VE	July 2008	3.6	180	1700	105.88	8.6

Source: Richard Lewis, *Holden Specifications* (2008) <http://richardlewis.org/holdenspecs.html>.

Even though the engines powering our vehicles have become more efficient at extracting energy from liquid fuels, this has not resulted in an energy saving. The reason for this is that vehicle power output has increased, and greater power output has led to a real term net gain in vehicle size and weight as demonstrated in Table 3.2 above. For example, the first Holden family motor vehicle, the 1953 FJ Holden, had a 2.15 litre engine and a power output of 45kW, but the vehicle weighed only 1018kg, which gave a power-to-weight ratio of 44.46kW per tonne. By comparison, the average family car in 2008, the Holden VE Commodore, has a power output of 180kW, weighs 1700kg and has a power-to-weight ratio of 105.88kW per tonne.[179] If a vehicle with a power output of 45kW was produced today, it would need an engine with a capacity of only approximately 855cc with a much lower weight and fuel consumption.[180] This is based on 0.052kW per cubic centimetre as demonstrated by Schefter using the 'Smart Fortwo', with its one litre engine producing 52kW power and accelerating from 0 to 100km/h in 12.8 seconds.[181] This would be more than

[179] Richard Lewis, *Holden Specifications* (2008) <http://richardlewis.org/holdenspecs.html>.
[180] Kellen Schefter, 'Smart Car Offers Drivers New High MPG Option, Top Crash Rating' *Green Car Journal* (online), 20 January 2008 <http://www.greencar.com/articles/smart-car-offers-drivers-new-high-mpg-option-top-crash-rating.php>.
[181] Ibid.

adequate to drive on most roads as it almost matches the performance requirement of 0–100km/h in 10 seconds for general duty patrol and high performance vehicles.[182]

Various reports have noted that there has been no real gain in average fuel efficiency over the last few decades. In September 2008, the Australian Transport Council released a public discussion paper and noted that:

> The average fuel consumption of all light vehicles has hardly changed over the last decade. Engine technology in terms of fuel consumption per power output has improved substantially due to a number of reasons such as higher compression ratios and fuel injected Otto engines and as a result there has been an improvement in fuel efficiency in the new passenger vehicle fleet. However, potential fuel savings across the whole light vehicle fleet have been offset by increases in vehicle power, size and weight and by the strong growth in sales of four wheel drive sports utility vehicles (SUVs), and increases in the fuel consumption of light commercial vehicles.[183]

This is demonstrated in Figures 3.2 and 3.3.

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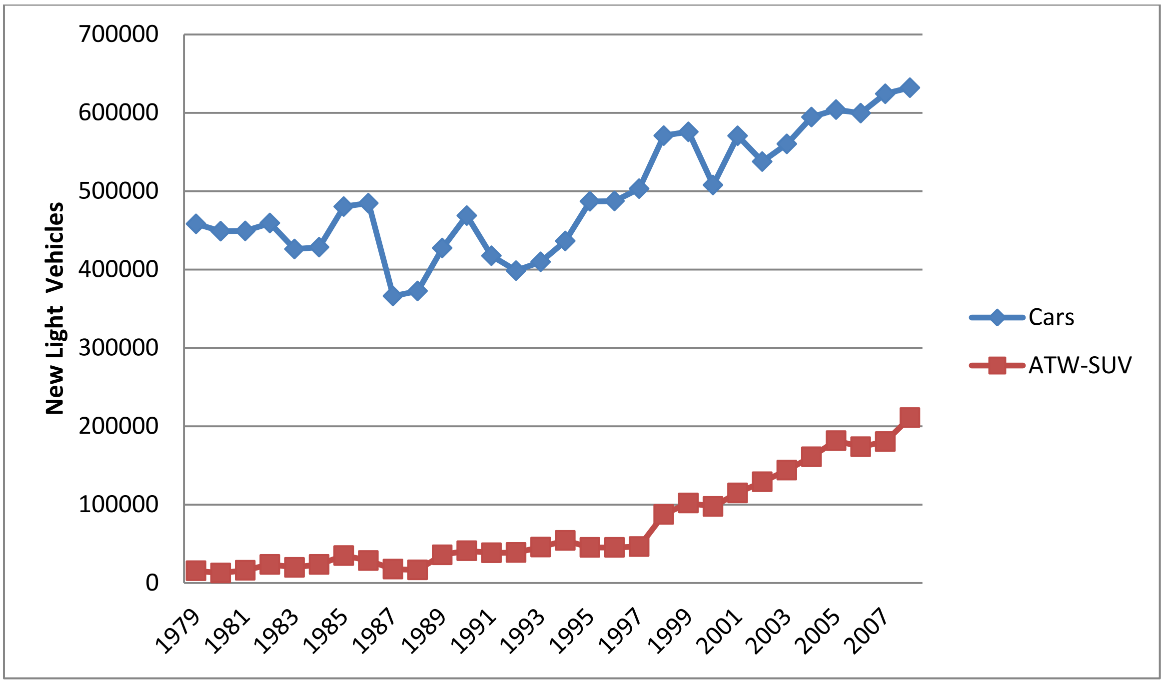
[182] Australasian Centre for Policing Research, *National Specifications for General Duty Patrol & High Performance Vehicles* (National Police Research Unit, Payneham, 6th revision, 2006).

[183] Australian Transport Council and Environment Protection and Heritage Council Fuel Efficiency Working Group, above n 4, 16.

FIGURE 3.2: New Car and All Terrain Wagon-Sports Utility Vehicle (ATW-SUV) Sales in Australia



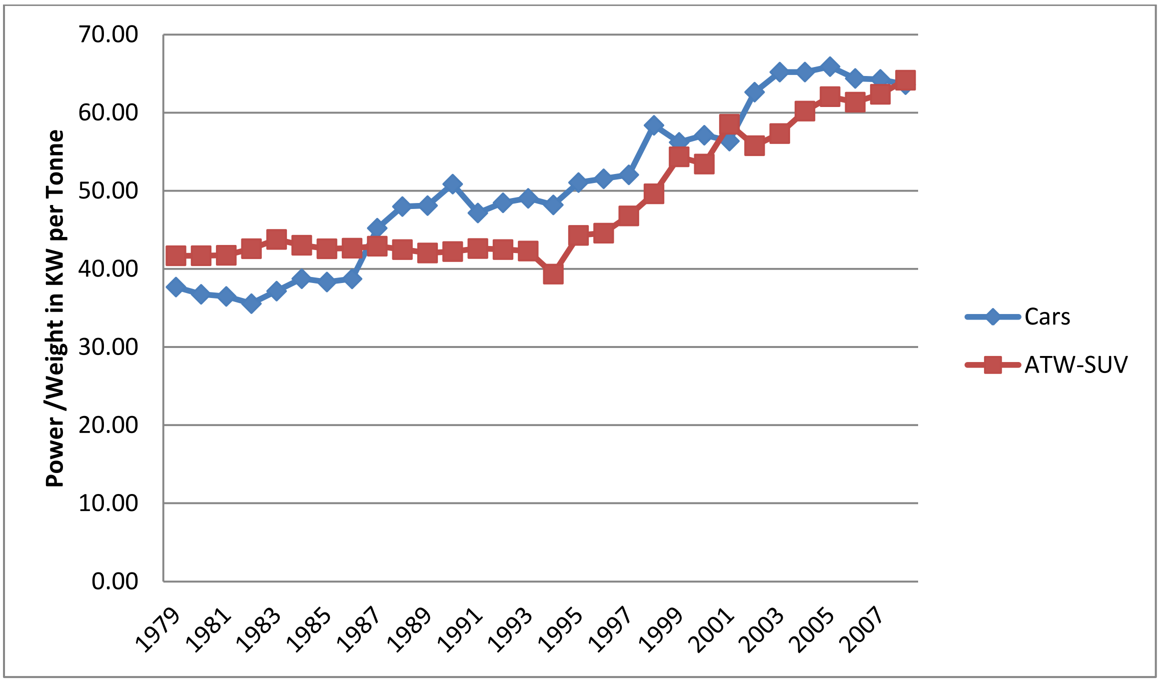
Source: Bureau of Infrastructure, Transport and Regional Economics, 'Fuel Consumption by New Passenger Vehicles in Australia 1979–2008' (Information Sheet No 30, August 2009).

The new car sales in Australia increased from 458 131 in 1979 to 631 866 in 2008, an increase of 37.9 per cent, whereas the ATW-SUVs in the same period increased from 15 556 to 210 933, an increase of 1255.9 per cent. Bearing in mind that Australia is increasingly relying on imported oil as discussed in Chapter 2, it is worth questioning whether there is a need for the Australian government to curb the demand for large and powerful passenger cars including SUVs. The LET proposed in Chapter 6 considers energy as a luxury, and suggests that driving a vehicle beyond the power and weight necessary to transport a person should be considered a luxury to be paid for in order to deter excessive use.

Figure 3.3 below shows that the average power of new cars in 1979 was 75.14kW and the average weight was 1994.01kg. In 2008, the average power of new cars increased to 118.31kW and the average weight increased to 1860.73kg. Thus the power-to-weight ratio of cars increased from 37.68kW/tonne in 1979 to 63.58kW/tonne in 2008, an increase of 68.73 per cent.

Similarly, the average power of ATW-SUVs increased from 105.40kW in 1979 to 157.25kW in 2008. The average weight of ATW-SUVs was 2528.08kg in 1979 and 2451.00kg in 2008. Thus the power-to-weight ratio of ATW-SUVs increased from 41.69 kW/tonne in 1979 to 64.15 kW/tonne in 2008, an increase of 53.87 per cent.[184]

FIGURE 3.3: Power-to-Weight Ratios for New Light Vehicles in Australia



Source: Bureau of Infrastructure, Transport and Regional Economics, 'Fuel Consumption by New Passenger Vehicles in Australia 1979–2008' (Information Sheet No 30, August 2009).

The Bureau of Infrastructure, Transport, Regional Economics (BITRE) examined trends in the fuel consumption of new passenger vehicles in Australia from 1979 to 2008 and reported that the preference of Australian consumers for vehicle characteristics that increase fuel consumption, being power, weight, accessories and 4WD capability, has meant that potential reductions in fuel consumption made possible by technological advances have not been fully realised. The report also confirmed that this is a worldwide trend and cautions against reliance on technology

[184] Bureau of Infrastructure, Transport and Regional Economics, 'Fuel Consumption by New Passenger Vehicles in Australia 1979–2008' (Information Sheet No 30, August 2009).

alone to deliver reductions in fuel use.[185] This indicates that the choice of extra power and weight should be discouraged through appropriate government policies.

Studies undertaken by Van den Brink and Van Wee[186] on European vehicles indicate that any energy efficiency achieved by enabling vehicles to do more mileage with less fuel has been directed toward increasing the power and weight of vehicles rather than reducing their fuel use. The study on new passenger vehicles in the Netherlands showed that between 1985 and 1997 the average weight of new passenger cars increased by 20 per cent, or about 190kg, and without this increase in weight, the average new passenger car would have been 12 per cent more fuel efficient.[187] The reason for the increase in weight was that successive models of cars got larger, and this was partly due to competition between car manufacturers, but also due to demand from customers. Motor vehicle advertisements emphasising the importance of space, speed, and acceleration discourage consumers from choosing smaller, lighter and less powerful models.[188] The new models also tend to have a greater cylinder capacity. From 1985 to 1995, the cylinder capacity of the average new car sold in the Netherlands increased from 1475 to 1640cc.[189]

The increase in weight of a motor vehicle can be attributed to the actual increase in its size together with an increase in safety standards, extra insulation materials and conveniences such as air conditioning and electric windows. The Netherlands study also showed that the increase in weight directly affects specific fuel consumption in two ways, firstly through acceleration resistance, where energy is needed to accelerate the vehicle, and secondly through rolling resistance. The study concluded that an extra 100kg of weight leads to a seven to eight per cent increase in fuel consumption.[190]

It is also interesting to note that a substantial increase in motor vehicle power was the indirect result of technological improvements required in order to comply to changes in laws on vehicle emission standards. In Australia, the vehicle emission standards

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[185] Ibid 10.
[186] Robert M M van den Brink and Bert van Wee, ‘Why Has Car-Fleet Specific Fuel Consumption Not Shown Any Decrease Since 1990? Quantitative Analysis of Dutch Passenger Car-Fleet Specific Fuel Consumption’ (2001) 6 *Transportation Research Part D* 75.
[187] Ibid 84.
[188] Ibid 84–5.
[189] Ibid 86.
[190] Ibid 83.

are set by the Commonwealth government through the Australian Design Rules (ADRs). Table 3.3 lists the emission requirements for new petrol passenger cars in Australia from 1972 to 2010.

TABLE 3.3: Summary of Emission Requirements for New Petrol Passenger Cars in Australia 1972–2010

Standard	**Date Introduced**	**Exhaust Emission Limits**			**Source**
		Hydrocarbons(HC)	**Carbon Monoxide (CO)**	**Oxides of Nitrogen (NOx)**	
ADR26	1/1/72	NA	4.5% by vol	NA	Idle CO test
ADR27	1/1/74	8.0–12.8g/test	100–220 & 4.5% by vol	NA	ECE
ADR27A	1/1/76	2.1g/km	24.2g/km	NA	US 72 FTP
ADR27B	1/1/82	2.1g/km	24.2g/km	1.9g/km	US 72 FTP
ADR27C	1/1/83	2.1g/km	24.2g/km	1.9g/km	US 72 FTP
ADR37/00	1/2/86	0.93g/km	9.3g/km	1.93g/km	US 75 FTP
ADR37/01	1/1/97–1/1/99	0.26g/km	2.1g/km	0.63g/km	US 75 FTP
ADR79/00	1/1/03–1/1/04	0.25g/km	2.2g/km	0.25g/km	UN ECE R83/05 (Euro2)
ADR79/01	1/1/05–1/1/06	0.2g/km	2.3g/km	0.15g/km	UN ECE R83/05 (Euro3)
ADR79/02	1/7/08–1/7/10	0.1g/km	1.0g/km	0.08g/km	UN ECE R83/05 (Euro4)

Source: Department of Infrastructure and Transport, *Vehicle Emission Standards* (6 March 2012) Commonwealth of Australia <http://www.infrastructure.gov.au/roads/environment/emission/index.aspx>.

Over past decades, changes in environmental regulations have required a reduction in vehicle carbon monoxide emission levels. The required maximum levels were

24.2g/km in July 1976 (ADR 27A), decreasing to 9.3g/km from 1986 for new passenger vehicles (ADR 37-00) and 2.1g/km for new models (ADR 37-01) from 1997 and for all new passenger vehicles from 1998. These have been further reduced to 1.0g/km from 2008. The removal of lead from petrol since 1986 and the installation of catalytic converters (ADR 37-00; Australian Standard 2877) has assisted in reducing environmental air pollution from exhaust emissions. The catalytic converter transforms carbon monoxide and other pollutants into the by-products carbon dioxide and water, reducing emissions and increasing performance. It reduces NOx emissions, unburned hydrocarbons and carbon monoxide. Performance is enhanced via an oxygen sensor mounted in the catalytic converter that conveys to the engine computer how much oxygen is in the exhaust, so that the engine computer can adjust the air-to-fuel ratio, making sure that the engine is running at close to the stoichiometric point.[191]

With the introduction of emission laws, motor manufacturers began installing microprocessors in vehicle Engine Control Units (ECU) that regulate the air/fuel mixture so that the catalytic converter can remove most of the pollution from the exhaust. The ECU collects data and performs millions of calculations each second to decide the best spark timing and determine how long the fuel injector is open, thus obtaining the lowest emissions and the best mileage.

A motor vehicle fuel system that provides an incorrect fuel intake creates high levels of emissions. In order to keep up with emission and fuel efficiency laws, the fuel system used in modern cars has been changed over the years. The throttle body fuel injection systems have been replaced by multi-port fuel injection systems, which have a fuel injector for each cylinder so that the correct amount of fuel is delivered at the intake valve, thereby increasing the engine performance.

The increase in performance and power brought about by these technological advances has been eroded by the motor vehicle manufacturers providing consumers with larger and heavier vehicles. Larger and heavier motor vehicles require more energy to get them moving and this means an increase in oil consumption. A New South Wales study on the change in car fleet characteristics from 1990 to 2000

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[191] Karim Nice and Charles W Bryant, *How Catalytic Converters Work* (2011) How Stuff Works <http://auto.howstuffworks.com/catalytic-converter2.htm>.

showed that car size increased by 27 per cent, the kilometres travelled increased by 23.5 per cent and the fuel efficiency improved by only four per cent.[192]

From the analysis so far, it can be concluded that Australians are mainly relying on passenger motor vehicles to transport themselves and they are increasingly purchasing heavier and more powerful vehicles that consume more fuel, when a smaller car could also meet their needs. If oil is becoming scarcer, the first place where oil consumption should be curtailed is where it will have the least impact on the Australian lifestyle. It is argued in this thesis that a behaviour change is required in regard to both the choice of motor vehicle type and the use of motor vehicles and alternative modes of transport. Critics may argue that if oil becomes scarce, conventional motor vehicles will be replaced by electric and hybrid motor vehicles, or motor vehicles using alternative fuels.

The next part explores whether future car designs could help reduce oil consumption.

3.5 FUTURE MOTOR VEHICLE DESIGNS AND THEIR LIMITATIONS

The main problem with current motor vehicle design is its reliance on a plentiful supply of oil. The fact that oil is non-renewable means that one day motor vehicles will need to be redesigned to run on alternative energy sources. Some alternative sources may impact on other resources such as water, land and agriculture, upon which our population relies for survival. Attempts have been made in the past to use different fuel sources for motor vehicles. In 1901, Ferdinand Porsche invented the ‘mixed’ gas-electric hybrid car. The American Baker Motor Vehicle Company sold thousands of electric cars from 1899 to 1915. These electric cars could reach speeds of 23 kilometres per hour (km/h). In 1990, General Motors (GM) introduced its ‘EV’ two-seater electric car that could reach a speed of 120km/h and could accelerate from zero to 90km/h in less than seven seconds. However, GM only built 1000 of these cars.

[192] Environment Protection Authority, *Clean Cars for NSW* (Environment Protection Authority, revised ed, 2003) 3.

Electric and hybrid electric vehicles may be the alternative future vehicles that reduce oil demand. However, there is a heavy reliance on fossil fuel, ie coal, to make electricity. Moreover, electric or hybrid cars tend to cost more to purchase, and it is only through appropriate policies by providing grants for hybrid production and infrastructure development that the demand for alternative future vehicles will increase. A recent parliamentary report canvassed that Australia has a role to play in assessing technologies such as nanotechnologies, compressed air and hydrogen that may be required in developing concept hybrid cars and introducing new car systems with alternative fuel supplies. The report further states that Australia has the potential to be influential in the global automobile manufacturing industry.[193]

Many different types of electric vehicles have been designed in recent years. The simplest of the vehicles with an electric driveline is the battery-powered electric vehicle. The energy required to power the vehicle comes from a battery, which can be recharged from the wall plug. The vehicle's driving distance is determined by the energy storage capacity of the battery, and its acceleration and top speed depend on the power rating of the electric motor.

Table 3.4 shows selected battery-electric vehicles that have been designed and built in recent years:[194]

TABLE 3.4: Electric and Hybrid Vehicles — Design and Performance

Model/Manufacturer	**Weight (kg)**	**Battery (kWh)**	**Motor (kW)**	**Range (Miles)**	**Max Speed (km/h)**
EVI/GM	1350	NiMthyd/29	104	140	>120
EV Plus/Honda	1634	NiMthyd/30	49	100	>120
RAV4/Toyota	1560	NiMthyd/28	50	95	>120
Altra/Nissan	2080	Lithium-ion/32	62	120	>100

[193] Matthew L James, 'The (Green) Car of the Future' (Background Note No 2009–10, Parliamentary Library, Parliament of Australia, 2009) <http://www.aph.gov.au/binaries/library/pubs/bn/sci/carofthefuture.pdf> 1.
[194] Andrew Burke, 'Electric and Hybrid Vehicle Design and Performance' in Myer Kutz, *Environmentally Conscious Transportation* (John Wiley & Sons, 2008) 131.

Model/Manufacturer	Weight (kg)	Battery (kWh)	Motor (kW)	Range (Miles)	Max Speed (km/h)
Smart/Mercedes	1380	NaAICI/ 30	50	125	>120
Think/Ford	960	NiCad/12	12	50	40
E-com Toyota	790	NiMthyd/8	20	50	80
Hypermini/Nissan	840	Lithium-ion/10.5	24	60	80
Zenn/Feelgood cars	510	VRLA lead-acid/7	8	35	40

Source: Myer Kutz, *Environmentally Conscious Transportation* (John Wiley & Sons, 2008).

Tesla Motors was founded in 2003 in California and has produced a number of electric vehicles such as the Tesla Roadster, which was released in 2008.[195] The Tesla Roadster operates on 6831 lithium-ion batteries that can be recharged using a 13A socket from any conventional 110 volt or 220 volt power outlet. The charging times depend upon the breaker amperage. At 13A, it takes about 16 hours to recharge the batteries, but at a 50 ampere breaker rating, the charge time is approximately six hours.[196] With a full charge and driving at reasonable speed, the Tesla Roadster gives 394 kilometres (245 miles) of driving range. It has an AC induction motor and a single speed gearbox producing 400 newton meter (295 pounds per square foot) of torque and 288 horsepower, and it accelerates from zero to 97km/h (60mph) in 3.7 seconds. The drive efficiency of the Tesla Roadster is 88 per cent, making it three times more efficient than an internal combustion powered vehicle.[197] The disadvantages of Tesla Roadster are that it is expensive to buy, costing about USD100 000, and that the electricity to recharge the batteries comes from burning fossil fuel. To put this in terms of an alternative energy source, using a single windmill to recharge the Tesla batteries would take 600 hours or 25 days.[198]

[195] Tesla, *About Tesla* <http://www.teslamotors.com/about>.
[196] Tesla, *Charging/High Power Wall Connector* <http://www.teslamotors.com/goelectric/charging/high-power-wall-connector>.
[197] Tesla, *Using Energy Efficiently* <http://www.teslamotors.com/goelectric/efficiency>.
[198] British Broadcasting Corporation, 'Jeremy Drives the Tesla Roadster', *Top Gear: Series 12, Episode 7*, 2008 (Jeremy Clarkson) <http://www.topgear.com/uk/tv-show/series-12/episode-7>.

A new type of lithium-ion battery that uses nanophosphate maybe soon be marketed by Norwegian company ‘Think’. These batteries are made from specialised electrode materials using nanotechnology, and should be able to provide up to 15 years of daily charging cycles of about four hours each. They are being developed by A123 systems and will be used in the new GM Chevy Volt.[199]

For plug-in electric motor vehicles to be successful, they would require an infrastructure of electric recharge grids. An organisation called Better Place is building electric recharge grids in many countries including Israel, Denmark, Australia and California.[200] In Australia, Better Place announced the launch of Network Operations Centre (NOC) which will manage the intelligent systems, software and assets for the Better Place electric vehicle recharge network.[201]

Another type of vehicle that is becoming common is the hybrid electric vehicle. Here the electricity is generated on board the vehicle from liquid or gaseous fuel and the electric motor provides the torque to propel the vehicle. In a parallel hybrid vehicle, the engine is connected directly to the wheels, whereas in a series hybrid vehicle, the engine is connected to a generator. In a charge-sustaining hybrid vehicle, the energy storage battery is charged off the engine and only requires a low charge, whereas in a plug-in hybrid vehicle, the battery is charged off the wall plug. The charge-sustaining hybrid vehicles operate in a similar manner to the conventional internal combustion engine. The development of plug-in hybrids is at an early stage and may become important in the future. The plug-in hybrid significantly replaces oil with electricity.[202] The Toyota hybrid technology appears to be the most advanced.[203] More hybrids have now come on the market, with Lexus announcing its GS 450h hybrid sedan in March 2006, followed by the RX400h 4WD in September 2006. GM brought in the Chevrolet Silverado and the GMC Sierra. A Hungarian hybrid, the Solo, was also introduced in June 2008.[204] Holden has also announced its electric Volt, which will come onto the market as a four passenger extended range electric vehicle. It uses electricity as its primary power source and petrol as its secondary

[199] Kevin Bullis, ‘An Electrifying Startup’ (2008) 111(3) *Technology Review* 68.
[200] James, above n 193, 12.
[201] *Better Place Australia* <http://australia.betterplace.com/>.
[202] Burke, above n 194, 131.
[203] See Toyota Motor Corporation, *How Hybrid Works* <http://www.toyota.com.au/hybrid-synergy-drive/hybrid-technology/how-hybrid-works>.
[204] James, above n 193, 9.

power source. The energy in the Volt is stored in a 16kWh lithium-ion battery pack which can drive 64km without using any oil.[205]

Hydrogen fuel cell vehicles are also being designed, where the fuel cell is an electrochemical device that converts hydrogen directly to electricity with only water and vapour as emissions.[206] The Honda FCX Clarity is one such motor vehicle which has its own electricity generating centre on board, using the hydrogen fuel cell. The compressed hydrogen is converted into electricity that drives the electric motor, producing 136 horsepower and reaching a speed of 160km/h (100mph). It can go from zero to 97km/h (60mph) in nine seconds. The advantage of using hydrogen is that it is renewable.[207] However, the chemical and atomic properties of hydrogen are such that it is difficult to separate hydrogen atoms out of the molecules in which it exists, and a substantial amount of power is required to do so. To obtain two grams of hydrogen and 16 grams of oxygen by electrolysis of 18 grams of water, an equivalent of 68 300 calories of electrical energy is required. Thus 100kWh of electricity is required to produce 18kWh of electricity or energy available in one pound of hydrogen gas.[208]

Compressed air cars are also being developed by a French company Motor Development International, based on the French compressed air technology (CAT).[209] It works on four cycles. Firstly, outside air is drawn into the combustion chamber and compressed to 400°C. Cold air is then injected to cause an explosive stroke of the piston which is then exhausted.[210] This technology is also being developed by an Indian company Tata Motors, which has operations in the UK, South Korea, Thailand and Spain. Deakin University in Australia designed a car that runs on compressed air as part of the Ford Global Challenge to design a Model T for the 21st century, and was a joint winner with Aachen University in Germany. Ford pronounced the Deakin design simple, lightweight, practical, compelling and low

[205] Holden, *Holden Volt – Coming Soon* <http://www.holden.com.au/pages/volt-coming-soon>.
[206] Burke, above n 194, 132.
[207] British Broadcasting Corporation, above n 198.
[208] C Johnson, *Hydrogen as a Fuel for Automobiles and Other Vehicles* (2003) <http://mb-soft.com/public2/hydrogen.html>.
[209] CAT volution, *MDI OneCAT CAV @ the 2008 NY Auto Show – Questions and Answers* (21 March 2008) You Tube <http://www.youtube.com/watch?v=rldgXhLW0h0&feature=player_embedded>. Also see <http://www.mdi.lu/eng/affiche_eng.php?page=communique3>.
[210] James, above n 193, 18.

cost, saying that it could be retailed for under AUD9000.[211] The Ford WS Fiesta Econetic is lightweight and therefore boasts a fuel economy of 3.7 litres per 100km, but does not match the AUD9000 price tag as pronounced by the Ford Global Challenge.

Volkswagen presented its L1 concept car at the Frankfurt International Motor Show in September 2009, driven by a new high-tech TDI and E-motor engine. With a carbon fibre body, the car weighs 380kg and can drive at a maximum speed of 160km/h. The L1 consumes 1.49 litres of diesel per 100km and is a small car at 3.813 metres long, 1.143 metres high and 1.2 metres wide. It has an aerodynamic design using the glider concept where driver and passenger sit one behind another, and it employs Formula 1 racing and airplane construction techniques. Volkswagen targeted release date for the vehicle is in 2013.[212]

It should be noted that mass production and marketing of motor vehicles using new technologies is in its infancy and may take many years to become viable. The reason for this is that the technologies must be first developed to be feasible at an affordable cost. They must compete with conventional technology, and the cost of the batteries and fuel cell technologies is still high.[213] In short, although the future car designs may be the solution for a reduced reliance on oil, they are not the solution for today. Government policies need to focus on reducing the use of oil in the existing vehicles with internal combustion engines, and encourage the purchase of vehicles with alternative energy sources. In this respect, the next part examines whether biofuels can replace the use of oil in the currently available motor vehicles.

3.5.1 Biofuels for motor vehicles

Biofuels may become an alternative source of energy for motor vehicles when oil becomes very expensive. Biofuels are made from renewable materials such as plants

[211] Deakin Research Services Division, *T^2 proves a winner in Global Challenge* (October 2008) <http://www.gsdm.com.au/newsletters/deakin/Oct08/t2.html>.
[212] Volkswagen International, 'Breakthrough for the 1-Litre Car: Volkswagen Presents the Most Fuel-Efficient Automobile in the World' (Press Release, 15 September 2009).
[213] Burke, above n 194, 187.

and organic waste. Common biofuels that may become popular in the future are ethanol, biodiesel and hydrogen.

a. Ethanol

Ethanol was used by Nikolaus Otto in 1876 when he invented the four-stroke engine. Even the Model T ran partly on ethanol. However oil became cheaper than ethanol and took over as a motor fuel. Ethanol can be produced from sucrose and starch, by the fermentation of crops into ethanol. There are a number of methods of making ethanol using the sugars or the starch, and new methods of making ethanol from plant fibres are being investigated as they would yield twice the amount of ethanol. Ethanol can be used in spark-ignition engines as a pure fuel or blended with oil. Vehicles manufactured after 1990 may use E10 ethanol, which has 10 per cent ethanol by volume. Since ethanol has poor cold-start properties, vehicles that run on blends greater than E85, ie containing up to 85 per cent ethanol, require an oil reservoir for cold starts. Some problems with ethanol include water separating oil from the ethanol, causing poor engine performance. Also, ethanol is hygroscopic and can be corrosive to common metals used in fuel systems and cause plastics to deteriorate. Ethanol contains less energy than oil, with 1.5 gallons of ethanol necessary to match the energy of one gallon of oil.[214]

The problem with using ethanol as a fuel supply is the reliance on production of crops with sucrose and starch. This brings about problems relating to the use of land and water required for human sustenance, and the need to feed the world's growing population rather than to use these resources to produce transportation fuel.

b. Biodiesel

Another biofuel that is increasingly being used for transportation is biodiesel. Biodiesel or vegetable oil was first used in engines developed by Rudolf Diesel. It

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[214] Aaron Smith, C Granda and M Holtzapple, 'Biofuels for Transportation' in Myer Kutz, *Environmentally Conscious Transportation* (John Wiley & Sons, 2008) 215.

can be used in diesel engines without modification and in fact extends the life of the engines. The advantages of biodiesel are that it produces lower emissions, is biodegradable, non-toxic and has a higher flash point. Rapeseed is the primary crop used for biodiesel in Europe, whereas soybean is used in the USA. Biodiesel is a well-developed biofuel. Pure biodiesel yields 12 per cent less energy per kilogram than conventional diesel but seven per cent higher combustion efficiency. It has a higher cloud point than conventional diesel and is therefore less tolerant to cold temperatures. Since biodiesel contains 10 per cent oxygen by mass, it burns cleaner than conventional diesel and it is safer to transport. However it can produce greater nitrogen oxide (NOx) emissions. Biodiesel can be stored in the same containers as normal diesel. The future of biodiesel depends upon the vegetable oil production capacity. Algae have potential as a source of biodiesel,[215] however, this research is still in its infancy.

c. Hydrogen

Hydrogen is an energy carrier rather than an energy source. Hydrogen is molecularly bound in many organic and inorganic compounds. To produce hydrogen, water, biomass and hydrocarbons are required. However, it takes energy to produce hydrogen and there are various methods of doing so. The cost of producing hydrogen is the biggest barrier to moving towards a hydrogen economy. Hydrogen needs to be pure and would require new standards for storage, delivery, infrastructure and end-use. About 0.45kg of hydrogen has the equivalent energy of approximately 3.1 gallons of oil. The internal combustion engines that use hydrogen are 20 per cent more efficient. It is the cleanest fuel on the planet with zero emissions, however this depends on how the hydrogen is produced. The distribution and storage of hydrogen is very expensive. Storage is expensive because hydrogen is very low in volumetric density and increasing the density requires energy. Because hydrogen burns rapidly, there are also safety issues to consider. For hydrogen to become a widespread source

[215] Ibid 224–34.

of fuel, it must be economical and practical to produce. Currently it is very expensive to produce and store.[216]

3.6 CONCLUSION

This chapter addressed the second research objective of the thesis which is whether there is a need to focus on reducing the use of oil in passenger motor vehicles. It also addressed the second research question: To what extent does the growth, usage, design and choice of motor vehicles have an impact on the consumption of oil?

The growth of the motor vehicle industry over the last 100 years has depended on the plentiful supply of oil. Australians rely on passenger motor vehicles for their transportation and have been choosing large and powerful passenger motor vehicles which consume more oil. This dependence on oil has the potential to become a problem as discussed in Chapter 2. Future cars may resolve the problem, but this is not likely to occur in the near future as discussed in this chapter.

Since passenger motor vehicles consume the most oil in Australia, and larger and more powerful motor vehicles are increasingly being demanded by Australians, this leads to the logical conclusion that the increased size and usage of these vehicles needs to be controlled by appropriate government policies. If oil is becoming scarce, the first place where oil consumption should be curtailed is where this would have the least impact on the lifestyle we are accustomed to. The oil should be preserved for other necessities, such as the production of food, plastics and pharmaceuticals, and to develop other sources of energy.

The next chapter explores existing regulatory and fiscal measures implemented by various countries that impact on passenger motor vehicles, so that lessons can be learnt that help in designing a tax framework to control the growth, choice and usage of passenger motor vehicles and reduce the use of oil.

[216] Ibid 234–50.

CHAPTER 4: ANALYSIS OF REGULATORY AND FISCAL MEASURES IMPLEMENTED IN VARIOUS COUNTRIES THAT IMPACT ON PASSENGER MOTOR VEHICLES

4.1 INTRODUCTION

This chapter examines the regulatory and fiscal measures that countries in the world have implemented and that impact on the design, choice and usage of passenger motor vehicles. This examination will assist in answering the second research question: What are realistic tax measures that can be implemented to reform design, choice and usage of motor vehicles for personal transportation in Australia?

The literature review in this chapter explores both regulatory and fiscal measures that have been adopted in other countries to attempt to curb passenger vehicle population growth, reduce travel demand in passenger motor vehicles and improve fuel efficiency in passenger motor vehicles. A wide variety of possible approaches to addressing the areas under consideration in this thesis have been introduced in different parts of the world. Table 4.1 summarises the major approaches used by various countries which will be discussed in detail in this chapter as indicated below, from which lessons can be drawn for Australia.

TABLE 4.1: Measures to Promote Use of Fuel-Efficient Private Vehicles

Approach	Approach Details	Measures	Country/Region	Discussion
Standards	Fuel economy and CO_2	Numeric standard averaged over fleets or based on vehicle weight-bins or sub-classes	US, Japan, China, Republic of Korea, Canada, EU, Australia.	Part 4.2
Consumer	Fuel economy/green	mpg, km/L,	USA, Sweden, EU, Republic of Korea,	Part 4.3

Approach	Approach Details	Measures	Country/Region	Discussion
awareness	house gas (GHG) emission labels and compulsory fuel information in model-specific vehicle advertising	L/100km, g CO_2/km	Japan, New Zealand, Australia and others	
Fiscal measures	Differential charges on purchase or use of motor vehicles	Tax or registration fee based on engine size, efficiency & CO_2 emissions	USA, Canada, EU, Norway, Singapore, Japan, Australia.	Part 4.4
	Fuel taxes and fuel excise	Tax rate on petrol	OECD countries	
	Income tax incentives	Tax credit and tax subsidies	USA, Canada, China, EU, Japan,	
Demand management programs	Incentives and disincentives	Road user charges based on vehicle kilometres travelled, congestion charge, high vehicle occupancy (HVO) lanes, road space rationing, no driving day, vehicle quota system, bridge and road toll policies, pay-as-you-drive insurance.	Canada, Germany, Benelux countries, California, USA, Norway, Singapore, UK, Bogota, Mexico, China, the Republic of Korea, Italy, Zurich and Australia.	Part 4.5
Compulsory inspection and retiring of motor vehicles	Safety, fuel efficiency, reduction of emissions and reduction of fleet age	Compulsory action, rebates and surcharge	USA, the Netherlands, Japan, Singapore and Egypt.	Part 4.6

In each of the parts 4.2 to 4.6, the literature is reviewed first followed by an analysis under the heading ‘Lessons for Australia’. The chapter will make concluding comments in part 4.7. The lessons learnt from this chapter will be applied in Chapter 6 where a critical examination of some policy options for Australia is undertaken.

4.2 FUEL ECONOMY AND GREENHOUSE GAS (GHG) EMISSIONS STANDARDS FOR PASSENGER MOTOR VEHICLES

Fuel economy and GHG emission standards are currently the main policy option being increasingly adopted by many countries in order to reduce the fuel consumption and emissions of their motor vehicle fleet. This thesis explores the impact of this policy in bringing about a reduction in fuel consumption. This part first explains in detail the policy behind the setting of the standards in various countries and then, under 'Lessons for Australia', explores the impact of these standards in bringing about a behaviour change favouring personal vehicles that consume less oil.

A fuel economy standard is normally set by a country's regulatory authority with the aim of improving the fuel economy of motor vehicles, raising awareness of the fuel economy of motor vehicles sold to consumers, and allowing consumers to make better-informed purchasing decisions based on the fuel efficiency of motor vehicles. The standards indirectly persuade consumers to choose fuel-efficient or emission-efficient vehicles by imposing regulations on the manufacturers and importers of motor vehicles. It is questioned in this thesis whether this indirect method of persuasion is sufficient.

Fuel economy and GHG or CO_2 emission standards have been implemented in some countries as a regulatory measure to improve motor vehicle fuel efficiency and emissions. The adoption of these standards varies in stringency, form and structure and how fuel economy and emissions are measured. Some countries have set mandatory standards whereas other countries such as Australia rely on voluntary commitment from the automotive industry. Table 4.2 shows the various countries and regions that have implemented fuel economy and GHG or CO_2 emission standards.

TABLE 4.2: Fuel Economy and GHG Emission Standards for Passenger Vehicles Around the World

Country/Region	Type	Measure	Structure	Test Method	Implementation
USA	Fuel	mpg	Footprint-based value curve	US CAFE*	Mandatory
California	GHG	g/mile	Car/LDT1	US CAFE	Mandatory
European Union (EU)	CO_2	g/km	Weight-based limit value curve	EU NEDC**	Voluntary for now, mandatory by 2012
Japan	Fuel	km/L	Weight-bin based	Japan 10-15/JC08	Mandatory
China	Fuel	L/100km	Weight-bin based	EU NEDC	Mandatory
Korea	Fuel	km/L	Engine size	US CAFE	Mandatory
Canada	Fuel	L/100km	Cars and light trucks	US CAFE	Voluntary
Australia	Fuel	L/100km	Overall light duty fleet	EU NEDC	Voluntary

Source: Adapted from Table 2 of Feng An, Robert Early and Lucia Green-Weiskel 'Global Overview on Fuel Efficiency and Motor Vehicle Emission Standards: Policy Options and Perspectives for International Cooperation (updated)'.[217]
*US CAFE is the manufacturer's Corporate Average Fuel Economy derived from vehicle testing by US Environmental Protection Agency.
**EU NEDC stands for New European Driving Cycle developed by the EU.

The fuel economy standard in the US is based on sales-weighted average fuel consumption and footprint or area between four wheels, whereas the standards in Japan and China are based on a weight classification system. The standards in the Republic of Korea were based on engine size, but will be changed to a weight-based system, whereas the EU currently bases its standards on GHG. These standards are discussed below.

[217] Feng An, Robert Early and Lucia Green-Weiskel, 'Global Overview on Fuel Efficiency and Motor Vehicle Emission Standards: Policy Options and Perspectives for International Cooperation (updated)' (Background Paper No 3 UN Doc CSD19/2011/BP3 presented at 19th session of the Commission on Sustainable Development, New York, 2–13 May 2011).

4.2.1 Fuel Economy Standards in the USA

The United States of America has had mandatory Corporate Average Fuel Economy (CAFE) standards in place since 1975 for passenger cars and light trucks sold by manufacturers. It was the dependence on foreign oil in the wake of the oil embargo that led the US Congress to pass the *Energy Policy and Conservation Act 1975* that requires each manufacturer in the US to separately meet the CAFE standards for each of its fleets, ie the domestic fleet and the imported fleet.[218]

The CAFE standards are based on the sales-weighted corporate average fuel economy for passenger motor vehicles and the vehicle footprint. For passenger cars and light-duty trucks built in model years 2012 to 2016, the standards are expressed as a mathematical function depending on vehicle footprint and set in a curve so that the burden of compliance is distributed across all vehicles and all manufacturers. The footprint is determined by multiplying the vehicle's wheelbase by its average track width. Whether the manufacturer has met the standard is determined by computing the sales-weighted average, being the harmonic average of the targets applicable to each of the manufacturer's cars and light trucks. Thus each manufacturer's compliance will depend upon the mix of vehicles sold.

A formula is used to calculate the manufacturers' CAFE as a sales-weighted CAFE based on production volume of passenger cars manufactured for sale in a model year. The fuel economy is expressed in terms of 'miles per gallon' (mpg). The CAFE applicable to each manufacturer must exceed the CAFE target set for the model year.

To understand the impact of CAFE standards in the US, it is important to analyse the policy criteria behind the setting of the target standards for each model year. The CAFE standards in the US are set by the Secretary of the Department of Transport through the National Highway Traffic Safety Administration (NHTSA) and the Environmental Protection Agency (EPA). In setting the CAFE standards, Congress

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[218] National Highway Traffic Safety Administration, *CAFE Overview – Frequently Asked Questions* (3 March 2005) US Department of Transport <http://lobby.la.psu.edu/_107th/126_CAFE_Standards_2/Agency_Activities/NHTSA/NHTSA_Cafe_Overview_FAQ.htm>.

directed that the following four factors must be considered by the NHTSA in determining the ‘maximum feasible’ fuel economy level:

1. Technological feasibility: This requires the NHTSA to consider whether particular methods of improving fuel economy will be available for commercial application in the model year for which a standard is being established.
2. Economic practicability: This requires the NHTSA’s consideration of whether the implementation of projected fuel economy improvements is within the economic capability of the industry.
3. The effect of other federal motor vehicle standards on fuel economy: This requires an analysis of the unavoidable adverse effects on fuel economy of compliance with emission, safety, noise, or damageability standards.
4. The need of the nation to conserve energy: This requires consideration of the consumer cost, national balance of payments, environmental and foreign policy implications of the nation’s need for large quantities of oil, especially imported oil.[219]

It is questioned in this thesis and explored further in Chapter 6 whether the fourth factor stated above is being achieved in terms of bringing about an overall reduction in the use of oil by passenger motor vehicles.

In the US, the EPA is also now required to address an additional factor in setting the standards, which are emissions. The requirement for this factor arises from s 202 (a)(1) of the *Clean Air Act* and confirmed in the US Supreme Court in the case of *Massachusetts v Environmental Protection Agency*.[220] This case was brought by 12 states and several cities of the United States against the EPA to force the EPA to regulate carbon dioxide and other greenhouse gases as pollutants.

The US President also issued a memorandum on 26 January 2009 stating that the CAFE standard for model year 2011 and beyond needed to take into consideration the requirements of the *Energy Independence and Security Act 2007* as well as the decision in *Massachusetts v Environmental Protection Agency*. In setting the

[219] *Center for Auto Safety v NHTSA*, 793 F 2d 1322 (Ct App, Dist of Columbia Circuit, 1986) 147, footnote 12.
[220] *Massachusetts v Environmental Protection Agency*, 549 US 497 (2007).

standards for model year 2012 and beyond, the NHTSA will also address the issues of energy independence, energy security and climate change, in addition to the financial health of the industry, technologies for reducing fuel consumption and fuel prices.

Another factor that the CAFE standards need to consider is the vehicle footprint. The *Energy Independence and Security Act 2007* mandated that the standard assign higher fuel economy targets to smaller vehicles and lower ones to larger vehicles.[221] The footprint is calculated by multiplying the track width by the wheelbase. The track width is the distance between the centrelines of the right and left wheels, whereas the wheelbase is the distance between the centres of the front and rear axles.[222] The question to consider is why the US has changed to a footprint-based standard. According to the NHTSA, there are four advantages to a system that relies on footprint-based targets.

1. The footprint-based system accounts for size differences in manufacturers' product mixes.
2. The footprint-based system reduces incentives for manufacturers to pursue unsafe practices by downsizing and down-weighting and thereby increasing the propensity for the vehicle to roll over.
3. The footprint-based system is more equitable as the manufacturer has to comply with the potential fuel economy of the actual fleet, thereby spreading the cost burden of the fuel economy more broadly across the industry.
4. The footprint-based system is more market-oriented and satisfies consumer choice rather than force manufacturers to make vehicles not demanded by the public, but solely for the purposes of CAFE compliance.[223]

The next question to address is whether the CAFE standards do have an effect on improving the fuel economy of passenger motor vehicles. In the US, the passenger

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[221] *Average Fuel Economy Standards Passenger Cars and Light Trucks Model Year 2011*, 49 CFR §§ 523, 531, 533, 534, 536 and 537 (2011) 18.

[222] Ryoichi Komiyama, 'Overview of CAFE Standards and the Estimation of Petroleum Saving Potentials by Japanese Automobiles in the United States' (Report, IEEJ, May 2008) 15.

[223] US Department of Transportation, 'Final Environmental Assessment: National Highway Traffic Safety Administration Corporate Average Fuel Economy (CAFE) Standards' (Assessment Report, Department of Transportation, 29 March 2006) 10.

vehicle standard was initially set at 18mpg for model year 1978 and was increased to 27.5mpg from 1985 to 2010. The US government has successfully increased the fuel efficiency of the nation's fleet as the average CAFE achieved increased from 19.9mpg in 1978 to 33.7mpg in 2010 as demonstrated in Table 4.3.

TABLE 4.3: CAFE Standard and Fuel Economy of Passenger Motor Vehicles in the USA

Year	Standard (mpg)	Average CAFE (mpg)
1978	18.0	19.9
1979	19.0	20.3
1980	20.0	24.3
1981	22.0	25.9
1982	24.0	26.6
1983	26.0	26.4
1984	27.0	26.9
1985	27.5	27.6
1986	26.0	28.2
1987	26.0	28.5
1988	26.0	28.8
1989	26.5	28.4
1990	27.5	28.0
1991	27.5	28.4
1992	27.5	27.9
1993	27.5	28.4
1994	27.5	28.3
1995	27.5	28.6
1996	27.5	28.5
1997	27.5	28.7
1998	27.5	28.8
1999	27.5	28.3
2000	27.5	28.5
2001	27.5	28.8
2002	27.5	29.0
2003	27.5	29.5

Year	Standard (mpg)	Average CAFE (mpg)
2004	27.5	29.5
2005	27.5	30.3
2006	27.5	30.1
2007	27.5	31.2
2008	27.5	31.5
2009	27.5	32.9
2010	27.5	33.7

Source: US Department of Transportation, 'Summary of Fuel Economy Performance' 28 October 2010.[224]

The data in Table 4.3 demonstrates that CAFE standards do have a role to play in improving the fuel economy of the vehicles within the passenger motor vehicle fleet. However, in order to bring about a continuous improvement, the standards must be constantly revised. In the USA, the standards were not revised during the period spanning model years 1990 to 2010. This was remedied by the *Energy Independence and Security Act 2007* which now requires the standards for passenger cars to be set at the maximum feasible level and this means that the NHTSA must set the standard for each model year, leading to a combined industry-wide fleet of all new passenger cars and light trucks sold in the US during model year 2020 to conform to a standard of at least 35mpg.[225] US President Barack Obama announced that CAFE standards should be developed for the period up till 2025.

In response to this announcement, the NHTSA set standards for model years 2011 to 2016 as shown in Table 4.4 below.[226] The NHTSA estimates that the proposed standards for the five years from 2011 to 2016 would save approximately 54.7 billion gallons (207.06 billion litres) of fuel, being 18.7 billion gallons (70.78 billion litres) for passenger cars and 36 billion gallons (136.27 billion litres) for light trucks, with a monetary benefit of USD88 billion over the lifetime of the vehicles sold during those

[224] US Department of Transportation, 'Summary of Fuel Economy Performance (Public Version)' (Report, US Department of Transportation, 28 October 2010) 2–3.
[225] *Average Fuel Economy Standards*, above n 221, 18.
[226] Barack Obama, 'Presidential Memorandum Regarding Fuel Efficiency Standards: Improving Energy Security, American Competitiveness and Job Creation, and Environmental Protection through a Transformation of our Nation's Fleet of Cars and Trucks' (Presidential Memorandum, 21 May 2010) 3.

model years.[227] The EPA is finalising a set of fleet-wide CO_2 emission standards and they are projected to decrease from 263 grams per mile in 2012 to 225 grams per mile in 2016 for cars and from 346 grams per mile to 298 grams per mile for trucks.[228]

TABLE 4.4: NHTSA Fuel Economy Standards for Model Years 2011 to 2016

Model Year	Passenger Cars average mpg	Light Trucks average mpg	Combined cars & light trucks average mpg
2011	30.4	24.4	27.6
2012	33.3	25.4	29.7
2013	34.2	26.0	30.5
2014	34.9	26.6	31.3
2015	36.2	27.5	32.6
2016	37.8	28.8	34.1

Source: *Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards; Final Rule*, Table I.B.2-1.[229]

Another presidential memorandum was issued on 21 May 2010 by President Obama requesting that the EPA and the NHTSA develop standards for model years 2017–2025. In line with the presidential memorandum, the EPA proposes to achieve an industry fleet-wide average of 163 grams per mile of CO_2 emissions in model year 2025 which is equivalent to 54.5mpg if all of the CO_2 emissions reductions were achieved with fuel. The NHTSA proposes to achieve an industry fleet-wide average of 40.9mpg in model year 2021 and 49.6mpg in model year 2025.[230] Manufacturers will have to comply with both the NHTSA and the EPA standards and the standards are part of a national program allowing motor car manufacturers to build a single light duty national fleet that satisfies both federal and state criteria. Thus motor car

[227] *Average Fuel Economy Standards*, above n 221, 24–5.
[228] *Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards; Final Rule*, 75 Fed Reg 88 25324, 25331 (7 May 2010)
[229] Ibid 25330.
[230] *2017–2025 Model Year Light-Duty Vehicle GHG Emissions and CAFE Standards: Supplemental Notice of Intent*, 40 CFR §§ 85, 86 and 600, 49 CFR §§ 531 and 533 (2011) 7–8.

manufacturers will not have to build different cars to comply with different state laws.

It should be noted that the overarching goal of setting annual standards is to preserve energy, particularly the energy from oil. According to the NHTSA, the need to reduce oil consumption is more crucial today than in the late 1970s.[231] Compliance with the fuel economy standard can be judged from the penalties it imposes for non-compliance. US manufacturers are liable to a penalty for non-compliance with the set standard, which is then published on the NHTSA website. The penalty is calculated using the following formula:

USD5.50 / ((CAFE target –specific CAFE for a given manufacturer) / 10) x sales volume in a given model year.[232]

If a US manufacturer exceeds the established standard, the manufacturer earns credits which can be banked and can be carried back for three years or carried forward for three years.[233] This has been increased to five years carry forward under the *Energy Independence and Security Act 2007*.[234]

Currently, US CAFE credits cannot be transferred between manufacturers or between fleets. However, credits earned after model year 2012 will be tradeable.[235] Tradeable credits enable motor car manufacturers who find it difficult to comply with the standard to purchase credits from another manufacturer which has exceeded the fuel economy standard and obtained credits. It has been argued that tradeable credits are a better incentive to a complying manufacturer to further improve the fuel economy of its vehicles as the credits can be sold to other manufacturers.[236]

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231 *Average Fuel Economy Standards,* above n 221, 604.
232 Komiyama, above n 222, 18.
233 Ibid.
234 *Average Fuel Economy Standards,* above n 221, 19.
235 Ibid 25.
236 Carolyn Fischer, 'Comparing Flexibility Mechanisms for Fuel Economy Standards' (2008) 36(8) *Energy Policy* 3116, 3117–18.

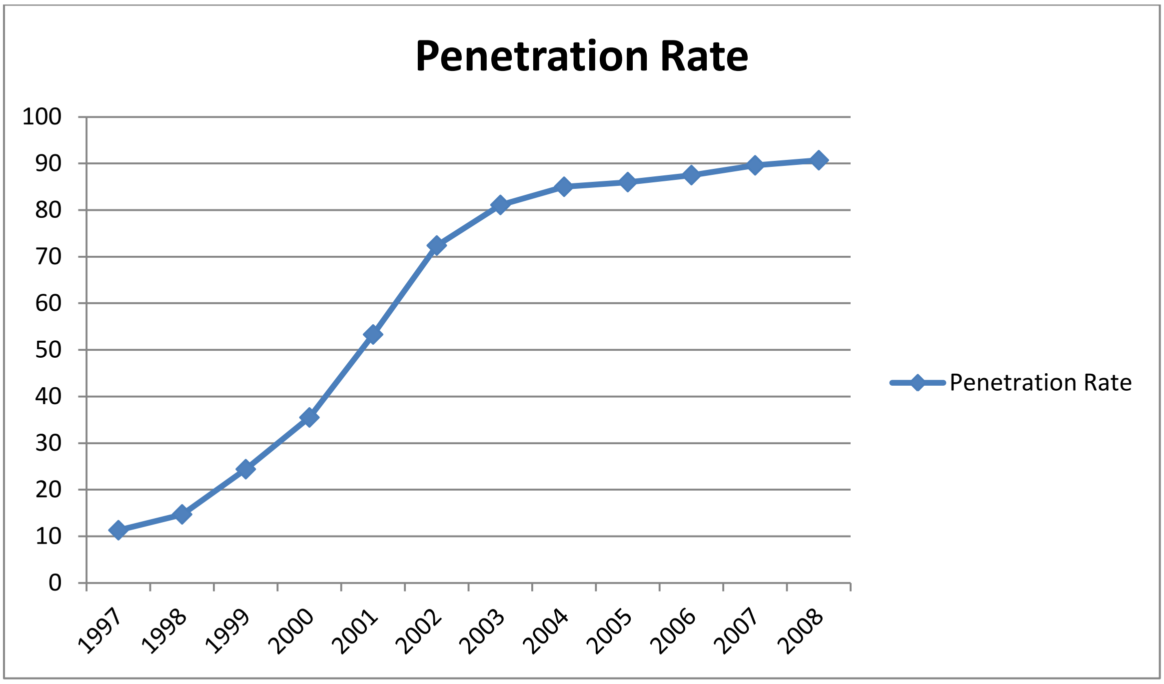
4.2.2 Japanese Top Runner Program

Similarly to the USA, Japan introduced motor vehicle standards to preserve energy through its Top Runner Program, introduced in 1998. The set-up of the Japanese fuel economy standard is different from that in the US, however. The Top Runner Program operates by setting energy efficiency targets for selected products including the improvement of energy efficiency in passenger motor vehicles. The program started with nine products in 1998, one of which was passenger motor vehicles. By 2009, the program had expanded to include 21 products.[237] Since motor vehicles mainly run on oil, the Japanese motor vehicle standards have been set to preserve oil-based energy.

The Top Runner Program requires producers to comply with the weighted average energy efficiency of the products they sell in the target year by achieving the requisite standard. The target year set in 1998 for passenger motor vehicles was 2010 and the target required was an average 15.1km per litre. This was achieved in 2005, five years ahead of the target year. The success story for passenger motor vehicles can be seen from the increase in the percentage of passenger motor vehicles that complied with the 2010 Top Runner Standards from 1997 to 2008, as shown in Figure 4.1 below, although not all fuel efficiency can be attributed to the Top Runner Standards.

[237] Osamu Kimura, 'Japanese Top Runner Approach for Energy Efficiency Standards' (SERC Discussion Paper No SERC09035, Socio-Economic Research Centre, 2010) 1.

FIGURE 4.1: Percentage of Motor Vehicles that Complied with 2010 Top Runner Standards



Source: Japan Automobile Manufacturers Association, *2009 Report on Environmental Protection Efforts: Promoting Sustainability in Road Transport in Japan* (October 2009, Tokyo).

The Japanese government recognised that in order to improve fuel efficiency, the weight of the vehicle needs to be controlled. Therefore in 2010, the improved 2015 standards based on vehicle weight were set as demonstrated in Table 4.5 below.[238]

TABLE 4.5: 2015 Fuel Economy Standards for the Top Runner Program in Japan

Category	Vehicle Weight (kg)	Target Standard Value (km/L)
1	Less than 600	22.5
2	601–740	21.8
3	741–855	21.0
4	856–970	20.8

[238] Adrian J Bradbrook, 'Policies and Legal Options to Promote the Energy Efficiency of Private Motor Vehicles' (Background Paper No 4 UN Doc CSD19/2011/BP4 presented at the 19th session of the Commission on Sustainable Development, New York, 2–13 May 2011) 4.

Category	Vehicle Weight (kg)	Target Standard Value (km/L)
5	971–1080	20.5
6	1081–1195	18.7
7	1196–1310	17.2
8	1311–1420	15.8
9	1421–1530	14.4
10	1531–1650	13.2
11	1651–1760	12.2
12	1761–1870	11.1
13	1871–1990	10.2
14	1991–2100	9.4
15	2101–2270	8.7
16	More than 2270	7.4

Source: Adrian Bradbrook, 'Policies and Legal Options to Promote the Energy Efficiency of Private Motor Vehicles' 4.

The compliance mechanism used in Japan is different from that used in the USA. If the standards are not met in Japan, a 'name and shame' approach is used, firstly with a recommendation to the non-compliant producer and if this does not fix the problem, the recommendation is followed by final orders and the details about the non-compliant producer are advertised. The name and shame approach is very effective in Japan due to the Japanese culture, where governmental criticism works like a penalty.[239]

The Japanese Top Runner program has been hailed as a success for a number of reasons, which are:

- Primary stakeholders are involved in setting targets. This brings about awareness and commitment and ensures that targets are feasible and not ambitious;
- The program is designed to be flexible, dynamic and adaptive, and allows for shortcomings and failures to be addressed and remedied;
- A number of supportive policy instruments have developed around the Top Runner program, such as e-labels;

[239] Kimura, above n 237, 4.

- The Top Runner program allows manufacturers who perform well at the start of the cycle to become free-riders; and
- The name and shame sanctions are effective deterrents in Japan.[240]

The most common criticism of the Top Runner program is that it only encourages incremental technical improvements, and innovations do not receive incentives under the scheme.[241]

4.2.3 Chinese Fuel Economy Standards

China has joined the USA and Japan in setting mandatory fuel consumption standards for its passenger motor vehicles. China's motivation for vehicle fuel economy standards is also oil, as China has oil security concerns associated with rapid vehicle population growth and the promotion of China's economic growth with a strong motor vehicle industry. Until the 1990s only nine car models were made and sold in China and the Chinese government's aim is to also use the national fuel economy standard to push domestic motor vehicle manufacturers to improve their products and overall competitiveness.[242]

In September 2004, China adopted its Phase 1 mandatory national fuel consumption standard for Chinese passenger vehicles. Phase 1 limits took effect on 1 July 2005. The standard limits were revised in Phase 2 which came into effect on 1 January 2008.

The standards in Phases 1 and 2 specified the fuel consumption limits for 16 different passenger vehicle classes according to vehicle kerb mass. This shows that the Chinese government also recognises the need to control the weight of the country's motor vehicle fleet in order to bring about fuel efficiency. The vehicles in heavier classes were required to meet stricter limits than vehicles in lighter classes, in order

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[240] Joakim Nordqvist, 'Evaluation of Japan's Top Runner Programme Within the Framework of the AID-EE Project' (Report, AID-EE, 2 July 2006) 28. The Active Implementation of the European Directive on Energy Efficiency (AID-EE) project commenced in February 2005 to successfully implement the Energy End-Use Efficiency and Energy Services Directive of the European Parliament and the Council. See <http://www.aid-ee.org/aid_ee.htm>.
[241] Ibid 29.
[242] Hongyan H Oliver et al, 'China's Fuel Economy Standards for Passenger Vehicles: Rationale, Policy Process, and Impacts' (2009) 37(11) *Energy Policy* 4720.

to encourage the Chinese to purchase lighter vehicles. Vehicles with automatic transmission or three or more rows of seats and SUVs with four-wheel drive (special vehicles) were allocated a slightly higher limit.[243]

The standards in Phases 1 and 2 were based on a strict compliance method. Vehicles that did not meet the consumption limit standards were prohibited from production. Chinese motor manufacturers prepared themselves to comply with these standards by eliminating high fuel consumption technologies such as three gear transmissions and two valve engines and by introducing new efficient technologies such as variable valves, overhead camshaft and multi-gear ratio transmissions.

The standards set in Phases 1 and 2 were successful in eliminating over 800 domestically produced vehicle models that did not comply with the standards. However, since the standards in Phases 1 and 2 did not apply to imported vehicles, there was an increase in vehicles being imported into China, especially large luxury sedans and SUVs. In 2008, China imported 409 769 vehicles, an increase of 30.4 per cent over the 2007 figures. Another problem with the standards in Phases 1 and 2 was that they were based on the mass of vehicles produced without any restriction on the mass of the motor vehicles that the consumers could purchase, so the standards did not deter the Chinese from purchasing large, sporty and luxury vehicles. The average kerb mass in 2002 was 1230kg and it increased to 1356kg in 2006, giving rise to 6.8 per cent extra fuel consumption. The incidence of motor vehicles with a capacity of less than one litre decreased from 16.8 per cent in 2005 to 2.7 per cent in 2008.

The Chinese government realised that the level of fuel consumption by Chinese vehicles was higher than those in the EU, the US and Japan by about 10 per cent and that these countries intended to use high fuel efficiency as a measure to maintain competitiveness in the automotive industry. In addition, China's increasing reliance on imported oil, importing 52 per cent of its total oil consumption in 2008, and the growth of the Chinese vehicle population, has led to the Chinese government approving the Phase 3 fuel consumption standard for passenger vehicles. The Chinese government incorporated some of the US CAFE principles together with the

[243] Zhao Wang et al, 'New Fuel Consumption Standards for Chinese Passenger Vehicles and Their Effects on Reductions of Oil Use and CO_2 Emissions of the Chinese Passenger Vehicle Fleet' (2010) 38(9) *Energy Policy* 5242.

weight classification used in Phases 1 and 2 in developing the Phase 3 Chinese fuel economy standard.

The Phase 3 Standard was introduced in 2009 and will take effect in 2012. The aim of the standard is to reduce the average fuel consumption rate of new passenger vehicle fleet to seven litres per 100km which is 14.28km per litre by 2015. The function of the Phase 3 standard is to stimulate innovation and promote automotive energy saving in order to hasten the introduction of new models of motor vehicles. The limits in Phase 3 correlate the kerb mass of the 16 mass-based classes of Phases 1 and 2 to engine displacement size, engine power output and vehicle footprint. Unlike the total restriction in Phases 1 and 2, Phase 3 has moved away from the prescriptive individual model compliance method to corporate average fuel consumption rates with financial penalties for non-compliance.[244]

The Phase 3 fuel targets in China were developed using a mathematical model by first creating a database of fuel consumption data covering 774 vehicle models manufactured in China, and 668 models that complied with Phase 2 limits. From this data, a linear curve was graphed correlating the kerb mass and the fuel consumption. A 17 per cent adjustment was then made around the target point of seven litres per 100km for a mass of 1300kg and 16 individual vehicle class targets were set by increment as shown in Table 4.6.[245]

TABLE 4.6: Comparative Phases 2 and 3 Fuel Economy Standards in China

Kerb Mass in kg	**Phase 3 Limits in L/100km**	**Comparative Phase 2 limits in L/100km**
Less than 750	5.2	7.2
750–864	5.5	7.2
865–979	5.8	7.7
980	6.1	8.3
1090	6.5	8.9
1205	6.9	9.5

[244] Ibid 5245.
[245] Ibid 5243–6.

Kerb Mass in kg	Phase 3 Limits in L/100km	Comparative Phase 2 limits in L/100km
1320	7.3	10.1
1430	7.7	10.7
1540	8.1	11.3
1660	8.5	11.9
1770	8.9	12.4
1880	9.3	12.8
2000	9.7	13.2
2110	10.1	13.7
2280	10.8	14.6
More than 2510	11.5	15.5

Source: Wang et al, 5243–6.

It can be noted from Table 4.6 above that the limits set in Phase 3 are stricter on heavy vehicles, thereby encouraging the production of light vehicles and discouraging the production of heavy vehicles. In order to discourage sales of SUVs the Phase 3 targets for SUVs come within the normal limits and not under the special vehicle limits.

Under Phase 3 the individual vehicle model is not required to meet the fuel consumption limit specified in the mass class, but the individual auto manufacturer or importer has to meet the Company Average Fuel Consumption (CAFC) target that has been calculated for that company. The manufacturer's average fuel consumption rate is based on the aggregate of the production volume multiplied by the fuel consumption certification levels for each individual model, divided by the aggregate production volume of passenger vehicles by the manufacturer in that year. In any case, the individual models must still not exceed the Phase 2 limits.

The penalties for non-compliance with the Phase 3 Chinese fuel efficiency standards are being discussed with several government agencies including the Ministry of Finance, and may range from fines or taxes on manufacturers who do not comply to a special tax on the vehicle model, or taxes on consumers who purchase vehicles whose fuel consumption does not meet the target. In addition the government may use the name and shame approach by announcing the names of manufacturers that do not comply.

The intent of the Phase 3 requirements is to encourage manufacturers to produce a variety of vehicles. Thus manufacturers who usually produce heavy model vehicles will have to start producing light model vehicles in order to comply with the Phase 3 standards. The overall objective of Phase 3 is also to control Chinese motor vehicle fuel consumption and CO_2 emissions. Based on certain assumptions such as vehicles driving 10 000km a year, the cumulative reduction in fuel use is likely to be 333Mb from 2012–2020.[246] China's Phase 3 fuel economy standards are likely to be implemented in 2012 with full compliance required by 2015, and it is anticipated that discussions for China's Phase 4 fuel economy standards will commence thereafter. Phase 4 standards are likely to become effective in 2016 with full compliance required by 2020.[247] It can be concluded that the Chinese government has refined its motor vehicle fuel economy standards and has incorporated the principles from the US CAFE standard and the Japanese Top Runner motor vehicle fuel economy standard.

4.2.4 Fuel Economy Standards in Korea

The Republic of Korea, being the fifth largest car manufacturer, introduced fuel economy standards in January 2006 as the government realised that other countries around the world were imposing stringent fuel economy standards. However, the standards were based on engine capacity, as a vehicle with a higher engine capacity is likely to be more powerful and heavier and therefore consume more fuel. The Korean program requires car manufacturers to meet an average fuel economy standard by 2011 of 12.4km per litre for vehicles with engines of less than 1500cc and 9.6km per litre for vehicles with engines over 1500cc.[248] The average fuel efficiency criteria from 2012 are 14.5km per litre for vehicles with engines of 1600cc or less and 11.2km per litre with engines over 1600cc. The manufacturer's average

[246] Ibid 5249.
[247] General Motors, 'Mobile Emissions & Fuel Economy' (December 2011) *General Motors Sustainability Report* <http://www.gmsustainability.com>.
[248] International Energy Agency, *Energy Policies of IEA Countries: The Republic of Korea 2006 Review* (OECD/IEA, 2006) 65.

fuel efficiency is required to correspond to the limit set by the government, and is calculated by dividing the sum of fuel efficiencies of passenger cars sold during the previous year by each car manufacturer with the quantity sold. The name and shame approach is also used in Korea whereby the manufacturers and importers who do not comply are issued an order of improvement, but no penalties are assigned with the orders.[249]

The Korean government has indicated new fuel economy standards from model year 2012 requiring local car manufacturers to manufacture vehicles that on average can travel 17km or more per litre of fuel and emit less than 140g of greenhouse gases per kilometre travelled. The new standards will be weight-based and use the US CAFE combined cycle for testing.[250] It is anticipated that the new standard will be flexible with a phase-in approach and carry-forward credits. It is proposed that credits be granted for including tyre pressure monitoring systems and low rolling resistance tyres. Gears and shift indicators and eco-innovations will also receive credits.[251]

4.2.5 Voluntary Standards in Canada

Since 1978, Canada has had only voluntary motor vehicle fuel economy consumption standards, whereby vehicle manufacturers are committed to meeting a progressively stringent annual CAFC limit for new motor vehicles sold in Canada. The standards are similar to the US CAFE standards, and approximately 98 per cent of total vehicles sold in Canada meet these standards.[252] Although the standards are strictly 'voluntary' in Canada, the national government enacted legislation similar to that in the US, which it stated that it would immediately invoke if the manufacturers did not 'voluntarily' comply. In April 2010, Canada issued regulations to implement

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[249] Ibid 66.

[250] Tony Lewis, *South Korea: More Realistic Fuel Economy Standards from 2012* (29 November 2011) Just-Auto <http://www.just-auto.com/news/more-realistic-fuel-economy-standards-from-2012_id117514.aspx>.

[251] International Council on Clean Transportation, *Global Light-Duty Vehicles: Fuel Economy and Greenhouse Gas Emission Standards* (April 2011) <http://www.theicct.org/info/documents/PVstds_update_apr2011.pdf> 2.

[252] Michael Hart, 'Potholes and Paperwork: Improving Cross-Border Integration and Regulation of the Automotive Industry' (C D Howe Institute Commentary No 286, April 2009) 7.

limits on emissions from passenger cars and light trucks from model year 2011 to 2016 based on the US footprint structure.[253]

4.2.6 CO_2 Standards in the EU

The EU has promoted voluntary CO_2 standards until 2009. However, as it became apparent that automakers were not going to comply with the voluntary standards, the EU has made the compliance mandatory as of 2012. The EU standards are based on a weight-based limit value curve.[254] The target set by the EU was 140g of CO_2 per km for 2008–09 which is equivalent to 17.2–19.0km per litre. The EU target that is now under consideration for 2012 is 120g CO_2 per km which is equivalent to fuel economy of 20.1–22.2km per litre.[255]

The EU CO_2 regulation would require each motor vehicle manufacturer to obtain an individual annual target based on the average mass of all its new cars registered in the EU in a particular year, and 65 per cent of those cars would need to have emissions below the target in year 2012, 75 per cent in 2013, 80 per cent in 2014 and 100 per cent in 2015. A limit curve based on vehicle mass would be set so that the fleet average of 130g of CO_2 per km is achieved for the EU as a whole. Manufacturers could form a pool to meet the requirements, if they so wished.

The EU's objective is to reduce CO_2 emissions from light duty vehicles. The aim is for the emissions to be under 130g of CO_2 per km by 2015 and 95g/km by 2020. The 130g standard will be phased in between 2012 and 2015.[256]

In conclusion it can be said that fuel economy standards are set in order to improve the fuel efficiency of the motor vehicle fleet in a country by encouraging technological advances and controlling the size, weight or fuel efficiency of motor vehicles that are manufactured or sold in a country with the aim of reducing vehicle oil consumption and CO_2 emissions. Tighter regulations are now being accepted by

[253] 'Canada, US Unite on Car Emission Standards', *CBC News* (online), 1 April 2010 <http://www.cbc.ca/news/politics/story/2010/04/01/vehicle-emissions-ottawa-washington.html>.
[254] Feng, Early and Green-Weiskel, above n 217, 4.
[255] International Energy Agency, above n 248, 66.
[256] European Commission, *Reducing CO_2 Emissions from Passenger Cars* (1 August 2011) <http://ec.europa.eu/clima/policies/transport/vehicles/cars/faq_en.htm>.

automakers as an advantage to increasing their market share, and the governments also see them as sources of economic growth and employment. For example, after China's fuel economy standard was adopted in 2005, China's first plug-in hybrid model appeared. Soon after the Obama administration announced the new national fuel economy standards target of 35.5mpg by 2016, the Tesla-Toyota joint venture was launched. Car manufacturers and importers need clear signals from the government and therefore standards should be predictable more than a decade into the future.[257] The next part analyses the lessons that Australia can learn and explores whether there is place for a mandatory fuel economy standard in Australia.

4.2.7 Lessons for Australia

Australia does not currently have a mandatory fuel consumption target, but has a voluntary target which has been established by the Federal Chamber of Automotive Industries. In March 2003, the voluntary target was aimed at improving consumption for new petrol passenger vehicles to an average of 6.8 litres per 100km by 2020. In 2005, an average CO_2 emissions target for vehicles under 3.5 tonnes of gross mass was set at 222g/km by 2010.[258] The current Labor government in Australia has indicated that it will set a mandatory standard for a national fleet-wide target for average CO_2 emissions of 190g/km by 2015 and 155g/km by 2024.[259] A CO_2-based standard will only correlate with fuel consumption, if the vehicle fleet is mainly homogeneous from a fuelling perspective.[260] However, if the fuelling market diversifies, or technology develops to capture the CO_2 emissions, then a regulation based on CO_2 would have no bearing on reducing the use of oil in motor vehicles.

A key issue discussion paper was released by the Australian government in August 2011 to obtain views from interested parties on the key issues that would need to be

[257] Drew Kodjak et al, 'The Regulatory Engine: How Smart Policy Drives Vehicle Innovations' (Research Paper No 02, International Council on Clean Transportation, January 2011) 9.
[258] Federal Chamber of Automotive Industries 'National Average Carbon Emission (NACE) Fact Sheet' <http://www.fcai.com.au/library/nace.pdf>.
[259] N Martin, 'Emission Standards for Cars – Julia Gillard and Labor – Let's Move Australia Forward' (Fact Sheet, Australian Labor Party, 24 July 2010) <http://www.alp.org.au/getattachment/97cd68c5-087f-4ff8-b1d5-ee2aadae31c9/emission-standards-for-cars/>.
[260] Hui He and Anup Bandivadekar, *A Review and Comparative Analysis of Fiscal Policies Associated with New Passenger Vehicle CO_2 Emissions* (International Council on Clean Transportation, 2011) 5.

addressed to develop the standards. The key issues identified in the discussion paper were:

- Whether the emission targets should involve only one setting or should be set in stages;
- The appropriate reference or base year against which the assessment of improvements is measured;
- The reasonable target for Australia taking into consideration the business as usual scenario;
- The costs and benefits that the mandatory standards would deliver;
- Whether there should be a single target for the whole light vehicle fleet or whether it should be split between light passenger vehicles and light commercial vehicles;
- How to calculate the target for each motor vehicle model and its variants and the methodology for setting the manufacturer's targets;
- The appropriate regulatory model for implementing the standards;
- Identifying the specific data requirements in order for the standards to work;
- Whether the current data set published as VFACTS are adequate and appropriate;
- Amendments that may be required to the *Motor Vehicles Standards Act* or other legislation or legal framework that would be required;
- The entities that would be responsible for reporting performance;
- Whether credit banking and trading should be permitted; and
- The appropriate sanctions for non-compliance.[261]

Submissions were obtained from interested parties from which the Department of Infrastructure and Transport will develop a Regulatory Impact Statement for public scrutiny and comment. The Department of Infrastructure and Transport will also present a set of recommendations to the Australian government on the mandatory standards for Australia.

If the Australian government is going to set a mandatory fuel economy standard for its motor vehicle fleet, then it is submitted that it should draw lessons from other countries in developing the standard. Australia is not a major motor vehicle

[261] Department of Infrastructure and Transport, above n 30, 9–25.

manufacturer on the world stage. However, that does not mean that it should not aspire to develop its motor vehicle industry. A mandatory fuel economy standard in Australia might assist in reducing the average fuel consumption of the Australian fleet if it is applied to both manufacturers and importers of motor vehicles.

From the literature review above, standards based on vehicle weight and footprint combined with corporate average sales are likely to be most effective in reducing the fuel consumption of the national fleet of vehicles. However, standards do not have a controlling impact on the growth of the national motor vehicle fleet. This is because the standards apply to the average fleet. Thus if increased sales of larger motor vehicles are offset by increased sales of smaller motor vehicles, the fleet average may be satisfied, but the overall fleet fuel consumption may not necessarily be reduced, as the overall fleet size has increased. Therefore, it is argued that setting a mandatory fuel economy standard should not be the sole strategy for reducing fuel consumption in the motor vehicle fleet in Australia, but should be combined with appropriate fiscal measures.

Other problems with the standards include: tension between the government and the motor vehicle industry;[262] vehicle safety potentially being compromised by standards;[263] manufacturers exercising 'policy gaming' in order to overcome the standards set by the government; and the efficiency gained from the standards giving rise to an increase in fuel use called the rebound effect.[264] These are further discussed in Chapter 6 under part 6.3.4 of this thesis.

A study conducted by Austin and Dinan on US passenger vehicles using an empirically rich simulation model and cost estimates for anticipated fuel economy technologies states that taxes on fuel are more efficient than increases in fuel economy standards.[265] The study estimated that a 3.8mpg increase in standards would reduce oil consumption by 10 per cent over 14 years, whereas an increase in gasoline tax would produce greater immediate savings by encouraging people to

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[262] See Fischer, above n 236, 3118.
[263] Energy Efficiency and Renewable Energy, Vehicle Technologies Program, *Fact #630: Fuel Economy vs Weight and Performance* (5 July 2010) US Department of Energy <http://www1.eere.energy.gov/vehiclesandfuels/facts/2010_fotw630.html>.
[264] Fischer, above n 236, 3116.
[265] David Austin and Terry Dinan, 'Clearing the Air: The Costs and Consequences of Higher CAFE Standards and Increased Gasoline Taxes' (2005) 50 *Journal of Environmental Economics and Management* 562.

drive less, and eventually to choose more fuel-efficient vehicles.[266] The study also estimated that a gasoline tax of 30 cents per gallon would save the same discounted quantity of oil as a 3.8mpg increase in standards.[267]

For these reasons and other reasons explored further in Chapter 6, this thesis argues that a fuel economy standard should not be solely relied upon as a policy mechanism to change consumer behaviour by encouraging the choice of an appropriate motor vehicle for personal transportation that minimises oil consumption and reduces CO_2 emissions. This is supported by comments made by the NHTSA in setting CAFE standards in the USA. The NHTSA stated that the price of vehicles should reflect the value that the consumer places on the fuel economy attribute of his or her vehicle. However, it is not clear according to the NHTSA that consumers have the information or inclination to value the impact of fuel economy in their purchasing decisions. Consumers have no direct incentive to value benefits not included in the purchase price or the price of fuel, such as energy security and global climate change.[268]

It is argued in this thesis that setting a mandatory fuel economy and GHG standard in Australia is a way forward in regulating the types of motor vehicles that are going to be sold to the Australian public. However, setting a fuel economy standard may not be sufficient to address the problem of reducing the consumption of oil in passenger motor vehicles in Australia. If a mandatory standard is going to be set in Australia, it should not only take into consideration the factors considered by the USA, Japan, China and Korea in setting their standards, especially the power and weight of a vehicle, but the standard should be accompanied by an appropriate tax such as the LET proposed in Chapter 6.

The next part examines the fuel consumption labelling requirements of various countries in the world and analyses the impact the labelling requirements can have in reducing oil consumption in passenger motor vehicles.

[266] Ibid 562.
[267] Ibid 576.
[268] *Average Fuel Economy Standards*, above n 221, 606.

4.3 CONSUMER AWARENESS PROGRAMS

Fuel consumption labels can be an effective way of making the consumer aware of the fuel efficiency of the motor vehicle he or she is about to purchase. Many countries including the USA, EU countries, Australia, Japan, the Republic of Korea and Singapore have laws requiring fuel efficiency labelling by way of a sticker attached to or printed on the motor vehicle as described below. The fuel consumption labels serve three purposes: to enable customers to make an informed choice regarding the vehicle they are about to purchase; to provide an incentive to manufacturers to design more energy-efficient vehicles; and to bring awareness about energy conservation in general.

On the other hand, a major criticism of the fuel labelling system is that the consumption figure achieved under test conditions may not reflect actual driving conditions.[269] However, the figure displayed on the label can be modified to give an allowance for various driving conditions, such as city driving and highway conditions.

To achieve the desired objectives, the labels need to be carefully designed to ensure that the information on them is clear, unambiguous and easily deciphered. The common labelling systems used in various countries as discussed below include star ratings, ticks and other signs, use of different colours to represent efficiencies, and information about estimated fuel costs, fuel consumption and emissions rating. The label design should be kept simple to be effective and colours, pictures or symbols used which communicate the technical information better than words or figures.

The concept of labelling was first introduced in the USA in 1975, and the labels were redesigned in 1986 to show the city-mpg and highway-mpg. In May 2011, the US EPA and the NHTSA established a final rule, requiring passenger vehicles, SUVs and light trucks for model year 2013 and later with improved fuel economy labels to show the following information: the vehicle's fuel economy; information enabling a comparison of the vehicle's fuel economy with other vehicles in the same category; fuel consumption rate in gallons per 100 miles for combined city and highway

[269] 'Car Emissions Ratings Flawed, Say Researchers', *ABC News* (online), 13 April 2011 <http://www.abc.net.au/news/2011-04-13/car-emissions-ratings-flawed-say-researchers/2619090>.

driving; fuel economy and greenhouse gas rating from one to 10, 10 being the best; CO_2 emission information in grams per mile for combined city and highway driving; and fuel costs over five years relative to the average new vehicle as well as an estimated annual fuel cost. The label also shows details of a website where additional information can be sought to compare different vehicles, together with a Smartphone interactive QR code enabling the consumer to obtain further information about the vehicle.[270] The new labels are required for conventional fuel vehicles as well as the 'next generation' vehicles such as plug-in hybrids and electric vehicles. An example of a label for a conventional fuel vehicle with the gas guzzler tax is shown in Figure 4.2.

FIGURE 4.2: The US Fuel Economy and Environment Label for a Gasoline Vehicle with Gas Guzzler Tax

Source: *Revisions and Additions to Motor Vehicle Fuel Economy Label; Final Rule*, 76 Fed Reg 3948 (6 July 2011).

[270] US Environmental Protection Agency, 'New Fuel Economy and Environment Labels for a New Generation of Vehicles' (Regulatory Announcement No EPA-420-F-11-017, Office of Transportation and Air Quality, May 2011).

The mandatory Swedish program requiring energy labelling for all new cars has been in force since 1 January 1978 and has been reviewed in 1988 and 1996. In 1996, the Swedish National Economy Information Programme prescribed two types of mandatory fuel economy information to be provided at point of sale: a minimum A4-sized fuel economy declaration placed on the windshield of the car, and comparative information on all models available at the sales outlet.[271] The size and simplicity of the design in Sweden ensures that customers comprehend the energy information. Swedish regulations also require all passenger car marketing materials including printed advertisements, brochures and posters to show fuel consumption information.[272]

The Council of the European Union adopted a legislative proposal on 21 December 1998 requiring its member states to introduce fuel economy labels for passenger cars by the year 2000.

The Republic of Korea has a mandatory fuel economy car labelling program, established in 1991/92 under the *Rational Energy Utilisation Act*. The Korean system differentiates fuel economy efficiency with grades, 1st grade being the best and 5th grade being the worst. The label is placed on the window of the rear door of the motor vehicle, and remains on the car throughout its lifespan.[273]

In Japan there are several energy performance labelling schemes to bring about consumer awareness, such as the Energy Star label and e-Mark program as shown in Figure 4.3.

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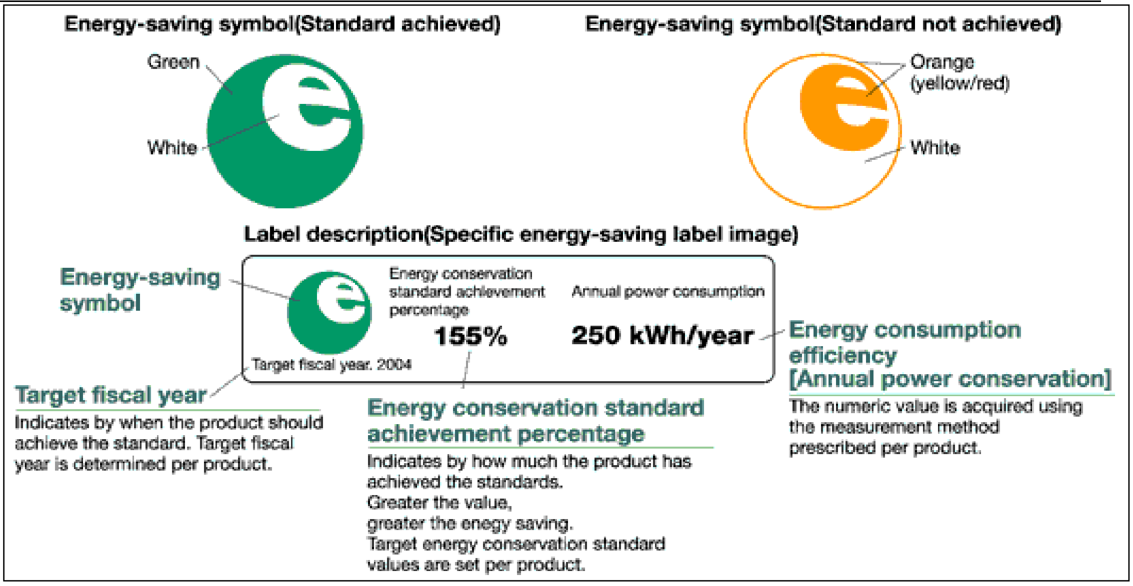
[271] Ralph Wahnschafft and Kwisun Huh, 'Effective Implementation of Fuel-Economy Labelling for Passenger Cars: Experiences from the USA, Sweden and Republic of Korea' (Research Paper, Energy Resources Section UN-ESCAP and Department of Environmental Science & Engineering, Hankuk University of Foreign Studies, December 2000) 540.
[272] Ibid.
[273] Ibid.

FIGURE 4.3: Japanese Motor Vehicle Label



Source: Energy Conservation Centre, Japan[274]

The *New Zealand Energy Efficiency (Vehicle Fuel Economy Labelling) Regulations 2007* (NZ) came into effect on 7 April 2008, requiring the label to show the vehicle make, vehicle model, fuel economy in terms of cost per year, star rating out of six and fuel consumption in litres per 100km, the basis for calculating fuel economy and the reference number confirming that the label refers to the vehicle it is displayed with, as demonstrated in Figure 4.4.[275]

FIGURE 4.4: New Zealand Motor Vehicle Label

Source: New Zealand Transport Agency Waka Kotahi

[274] Nordqvist, above n 240, 14.
[275] New Zealand Transport Agency Waka Kotahi, *Fuel Economy Labelling* (2009) <http://labelling.fuelsaver.govt.nz>.

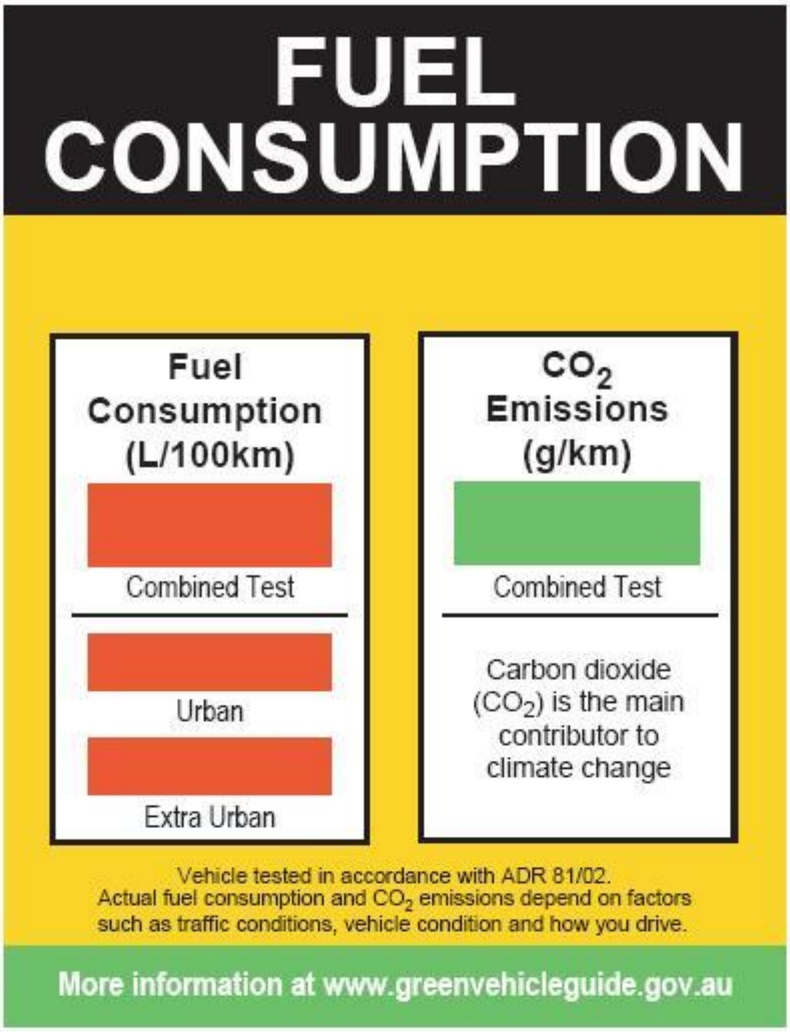
4.3.1 Lessons for Australia

Australia does have mandatory fuel consumption labelling, requiring that the fuel consumption and the emissions of a motor vehicle be displayed on the vehicle's windscreen. However, arguably more can be done in this area to promote the use of lighter and less powerful vehicles in order to reduce oil use in passenger motor vehicles.

Australia's mandatory fuel consumption labelling requirement was introduced in 2001 to address a market failure to provide consistent fuel consumption information for purchasers of new vehicles.[276] The Australian Design Rule (ADR) 81/00 requires fuel consumption labelling on the windscreen of the vehicle at the point of sale for light vehicles up to 3.5 tonnes in gross vehicle mass. The label indicates the vehicle's fuel consumption in litres of fuel per 100km and its CO_2 emissions in grams per km. The Australian government's Green Vehicle Guide states that the label is designed to help Australian motorists make informed choices about the environmental impact of their new car and the cost of running their vehicle. Since 2009, the label is required to display three fuel consumption numbers, urban, extra-urban and combined as well as the combined CO_2 value, as shown in Figure 4.5.[277]

[276] Australian Greenhouse Office, *Regulation Impact Statement – Proposed Changes to ADR 81/00 Fuel Consumption Labelling for Light Vehicles* (29 May 2002) 8.
[277] Green Vehicle Guide, *Fuel Consumption Label* (2010) Department of Infrastructure and Transport <http://www.greenvehicleguide.gov.au/GVGPublicUI/Information.aspx?type=FuelConsumptionLabel>.

FIGURE 4.5: Australian Motor Vehicle Label



Source: Green Vehicle Guide

It is submitted that in the Australian context, the label should complement the existing regulatory and fiscal measures, and if a LET is implemented as proposed in Chapter 6, then the LET attracted should also be displayed. The display should not only appear on the windscreen of the vehicle, but also on all related model-specific advertising material. Compulsory fuel information in model-specific vehicle advertising also brings about consumer awareness and assists consumers in making appropriate choices when making a decision to purchase a motor vehicle. Although the general law pertaining to misleading and deceptive conduct[278] would encompass

[278] See sch 2 of the *Competition and Consumer Act 2010* (Cth) for full text of the Australian Consumer Law. Chapter 2 of the Australian Consumer Law deals with a general ban on misleading and deceptive conduct in trade or commerce.

misleading fuel information in model-specific vehicle advertising, it may be better for the law to prescribe the type of information that should be released when advertising a specific model of a motor vehicle. Not many countries have enacted such specific laws. The Republic of Korea enacted the *Rational Energy Utilisation Act* requiring the manufacturer or importer of motor vehicles to include energy consumption efficiency when the motor car is advertised.

The next part explores the fiscal measures in place in various countries around the world.

4.4 A SURVEY OF FISCAL MEASURES IMPLEMENTED IN VARIOUS COUNTRIES

Many countries have implemented a variety of fiscal measures not only to raise revenue, but to influence the purchase of a fuel-efficient vehicle and to reduce the vehicle kilometres travelled (VKT) or CO_2 emissions. Unlike the fuel economy standards, fiscal measures generally do not have any direct bearing on the manufacturer or importer of the motor vehicles, except through satisfying consumer demand on the part of the customers who may be affected by fiscal measures. The fiscal measures adopted by various countries and discussed below include: Differential charges on the purchase and use of motor vehicles, fuel taxes and fuel excise and income tax incentives.

4.4.1 Differential charges on purchase and use of motor vehicles

It is common for countries to use differential one-off registration and annual motor vehicle charges based on the type of vehicle, its weight, the engine capacity, its CO_2 emissions or whether the vehicle is used for business or private purposes.[279]

In the US, various states impose differential charges on the purchase or use of a motor vehicle based on a flat fee, the weight of the vehicle, the age of the vehicle or

[279] Bradbrook, above n 238, 13.

its value. The federal government in the US also imposes a supplementary lump sum tax on manufacturers on the sale of new passenger motor vehicles, called the 'gas guzzler tax' that do not comply with the prescribed energy efficiency standards. The 'gas guzzler tax' has been in operation since 1978. The tax is collected from the manufacturer or importer of the vehicles and the payment has to be made on each vehicle that does not meet the minimum fuel economy level of 22.5mpg. The following Table 4.7 shows the gas guzzler rates that have been in effect since 1 January 1991.

TABLE 4.7: US Gas Guzzler Tax

Combined Fuel Economy in mpg	Amount of Tax USD
At least 22.5	No tax
At least 21.5 but less than 22.5	1000
At least 20.5 but less than 21.5	1300
At least 19.5 but less than 20.5	1700
At least 18.5 but less than 19.5	2100
At least 17.5 but less than 18.5	2600
At least 16.5 but less than 17.5	3000
At least 15.5 but less than 16.5	3700
At least 14.5 but less than 15.5	4500
At least 13.5 but less than 14.5	5400
At least 12.5 but less than 13.5	6400
Less than 12.5	7700

Source: United States Environmental Protection Agency, 'Tax Schedule' (August 2011) *Gas Guzzler Tax: Program Overview* <http://www.epa.gov/fueleconomy/guzzler/420f11033.htm#tax>.

The gas guzzler tax on passenger cars has nearly eliminated cars designed to get less than 22.5mpg, except for high-priced luxury and performance cars. As a result the car market in the US is concentrated just above 22.5mpg.[280] Being politically

[280] David L Greene et al, 'Feebates, Rebates and Gas-Guzzler Taxes: A Study of Incentives for Increased Fuel Economy' (2005) 33 *Energy Policy* 757.

sensitive, the gas guzzler tax does not apply to light trucks, and therefore there is no policy incentive to reduce the number of SUVs on American roads.

Canada also imposes an excise tax (green levy) on the purchase of fuel inefficient vehicles as demonstrated in Table 4.8.

TABLE 4.8: Canadian Green Levy

Weighted Average Fuel Consumption in Litres per 100km	**Excise Tax (Green Levy) CAD**
13–14	1000
14–15	2000
15–16	3000
16 or more	4000

Source: Canada Revenue Agency, *Excise Tax on Fuel Inefficient Cars* (28 March 2007) <http://www.cra.gc.ca/gncy/bdgt/2007/xcs-eng.html>.

Unlike the gas guzzler tax in the US, the green levy in Canada applies to SUVs, discouraging their purchase.

Canada also introduced a system called the Tax for Fuel Conservation (TFFC) as part of its Retail Sales Tax (RST) system in 1990.[281] The TFFC applies to new passenger vehicles, including imported vehicles using six or more litres of oil and SUVs using eight or more litres of oil. The TFFC is calculated as shown in Table 4.9.

TABLE 4.9: Tax for Fuel Conservation (TFFC) Rates

Highway Fuel Use Ratings (Litres/100km)	**Tax on New Passenger Vehicles CAD**	**Tax on New SUVs CAD**
Under 6	0	0
6.0–7.9	75	0
8.0–8.9	75	75

[281] See *Retail Sales Tax Act*, RSO 1990 (as amended) c R-31, s 4. Extracted from Bradbrook, above n 238, 12.

Highway Fuel Use Ratings (Litres/100km)	Tax on New Passenger Vehicles CAD	Tax on New SUVs CAD
9.0–9.4	250	200
9.5–12.0	1200	400
12.1–15.0	2400	800
15.1–18.0	4400	1600
Over 18.0	7000	3200

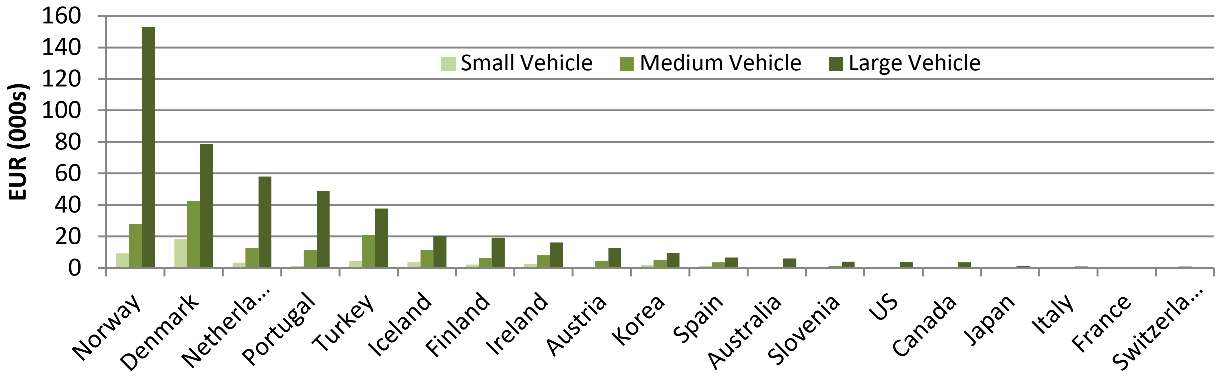
Source: Ontario Ministry of Finance, 'Tax for Fuel Conservation' (RST Guide No 513, April 2008) <http://www.rev.gov.on.ca/en/guides/rst/513.html>.

The TFFC is part of the taxable value of new vehicles before the eight per cent RST and the five per cent federal GST are calculated. The TFFC is paid to the dealer at the time of purchase.

To encourage the purchase of motor vehicles that use less than six litres of fuel per 100km, a tax credit of CAD100 is given against the RST. To encourage the use of alternative fuels, owners who purchase or convert their vehicles to operate exclusively on electricity, propane, natural gas, ethanol, methanol, other manufactured gas, dual powered or hybrid electrical vehicles are eligible for an RST rebate and may also be eligible for a TFFC rebate.

A number of European countries have one-off motor vehicle taxes that differ for small, medium and large motor vehicles as shown in Figure 4.6.

FIGURE 4.6: One-Off Motor Vehicle Taxes in Selected Countries as at 9 August 2010



Source: Organisation for Economic Co-Operation and Development, *Taxation, Innovation and the Environment* (OECD, 2010).

Many European countries have carbon-related differentiation of recurrent motor vehicle taxes, depending on the CO_2 emitted per km driven as shown in Appendix 1.

Norway has a unique motor vehicle tax that penalises heavy, powerful and large CO_2-emitting motor vehicles. In Norway, the one-off registration tax is based on a combination of the vehicle's unladen weight (kg), the engine output (kW), and either its CO_2 emissions or cylinder volume. If the CO_2 emissions data is not available, then the cylinder volume is used in calculating the tax. From 1 January 2008, motor vehicle cylinder volume is not used in calculating the tax. If motor vehicles do not have the documentation requirement for fuel consumption based on CO_2 emissions, then the road authorities will calculate their tax. From 1 January 2012, there is also a NOx component in the one-off registration tax. The registration tax is charged on each factor thereby discouraging heavy, powerful and CO_2-emitting motor vehicles. Moreover, the registration tax is quite high. For example, if a popular Australian passenger motor vehicle, the Holden VE, was purchased in Norway, the registration tax in year 2011 would be NOK434 933 which amounts to AUD79 078.67, as shown in Table 4.10. This is based on motor vehicle registration tax rates set in the 2011 Norwegian Budget and a conversion rate of one Australian dollar to NOK5.5. Based on the tax rates set in the 2012 Norwegian Budget, the one-off registration tax on the Holden VE would be NOK401 818 which includes a NOx component of NOK1320.

TABLE 4.10: Registration Tax for Holden VE in Norway

	Specifications	NOK	AUD
Tax on unladen weight	1700kg	114 194.50	20 762.63
Tax on engine rating	180kW	202 048.20	36 736.04
Tax on CO_2	217g/km	117 390.00	21 343.64
Vehicle scrap deposit		1300.00	236.36
Total Motor Vehicle Tax		434 933.00	79 078.67

Source: Extracted from Toll Customs, 'Calculator: Importation of Motor Vehicles <http://www.toll.no/templates_TAD/RegistrationTax.aspx?id=79&epslanguage=en&step=3#anchorResult>.

The Norwegian tax is further discussed in Chapter 5 as part of the case study. The Norwegian registration tax takes into consideration all the factors that increase the fuel consumption and emissions in a vehicle.

Singapore has a vehicle quota system that was implemented on 1 May 1990. Under this system, the government controls the release of new vehicles on the road by determining the number of new vehicles allowed for registration, taking into account the traffic conditions and the proportion which the vehicle category makes up of the total vehicle population. The vehicle quota for a given year is then administered through a monthly release of Certificates of Entitlement (COE). Thus, a Singaporean would need to purchase a COE to obtain the right to purchase a new vehicle. The COE has a life span of 10 years, after which it expires and can only be retained by paying an additional fee. This system restricts the number of vehicles that are on Singaporean roads.[282] The COE payable in Singapore for a popular Australian family car, the Holden Epica, also called the Chevrolet Epica, would have been about SGD63 000 on 9 June 2011.[283]

In addition to the cost of COE, a vehicle owner in Singapore is required to pay a registration fee of SGD140 and an Additional Registration Fee (ARF) of 100 per cent

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[282] Land Transport Authority, *Vehicle Ownership – Vehicle Policies & Schemes* (24 November 2009) Singapore Government <http://www.lta.gov.sg/content/lta/en.html>.
[283] Land Transport Authority, *One Motoring*, Singapore Government <http://www.onemotoring.com.sg/publish/onemotoring/en.html>.

of the vehicle's open market value when the vehicle is purchased. An annual road tax is also payable and the amount of road tax is based on the engine capacity of the vehicle. A road tax surcharge also applies for vehicles that are more than 10 years old. To encourage motor vehicles to be scrapped or exported before they are 10 years old, a 'Preferential Additional Registration Fee' rebate ranging from 75 per cent to 50 per cent of the ARF is granted.[284]

Singapore introduced the Green Vehicle Rebate scheme in 2001, and up until December 2011, electric, hybrid and gas-powered vehicles were eligible for a rebate of 40 per cent on the national vehicle registration fee. Since 2011, only electric vehicles are eligible for a rebate of five per cent of the ARF.

Japan has two acquisition taxes and two taxes during ownership of motor vehicles. On acquisition of a motor vehicle, the Japanese have to pay an acquisition tax and a consumption tax. The acquisition tax applies to both new and used motor vehicles and is based on five per cent of the purchase price, unless the price is less than JPY500 000, in which case it is exempted. The consumption tax of five per cent is also based on the purchase price of the motor vehicle. During ownership, the Japanese pay a tonnage tax and the automobile tax. An annual tonnage tax is assessed according to vehicle weight at each vehicle inspection, with a rate of JPY5000 (Approximately AUD59 based on an exchange rate of 85.3497) per 0.5 tonne per year. The tonnage tax is in addition to the annual automobile tax based on the engine capacity, ranging from JPY29 500 (about AUD345) per year for a passenger car up to 1000cc to JPY111 000 (approximately AUD1300) for a passenger car over 6000cc.[285] Thus the Japanese discourage the use of heavy and powerful motor vehicles.

Many OECD countries have been changing the manner in which they charge motor vehicle taxes, and they incorporate the fuel efficiency, CO_2 emissions per kilometre, engine power and weight of the vehicle. As demonstrated above, Norway has a high one-off tax as they take into account all the factors — CO_2 emissions, vehicle weight and engine power — in calculating the tax. Denmark has higher taxes for small and

[284] Land Transport Authority, *Vehicle Ownership – Vehicle Tax Structure*, Singapore Government <http://www.lta.gov.sg/content/lta/en.html>.

[285] Japan Automobile Manufacturers Association, 'The Motor Industry of Japan 2010' (Report, Japan Automobile Manufacturers Association, May 2010) 43.

medium-sized vehicles in comparison with other European countries.[286] In conclusion, one-off and recurrent motor vehicle taxes are a major source of revenue for most governments, but if they are set sufficiently high and measured against appropriate criteria, they can also play a role in affecting levels of motor vehicle ownership and the composition of the national fleet of vehicles.

a. Lessons for Australia

In Australia, the taxes and duties payable on the purchase of a vehicle include the Goods and Services Tax (GST), stamp duty and Luxury Car Tax (LCT). Annual motor vehicle licence fees are also payable in order to be able to use the vehicle on the roads.

The GST is a standard 10 per cent payable on the cost of the vehicle and has no bearing on the oil consumption of the vehicle. Stamp duty is imposed by the states and territories where the new vehicles are registered for the first time, or when registration is being transferred to another person. The amount of the duty is based on the dutiable value of the motor vehicles and the rate varies with each state or territory. The stamp duty has an impact on the price of the vehicles but no bearing on the oil consumption of the vehicle.

In Australia, the LCT can impact on the price of the vehicles. The LCT was first introduced in Australia on 1 July 2000 when the GST was introduced and the wholesale sales tax was abolished. The tax applies to vehicles whose GST-inclusive value exceeds the indexed threshold of AUD57 466 for 2010–11. The LCT applies to both domestically produced and imported vehicles.[287] The purpose of the LCT was not necessarily to curb excessive oil consumption but to protect the local car industry in Australia.

In an effort to have an impact on choice of motor vehicle, the federal government made recent amendments to the LCT in the *Tax Laws Amendment (Luxury Car Tax) Act 2008* (Cth) which came into effect on 1 July 2008 increasing the rate of LCT

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[286] Organisation for Economic Co-Operation and Development, *Taxation, Innovation and the Environment* (OECD, 2010) 41.
[287] *Tax Laws Amendment (Luxury Car Tax) Act 2008* (Cth)

from 25 per cent to 33 per cent. Also, a LCT exemption applies to fuel-efficient cars with a fuel consumption not exceeding seven litres per 100km as a combined rating under the vehicle standards in force in s 7 of the *Motor Vehicles Standards Act 1989* (Cth), and which are below the indexed fuel-efficient car limit of AUD75 000. The fuel-efficient car limit for the 2010–11 financial year is AUD75 375.[288]

The LCT is imposed only when the price of the car is above the legislated threshold of AUD57 466 for 2010–11. The price of the vehicle as a basis for the imposition of LCT is not indicative of its fuel efficiency or its emissions. Moreover, the proportion of vehicles subject to the LCT is not more than 11 per cent. Thus, the LCT is not sufficient to encourage the purchase of a fuel-efficient car, as it has no impact on about 89 per cent of the motor vehicles purchased.[289] Furthermore, applying the combined rating of seven litres per 100km only to luxury vehicles is not sufficient to reduce the oil use of the Australian fleet.

As regards the annual motor vehicle licence fees in Australia, the six states and two territories apply different methods of calculating vehicle registration charges. South Australian charges depend on the number of cylinders, whereas New South Wales charges are based on weight as shown in Table 4.11.

TABLE 4.11: Vehicle Registration Charges in New South Wales

Weight of Vehicle		**Private Use**	**Business Use**
Exceeding kg	**Not Exceeding kg**	**AUD**	**AUD**
	975	231	341
976	1154	254	375
1155	1504	285	429
1505	2504	406	619

Source: *Motor Vehicle Taxation Act 1988* (NSW) s 5 (as amended).

[288] Commissioner of Taxation, *Luxury Car Tax Determination LCTD 2010/1 – Luxury Car Tax: What is the Luxury Car Tax Threshold and the Fuel-Efficient Car Limit for the 2010–11 Financial Year?* (9 June 2010) Australian Taxation Office <http://law.ato.gov.au/pdf/pbr/lcd2010-001.pdf>.

[289] Australian National Audit Office, *Administration of the Luxury Car Tax* (2012) Commonwealth of Australia <http://www.anao.gov.au/Publications/Audit-Reports/2010-2011/Administration-of-the-Luxury-Car-Tax/Audit-brochure>.

In Western Australia, the vehicle licence fee for light vehicles weighing less than 4500kg is AUD17.02 per 100kg, plus a recording fee and a prescribed flat fee.[290] The Northern Territory and Victorian charges are based on engine size.[291] The differential charges on the use of motor vehicles in Australia have little influence on the purchase and use of motor vehicles as the charges are either not high enough or the basis on which they are imposed has no impact on the use of oil in motor vehicles.

The need for a tax to change behaviour, to drive less in more fuel-efficient motor vehicles, was recognised by the Australian government and referred to the review of Australia's future tax system commonly known as the 'Henry Tax Review'.[292] Around 1500 formal submissions were received, and included in the key messages from the submissions was that taxes on the purchase of motor vehicles should promote fuel efficiency.[293] The Henry Tax Review also made recommendations to the Australian government to abolish the LCT and to replace vehicle registration taxes with more efficient road user charges.[294] It also criticised the imposition of stamp duty on motor vehicles on the basis that it dissuades people from turning over their vehicles and thereby increases the age of the national fleet of vehicles.[295]

The LET discussed in Chapter 6 takes into consideration how countries use differential one-off registration and annual motor vehicle charges based on the type of a vehicle, its weight, the engine capacity, its CO_2 emissions (especially Norway), as well as some of the recommendations from the Henry Review, and proposes a differential charge on the purchase and use of motor vehicles that has the potential to change consumer behaviour in favour of smaller and lighter vehicles with reduced CO_2 emissions. The next section explores fuel taxes and fuel excise.

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[290] Department of Transport, *Schedule of Licensing Fees and Charges* (July 2010) Government of Western Australia <http://www.transport.wa.gov.au/licensing/566.asp> 5.
[291] Northern Territory Transport Group, *Vehicle Registration* (March 2012) Northern Territory Government <http://www.transport.nt.gov.au/mvr/registration>; VicRoads, *Registration* (18 May 2012) State Government Victoria <http://www.vicroads.vic.gov.au/Home/Registration/>.
[292] Australian Treasury, 'Architecture of Australia's Tax and Transfer System' (Report, Commonwealth of Australia, August 2008) <http://taxreview.treasury.gov.au/content/downloads/report/Architecture_of_Australias_Tax_and_Transfer_System_Revised.pdf> (Henry Tax Review).
[293] Commonwealth of Australia, 'Chapter E: Enhancing Social and Market Outcomes' in *Australia's Future Tax System: Final Report – Detailed Analysis* (Final Report, 2 May 2010) <http://taxreview.treasury.gov.au/content/FinalReport.aspx?doc=html/Publications/Papers/Final_Report_Part_2/Chapter_e.htm>.
[294] Ibid.
[295] Acil Tasman, 'Henry Tax Review: An Overview of Issues for Motorists' (Report, Australian Automobile Association, May 2010) 9.

4.4.2 Fuel Taxes or Fuel Excise

In the context of OECD terminology, excise systems comprise selective taxes on the production, sale, transfer, leasing and delivery of goods and the rendering of services.[296] Therefore taxation on motor vehicle fuel comes within the definition of an excise. A fuel excise is generally imposed for revenue purposes since it has no close substitutes and the demand for fuel is inelastic, and the potential for economic distortion by the imposition of an excise is relatively small.[297] Excise taxes are often rationalised as a charge to consumers for external costs, which then induces them to reduce their activities to the socially optimal level, known as the Pigouvian prescription.[298]

Motor fuel taxes or fuel excises have been implemented by many countries and the revenue raised from them is often quite high. Table 4.12 shows the different excise tax rates on petrol in OECD countries for the years 2000 and 2010 and the arithmetical percentage change and the real percentage change for that period. The arithmetical percentage change does not address how these taxes compare to the real impact they have on influencing consumer behaviour and on government revenues. The real percentage change takes into consideration the effect of inflation.

TABLE 4.12: Tax Rates on Motor Fuel in Euro per litre

	Petrol 2010	**Petrol 2000**	**Arithmetical % Change**	**Real % Change**
Mexico	-0.0658	0.0117	-661.57%	-139.90%
United States	0.0788	0.067	17.67%	-8.69%
Canada	0.1524	0.1451	5.05%	-14.67%
New Zealand	0.1913	0.1453	31.65%	3.7%
Chile	0.2082			

[296] Item 5120 in OECD 2009 classification extracted from Sijbren Cnossen, 'Excise taxation in Australia' (Paper presented at the Australia's Future Tax and Transfer Policy Conference 2009, Melbourne Institute, Melbourne, 18–19 June 2009) 236.
[297] Ibid 237.
[298] Ibid.

	Petrol 2010	**Petrol 2000**	**Arithmetical % Change**	**Real % Change**
Australia	0.2141	0.2595	-17.48%	-36.86%
Iceland	0.3644	0.2276	60.13%	-12.29%
Poland	0.3826	0.2901	31.90%	-2.07%
Japan	0.4139	0.4139	0.00%	3.02%
Korea	0.4206	0.4204	0.04%	-26.48%
Estonia[1]	0.423			
Spain	0.4247	0.3717	14.26%	-13.24%
Hungary	0.4275	0.2825	51.32%	-14.67%
Austria	0.442	0.4077	8.41%	-10.56%
Luxembourg	0.4621	0.3721	24.19%	-0.79%
Czech Republic	0.4852	0.4096	18.45%	-8.4%
Slovenia	0.4895			
Switzerland	0.4935	0.4846	1.85%	-6.88%
Slovak Republic	0.5145	0.3122	64.80%	-26.36%
Israel*	0.515			
Sweden	0.5173	0.4205	23.04%	5.82%
Ireland	0.5432	0.3739	45.29%	11.3%
Italy	0.564	0.528	6.82%	-14.16%
Belgium	0.5706	0.5072	12.50%	-8.44%
Denmark	0.5708	0.5114	11.61%	-8.73
Portugal	0.583	0.3706	57.31%	23.46%
France	0.6069	0.5863	3.50%	-12.40%
Greece	0.61	0.314	94.26%	41.85%
Norway	0.6179	0.6042	2.27%	-16.23%
Finland	0.627	0.5589	12.19%	-4.14%
United Kingdom	0.6307	0.5299	19.02%	-2.47%
Germany	0.6545	0.5624	16.37%	0.07%
Netherlands	0.6681	0.5968	11.96%	-7.65%
Turkey	0.8802	0.1475	496.88%	9.25%

Source: OECD/EEA database on instruments for environmental policy, extracted from Organisation for Economic Co-operation and Development, *Taxation, Innovation and the Environment*, OECD, 2010.

NOTE: The currencies are converted to euro using the average exchange rate for 2009. Data for the United States and Canada include average excise rates taxes at the state/provincial level. VAT or GST is not included.

From Table 4.12 it can be observed that Mexico has an effective negative excise tax rate due to high international crude prices in 2009 and the Mexican government heavily subsidising motor fuel as Mexico is one of the top ten oil producers in the world. On the other extreme, Turkey has the highest tax rate on petrol among OECD countries. The impact of this is that Turkey's economy is less dependent on personal vehicles than other OECD countries. In 2005, Turkey had only 117 vehicles per 1000 people compared with the OECD average of 607 vehicles per 1000 people. Since petrol is taxed at a much higher rate than diesel or LPG, the number of vehicles that shifted to LPG increased from 800 000 to 1.8 million between 2003 and 2007 and thus the petrol use declined significantly. A case study on Turkey suggests that fuel taxes and fuel excise can have an important impact on consumer behaviour.[299]

Although the real rate of motor fuel tax is declining in most OECD countries, motor fuel tax is a major source of revenue for many governments around the world. The UK pump price of petrol and diesel has a higher tax component than any other EU country. In April 2007, fuel tax formed 67 per cent of the pump price of a litre of unleaded fuel in the UK, compared with the 25 EU countries' average of 57 per cent.[300]

Many countries are conducting studies on reforming their road transport taxes. The 2008 Mirrlees Fullerton study in the UK on environmental taxation noted that an optimal system of road transport taxes would precisely target the taxes against the various externalities involved and that fuel taxation should correct environmental and road damage costs.[301]

In the US, the federal tax on petrol is USD0.184 per gallon and has not been raised since 1993. US legislators have been unwilling to raise the tax rate on motor fuels as the price of petrol is already high without adding on the extra tax. On the other hand, the costs of building and repairing roads have risen. Over the last 30 years the US has added very little capacity to its road network, while vehicle miles travelled (VMT)

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[299] OECD, above n 286, 38.
[300] Don Fullerton, Andrew Leicester and Stephen Smith, 'Environmental Taxes: Paper Written for the Mirrlees Review "Reforming the Tax System for the 21st Century"' (22 March 2007) *Institute for Fiscal Studies* <http://www.ifs.org.uk/mirrleesreview/reports/conference_drafts/environment.pdf> 37.
[301] Ibid 35–8.

rose 95 per cent between 1980 and 2008, increasing congestion. It is anticipated that revenues from motor fuel taxes in the US will continue to decline due to further improvements in fuel economy arising from stricter CAFE standards. Thus there is a push in the US to replace the tax on motor fuel with a user fee to fund transportation and infrastructure.[302]

The reason why many countries are considering replacing fuel taxation with a kilometre-based user fee structure is that the kilometre fee addresses the three main criticisms of the fuel tax: that the kilometre-based user fees are based on distance driven and not the amount of fuel purchased and consumed; the revenue base is not diminished by increased fuel efficiency of the motor vehicle fleet; and they capture miles driven by vehicles that do not use traditional fuel.[303]

A special 2006 research report by the US Committee for the Study of the Long-Term Viability of Fuel Taxes for Transportation Finance concluded that fuel taxes may become less reliable revenue sources for transportation programs in the future. The committee concluded that although the present highway finance system can remain viable for some time, travellers and the public would benefit greatly from a transition to a fee structure that more directly charges vehicle operators for their actual use of the roads.[304]

The Oregon Road User Fee Pilot Program Report commented that the fuel tax-generated revenue is eroding and is likely to fail in its original intended purpose as a reliable source of revenue for the state's road system. The Report identified the advantages of the fuel tax as: raises substantial revenue; ease of payment by consumer; ease of collection; easy to administer; and low cost of administration. However the disadvantages identified included disconnection to the highway system and revenue erosion. The Oregon Task Force created a mileage fee concept by emulating positive attributes of the fuel tax collection and designing the collection of mileage fees at the fuel pump; it thus raises fewer enforcement issues because access

[302] Keith Crane, Nicholas Burger and Martin Wachs, 'The Option of an Oil Tax to Fund Transportation and Infrastructure' (Occasional Paper, RAND, 2011) 45.
[303] Richard T Baker, Ginger Goodin and Lindsay Taylor, 'Mileage-Based User Fees — Defining a Path toward Implementation (Phase 2): An Assessment of Institutional Issues' (Final Report, University Transportation Center for Mobility, November 2009) 12.
[304] Committee for the Study of the Long-Term Viability of Fuel Taxes for Transportation Finance, Transportation Research Board of the National Academies, 'The Fuel Tax and Alternatives for Transportation Funding' (Special Report 285, Transportation Research Board, 2006) 3.

to fuel can be conditional upon payment of the mileage charge. Although designed to replace the fuel tax, the platform employed by the Oregon Task Force is tremendously flexible and can easily accommodate country and city options or congestion pricing without photographic or tolling style infrastructure.[305] This is further discussed in the Chapter 5 case study.

The European study on kilometre fees is not aimed at replacing the fuel tax, but is more focused on congestion taxes and road user charges. The European concept is further discussed below under Demand Management Programs and in Chapter 5 with the Netherlands case study.

a. Lessons for Australia

Table 4.12 shows that the Australian fuel tax rate has declined over the 10 years to 2010. As part of its *A New Tax System* reforms, the Howard government reduced excise on petrol and diesel by 6.656 cents per litre on 1 July 2000 in order to compensate for the introduction of the GST. The Australian government further reduced the excise by 1.5 cents on 2 March 2001. This brought the total reduction in excise to 8.156 cents. The excise rates in Australia are not indexed to the consumer price index and the excise rate has remained at 38.143 cents per litre, with the result that the real excise rate has decreased over the last 10 years to 2010.

The main reason that Australia imposes excise on petrol is to raise revenue. For every litre of petrol or diesel, whether imported from overseas or produced in Australia, an excise of AUD0.3814 cents per litre is imposed. The question to address is whether an increase in fuel excise is likely to affect the consumption of oil in passenger motor vehicles in Australia. It has been noted in various studies that the consumption of fuel is inelastic. The reason for this is that people have a need to drive. It is difficult to reduce demand for fuel without changing behaviour, for example, buying a fuel-efficient vehicle, using more public transport, or driving less. Moreover, there is no readily available substitute for oil which can be used without

[305] James M Whitty, 'Oregon's Mileage Fee Concept and Road User Fee Pilot Program' (Final Report, Oregon Department of Transportation, November 2007) <http://www.oregon.gov/ODOT/HWY/RUFPP/docs/RUFPP_finalreport.pdf>.

making major alterations to the current design of vehicles. The same argument applies if the price of fuel increases as a result of the Australian government introducing an emission trading scheme or a carbon tax.

The Senate Select Committee on Fuel and Energy conducted an inquiry on the impact of the Carbon Pollution Reduction Scheme on consumers and revealed arguments from organisations such as the Commonwealth Scientific and Industrial Research Organisation (CSIRO), Caltex Australia and the Royal Automobile Club of Queensland (RACQ) acknowledging that local and international research confirm that fuel use is quite inelastic, so an increase in fuel price will reduce the demand for fuel only slightly. The RACQ argued that in the short term, car fuel use declines about 1.5 per cent with any 10 per cent concurrent increases in the price of fuel. Caltex Australia commented that the price of fuel does little to change motorists' consumption behaviour.[306] The Bureau of Infrastructure, Transport and Regional Economics also confirmed in their 'Briefing Document – 1' that in the short term, car fuel use declines about 1.5 per cent with a 10 per cent increase in the petrol price.[307]

The Henry Tax Review suggested that fuel tax as a source of general government revenue should be phased out and transport-specific taxes should be imposed only where they improve social and market outcomes. The Henry Tax Review has proposed that fuel excise could serve as a distant second best option to collecting the variable part of the two-part (fixed price component and variable price component) road user charge. The Henry Review further stated that if fuel excise is kept for the variable pricing component of a road user charge, then the anomalies in the fuel excise system need to be remedied and the fuel tax needs to tax all energy sources on an energy-content basis.[308]

The Australian fuel excise has been reviewed in the proposed LET in Chapter 6. The next part explores the income tax incentives.

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[306] Senate Select Committee on Fuel and Energy, Parliament of Australia, *The CPRS: Economic Cost Without Environmental Benefit – Interim Report* (May 2009) 185.
[307] David Gargett and Afzal Hossain, 'How Do Fuel Use and Emissions Respond to Price Changes?' (Briefing Report No 1, Bureau of Infrastructure, Transport, Regional Development and Local Government, 2008) 2.
[308] Acil Tasman, above n 295, 9.

4.4.3 Income Tax Incentives

Many countries support the introduction of fiscal incentives for fuel efficiency, as tax measures are considered an important tool in shaping consumer demand in favour of fuel-efficient vehicles. Many countries also grant tax incentives to produce motor vehicles that do not rely on oil, ie electric motor vehicles or those driven on biofuels. Some countries grant income tax incentives to produce biofuels.

The *American Recovery and Reinvestment Act 2009* provides credits of between USD2500 and USD7500 for qualified plug-in electric drive vehicles purchased after 31 December 2009. To qualify for the credit, the vehicles must be newly purchased, have four wheels or more, have a gross weight rating of less than 14 000 pounds and draw propulsion from a battery with at least four kilowatt hours that can be recharged from an external source of electricity.[309] In the US, tax incentives have been available for electric and clean fuel vehicles since 1975 and these incentives have been amended over the years. For example, the 2005 *Energy Tax Incentives Act* added the 'Alternative Technology Vehicles' credit for qualified fuel cell vehicles, alternative fuel vehicles, qualified hybrid vehicles, advanced lean-burn technology motor vehicles and alternative fuel vehicle refuelling property.[310] Tax incentives have also been provided for ethanol production in the US since 1978 to reduce dependence on foreign oil, according to the *Energy Tax Act of 1978*.[311] In the US, the first major tax incentive was an exemption of ethanol from motor fuel excise tax. The US federal law now grants three income tax credits, ranging from USD0.10 to USD0.60, designed to encourage ethanol use by making ethanol prices competitive with petroleum-based fuels.[312] A credit of USD0.10 per gallon is granted to small producers if production exceeds a certain threshold, and is limited to a cap of 15 million gallons of production unless the fuel is produced from cellulosic sources.[313]

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[309] Internal Revenue Service, 'Energy Provisions of the American Recovery and Reinvestment Act of 2009' (Fact Sheet No FS-2009-10, US Department of the Treasury, 10 April 2009) <http://www.irs.gov/newsroom/article/0,,id=206871,00.html/>.

[310] Mona Hymel, 'The United States' Experience with Energy-Based Tax Incentives: The Evidence Supporting Tax Incentives for Renewable Energy' (Discussion Paper No 06-21, Arizona Legal Studies, 2006) 15.

[311] Mona L Hymel, 'Moonshine to Motorfuel: Tax Incentives for Fuel Ethanol' (Discussion Paper No 08-29, Arizona Legal Studies, 2008) 2.

[312] Ibid 3.

[313] Ibid 7.

The US also grants a credit of up to 50 per cent of the cost of refuelling equipment capped at USD50 000.[314]

In April 2009, the State of Colorado enacted legislation HB09-1331, allowing a tax credit of up to USD6000 for any alternative fuel or hybrid-powered vehicle. Starting with financial year 2009–10, HB09-1331 has changed the rebate scheme by classifying seven categories of vehicles and a percentage ranging from zero to 85 per cent of the purchase price with a cap to any one entity of USD350 000 per fiscal year.[315]

Other American states that have established incentives and tax exemptions for electric vehicles include California, Arizona, the District of Columbia, Florida, Georgia, Hawaii, Illinois, Louisiana, Montana, New Jersey, Oklahoma, Oregon, South Carolina, Tennessee, Utah and Washington.[316]

Effective from 1 July 2010, Ontario, a province in Canada, has enacted an incentive ranging from CAD5000 to CAD8500 towards the purchase or lease of a new plug-in hybrid electric or battery electric vehicle. The value of the incentive is based on the vehicle's battery capacity from 4kW to 17kW.[317] This is part of the Ontario government's vision to have one out of every 20 vehicles driven in Ontario be electrically powered by 2020.

The Chinese government has implemented a subsidy program in five of its cities, Shanghai, Changchun, Shenzhen, Hangzhou and Hefei, whereby buyers of pure electric vehicles would be entitled to a subsidy of CNY60 000 and CNY50 000 for plug-in hybrid cars.[318]

As of April 2010, 17 EU Member States levied passenger car taxes partially or totally based on the car's carbon emissions or fuel consumption or a combination of the two. These states include Austria, Belgium, Cyprus, Denmark, Finland, France,

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314 Ibid 19.

315 'Concerning Incentives for Efficient Motor Vehicles' (Colorado Legislative Council Staff Fiscal Note No HB09-1331, 20 April 2009) 3.

316 Alternative Fuels & Advanced Vehicles Data Center, *All Federal & State Incentives & Laws: All Incentives and Laws Sorted by Type* (15 June 2011) US Department of Energy <http://www.afdc.energy.gov/afdc/laws/matrix/tech>.

317 Ontario Ministry of Transportation, *Electric Vehicle Incentive Program* (July 2012) <http://www.mto.gov.on.ca/english/dandv/vehicle/electric/electric-vehicles.shtml>.

318 Fang Yang, 'China's Annual Output of Electric Vehicles to Hit 1 mln by 2020', *English.News.cn* (online), 16 Oct 2010 <http://news.xinhuanet.com/english2010/china/2010-10/16/c_13560296.htm>.

Germany, Ireland, Luxembourg, Malta, the Netherlands, Portugal, Romania, Spain, Sweden and the United Kingdom. All western European countries except Italy and Luxembourg have incentives for electrically chargeable vehicles. The tax incentives mainly consist of tax reductions, exemptions and bonus payments for the buyers of electric cars.[319]

In Japan, alternative-energy and next generation vehicles are either exempt from the tonnage tax and the automobile tax or subject to a reduction of the tax, based on certain criteria.

a. *Lessons for Australia*

Although many governments are providing incentives to encourage the use of alternative fuel or electric motor vehicles, the uptake of alternative fuel vehicles remains low. The reasons for this are that the price of petrol is still relatively low, there is a lack of infrastructure for refuelling motor vehicles with alternative fuels or electricity, and the extra costs that go with purchasing alternative fuel and electric vehicles.

The question is whether providing tax incentives is a better means of changing driver habits in order to reduce passenger motor vehicle oil consumption, as opposed to imposing taxation to curb undesirable behaviour. Studies in the US on the impact of oil and gas tax incentives to promote the conservation of oil indicate that tax incentives substantially increased the rate of return for the petroleum industry, but have not resulted in the conservation of oil and gas reserves, nor decreased the US security concerns associated with foreign imports. According to the General Accounting Office (GAO), a better approach to increasing US energy security would have been to develop alternatives, increase fuel efficiency in transportation, and

[319] European Automobile Manufacturers' Association, *2011 The Automobile Industry Pocket Guide* (September 2011) ACEA <http://www.acea.be/images/uploads/files/20110921_Pocket_Guide_3rd_edition.pdf>; European Automobile Manufacturers' Association, *Overview of Purchase and Tax Incentives for Electric Vehicles in the EU* (Report, 29 March 2012) ACEA <http://www.acea.be/images/uploads/files/Electric_vehicles_overview.pdf>.

continue the development of the Strategic Petroleum Reserve.[320] A study conducted by the EIA on the provision of tax credits for nonconventional fuels concluded that the tax credits had no impact in terms of reducing the dependence on fossil fuels or foreign imports.[321] It has been stated that lowering the cost of petroleum consumption in the US through tax incentives has had the effect of encouraging waste, not conservation.[322] The GAO has also stated that while incentives may encourage more efficient fossil fuel consumption, alternative fuel use has not resulted in lower fossil fuel consumption or reduced dependence on the car.[323]

Tax incentives, if properly designed, do have a role to play in improving energy efficiency. A 2001 study by the American Council for Efficient Economy outlined eight principles for designing energy efficiency tax incentives, being that the tax incentives should:

- Encourage development of advanced technologies;
- Establish clear performance criteria;
- Be substantial;
- Choose technologies where first cost is a major barrier;
- Be flexible as to who receives the credit;
- Complement other policy initiatives;
- Select priorities, but offer incentives in a variety of areas to increase likelihood of success; and
- Allow sufficient time before phasing out the incentives.[324]

The Australian government promotes the use of alternative fuels in passenger motor vehicles and provides a grant of 38.143 cents per litre under the *Energy Grants (Cleaner Fuels) Scheme Act 2004* (Cth), where the biodiesel and ethanol meet the relevant quality standard under the *Fuel Quality Standards Act 2000* (Cth). The

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[320] US General Accounting Office, 'Tax Policy Additional Petroleum Production Tax Incentives Are of Questionable Merit' (Report to the Chairman, Subcommittee on Energy and Power, Committee on Energy and Commerce, House of Representatives, July 1990) <http://www.gao.gov/assets/150/149358.pdf> 39.
[321] Energy Information Administration, 'Analysis of Five Selected Tax Provisions of the Conference Energy Bill of 2003' (Service Report No SR/OIAF/2004-01, February 2004) <ftp://ftp.eia.doe.gov/service/sroiaf(2004)01.pdf> 2.
[322] Hymel, above n 310, 76.
[323] US General Accounting Office, 'Tax Policy Effects of the Alcohol Fuels Tax Incentives' (Report to the Chairman, Subcommittee on Energy and Power, Committee on Energy and Commerce, House of Representatives, March 2007) http://www.gao.gov/archive/1997/gg97041.pdf> 6.
[324] Mann and Hymel, above n 38, 10422.

Australian government has enacted legislation into Parliament to extend this grant until 2021.[325] By providing these grants, the excise and excise-equivalent customs duty imposed on manufacturers and importers is reduced to nil. Under the new laws implemented in 2011, liquefied petroleum gas (LPG) for transport use will be subject to fuel tax at the rate of 12.5 cents per litre and liquefied natural gas (LNG) and compressed natural gas (CNG) for transport use will be subject to fuel tax at the rate of 26.13 cents per kg. The application for these taxes will be phased in over the period 1 December 2011 and 1 July 2015.[326]

The current Labor government supports a work program to ensure Australia's energy markets are ready to support the potential large-scale adoption of electric vehicles and related technologies. In order to address the barriers to the uptake of electric vehicles, the Gillard government, through the Ministerial Council on Energy and the Australian Energy Market Commission, will consider issues such as metering requirements, technical and safety standards, network protection and the adequacy of current network infrastructure.[327] The problem with electric cars is that Australia is still reliant on fossil fuel to make electricity and insufficient electricity is produced in Australia using renewable resources to satisfy the increase in its demand for electric cars. Moreover, oil is required for production of electric cars and their batteries and the depletion of oil will increase the cost of electric cars. Thus the tax incentives should complement other policy initiatives, ie tax imposition to bring about a reduction in oil consumption by passenger motor vehicles, which are currently the largest consumers of oil.

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325 Treasury, 'Fuel Tax Legislation Amendment (Clean Energy) Bill 2011, Excise Tariff Legislation Amendment (Clean Energy) Bill 2011, Customs Tariff Amendment (Clean Energy) Bill 2011 — Commentary on Provisions' (28 July 2011) <http://www.climatechange.gov.au/government/submissions/clean-energy-legislative-package/~/media/publications/clean-energy-legislation/Commentary-on-Clean-Energy-Fuel-Tax-Arrangements-PDF.pdf> 4.

326 Explanatory Memorandum, Taxation of Alternative Fuels Legislation Amendment Bill 2011 (Cth) 9.

327 Martin, above n 259.

4.5 DEMAND MANAGEMENT PROGRAMS

Demand management programs are designed to reduce the demand for driving a motor vehicle, which should result in reduced oil use and a reduction in other costs that cannot be accurately measured, such as lost time and effect on health due to traffic congestion. Many countries have enacted a wide variety of laws and regulations pertaining to demand management programs at the local, state or national government level in order to reduce the need for and amount of private vehicle use, some of which are discussed below.

The majority of the demand management programs hinge on road pricing. Efficient road pricing can be achieved by changing the structure of taxes and charges from fixed and blunt measures to more variable ones levied at the point of sale. There is enough knowledge on the monetary values of external costs to reform road pricing. Efficient pricing can increase the cost of car use in congested urban areas and make public transport a more viable option. Road pricing measures are effective in changing people's behaviour and travel patterns.[328]

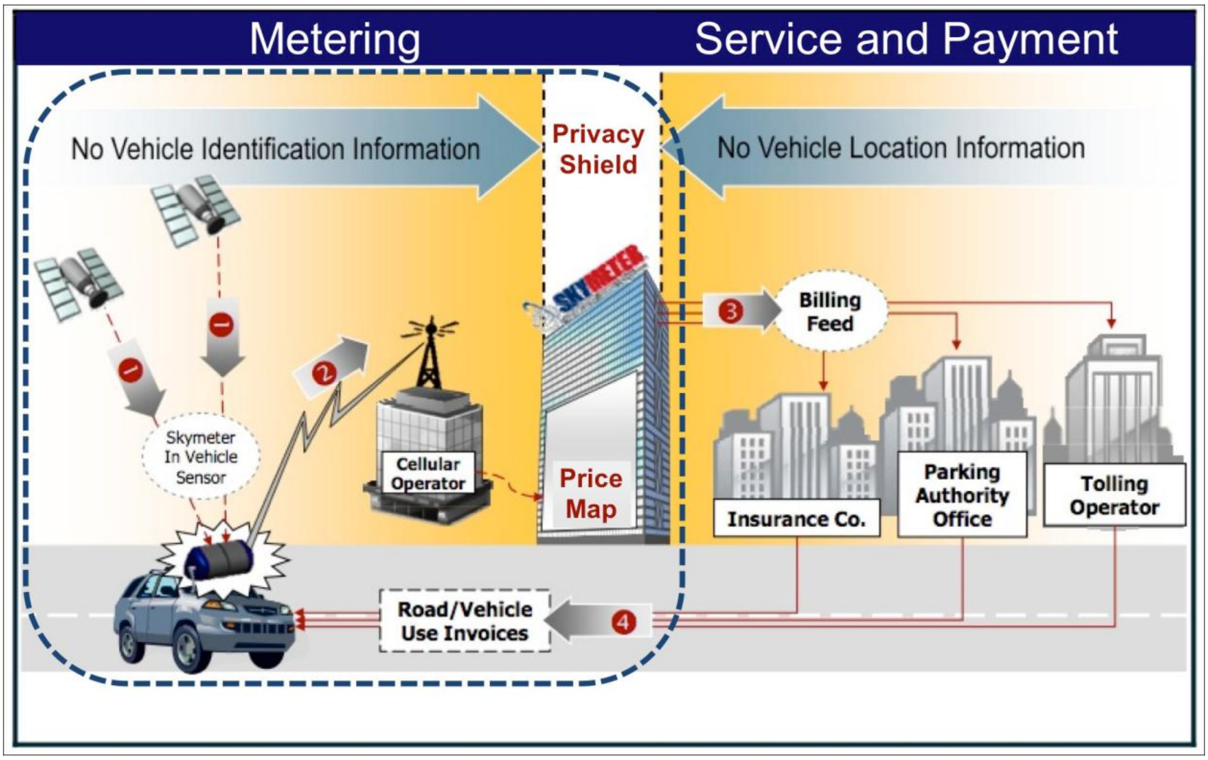
Many governments around the world are realising that government revenues from motor fuel taxes and excise may fall due to a reduction in driving resulting from increased fuel costs and an increase in alternative fuel-based vehicles such as plug-in hybrids and electric drive vehicles. As a result, there is increasing debate in many countries over nation-wide road pricing based on distance travelled.[329]

Technology is available to design demand management programs that are more variable and priced at the point of sale. An in-vehicle device with access to the vehicle data bus and powered through a single standard connector has been available since 1996 and capable of communicating information to a 'back office' for processing and calculating fees.[330] An example of such technology is developed by the Canadian firm Skymeter Corporation, removing critical barriers to the use of road-use charging, and paying particular attention to reliability, cost and privacy

[328] André de Palma, Robin Lindsey and Esko Niskanen, 'Policy Insights from the Urban Road Pricing Case Studies' (2006) 13 *Transport Policy* 149.
[329] Max Donath et al, 'Technology Enabling Near-Term Nationwide Implementation of Distance Based Road User Fees' (Report No CTS 09-20, Intelligent Transportation Systems Institute Center for Transportation Studies University of Minnesota, June 2011) 1.
[330] Ibid 2.

issues. The system operates by using infrastructure-free tolling, low-cost road-use metering and self-installable meters that are not connected to any vehicle system, except for battery recharging. The operation of the system is shown in Figure 4.7, whereby an in-vehicle sensor produces a trip log, which is forwarded to a proxy to determine the price. The proxy forwards the data to a service provider or to the vehicle owner for payment.[331]

FIGURE 4.7: Skymeter's Principle Architecture Deployment for Vehicle Identification and Trip Log



Source: Skymeter Corporation

Many European countries have adopted or are considering adopting road user charges based on vehicle kilometres travelled on the road. The European Eurovignette Directive has authorised lorry road-user charging since 1993. Germany

[331] Skymeter Corporation, 'Request to Participate in the Call for Tender Kilometre Price System For State of the Netherlands, Directorate-General for Mobility of the Ministry of Transport, Public Works and Water Management Skymeter Corporation' (Request to Participate in the Call for Tender, Skymeter Corporation, February 2009) 1–19.

was the first country in Europe to introduce a lorry road-user charging scheme, followed by Denmark and the Benelux countries (Belgium, the Netherlands and Luxembourg) on 1 January 1995. Sweden joined in 1997. The European Directives were amended in 1999 and again in 2006. The framework conditions allowed tolls to be levied according to the distance travelled and the type of vehicles and to scale the user charges according to the duration of the use made of the infrastructure as well as the vehicle emissions produced. The Directive only authorises the tolls and user charges to be imposed on vehicles weighing over 12 tonnes, using motorways or multi-lane roads similar to motorways as well as bridges, tunnels and mountain passes. However, from 2012 Eurovignette will apply to vehicles of 3.5 tonnes or more.[332]

In April 2010, the German 'Agency for the Environment' recommended the comprehensive introduction of VMT-based charging of cars on all roads and not just lorries on certain roads. In September 2010, the Vice-President of the German Research Society on roads and transport stated that the traditional tax financing of roads is no longer appropriate and recommended an urgent shift from fixed tax-based financing to a user-based financing. The VMT-based charges for heavy goods vehicles have been implemented in the Czech Republic, France, Poland, Portugal and Slovakia.[333]

The Dutch National Traffic Transport Plan was going to replace the existing motor vehicle tax, vehicle purchase tax for passenger cars and motor cycles and the heavy motor vehicle tax by a charge per kilometre driven tax on all vehicles.[334] Under the new tax, different vehicle types would have had different base rates, determined by CO_2 emissions or weight. Higher charges would have been levied during rush hour and for travelling on congested roads. Also, bigger cars emitting more carbon dioxide would have been assessed at a higher rate, while smaller cars would have paid less. The proceeds from this new tax were not expected to exceed the combined cost of the older taxes and were earmarked to go directly to the Infrastructure Fund to

[332] Louise Butcher, 'Roads: Lorry Road User Charging' (House of Commons Library Note No SN/BT/588, 6 September 2010) 7.
[333] Andreas Kossak Hamburg, 'Road Pricing Updates 2010 from Germany to Europe' (Paper presented at Transport Research Board 90th Annual Conference, Washington, DC, 23–27 January 2011) 7–9.
[334] Explanatory Memorandum, Rules for Charging a Pay-By-Use Price for Driving with Motor Vehicle (Dutch Road Pricing Act).

support the building of roads and railways.[335] Due to a change in the government, the Dutch National Traffic Transport Plan was not implemented. However the principles of the abandoned Dutch Plan are discussed as part of the case study in Chapter 5.

It is not only the European countries that are at the forefront of transforming transportation tax policies. The State of Oregon in the US is in the process of developing a 'Road User Fee'.[336] Oregon's Parliament has concerns about the revenue from its existing fuel taxation, and in July 2001 it appointed a Task Force to design a new revenue collection strategy for road usage. The mandated mission was enacted in 2001 in US House Bill 3946 by the Oregon State Legislative Assembly, the mission being: 'To develop a revenue collection design, funded through user pay methods, acceptable and visible to the public, that ensures a flow of revenue sufficient to annually maintain, preserve and improve Oregon's state, country and city highway and road system.'[337]

The criteria used by the Task Force in designing the new system include: user pays; local government control of revenue sources; revenue sufficiency to support highway and road system; transparency; non-governmental burden; enforceability; and public acceptance. The Task Force recommended a mileage fee accompanied by a congestion charge. The Task Force recommended the switch from fuel taxation collection to mileage fee collection using technology. Unlike the Netherlands model, the Oregon study does not recommend using a centralised collection agency, but rather fuel pump stations as collecting agents as part of the fuel purchase.[338] The principles of the Oregon Road User Fee are further discussed as part of the case study in Chapter 5.

In January 2011, another state in the US, Texas, reported the results of an exploratory study on vehicle mileage fees as a possible funding mechanism for meeting the state's long-term transportation needs, and identified challenges and opportunities for

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[335] Green Car Congress, *Dutch Cabinet Approves Mileage Tax; In Effect in 2012 if Approved by Parliament* (14 November 2009) <http://www.greencarcongress.com/2009/11/dutch-cabinet-approves-mileage-tax-in-effect-in-2012-if-approved-by-parliament.html>.
[336] Whitty, above n 305.
[337] Ibid 72.
[338] Ibid 6.

implementation of vehicle mileage fees.[339] It can be concluded from these studies that road user fees based upon vehicle mileage are likely to be the way of the future for the design of demand management programs.

Another demand management program introduced in many countries is congestion charges. Congestion charges are designed differently based on their goals, which are mainly to reduce congestion, generate revenue or raise environmental quality and safety. For example, in Singapore, the UK and the US, the main purpose of introducing congestion charges is to reduce congestion, whereas in Norway, the congestion charge was initially designed to generate revenue, but is now focused on raising environmental quality and safety.[340]

Singapore was the first country to introduce congestion charging in 1976, whereby drivers had to purchase a licence to enter a central zone during peak hours. The system was modified in 1998 with electronic road pricing, and the fee is paid on entering the zone, rather than representing a daily fee. Some Australian cities also use the Electronic Tag (ETAG) which is a small device attached to vehicle windscreens. When the vehicle passes tolling points, the tag transmits a signal to the tolling equipment, which will acknowledge it and deduct an appropriate amount from the toll account.

In 2003, the UK government introduced a congestion charge scheme called cordon pricing in the city of London over a 22 square mile zone representing core shopping, government, entertainment and business districts. London and Stockholm have congestion charge schemes based on distance-based user charges.[341] In Stockholm, a congestion charging trial was performed from 3 January to 31 July 2006, the stated purpose being to implement a tolling system to reduce congestion, increase accessibility and improve the environment. The trial brought about a radical change in the public attitude and resulted in a positive outcome at the referendum and permanent implementation of the system in August 2007. The trial showed that a single-cordon toll could affect traffic within a large area and not just close to the

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[339] Richard Baker and Ginger Goodin, 'Exploratory Study: Vehicle Mileage Fees in Texas' (Report No FHWA/TX-11/0-6660-1,Texas Transportation Institute, January 2011) 1–91.
[340] Govinda R Timilsina and Hari B Dulal, 'Urban Road Transportation Externalities: Costs and Choice of Policy Instruments' (Research Paper, World Bank Research Observer, 3 June 2010) 8.
[341] David A Hensher and Sean M Puckett, 'Road User Charging: The Global Relevance of Recent Developments in the United Kingdom' (2005) 12 *Transport Policy* 377.

zone limits. The congestion charge scheme in Stockholm was supplemented by a public transport service which gave the public fast alternatives for travelling at peak hours.[342] Cordon pricing has also been introduced in Oslo and Trondheim.[343] A cordon-based scheme was implemented in Trondheim in 1991 and changed to a zonal system in 1998. The scheme was implemented to finance infrastructure and brought little change in the volume of traffic in the region. The scheme was scrapped in 2005.[344]

In order to reduce congestion, the US introduced high vehicle occupancy (HVO) lanes under the Federal-Aid Highway Program, whereby one lane is reserved for private vehicles carrying at least two to three passengers.

Another method used to control congestion in Bogota, Columbia, has been road space rationing, called ‘Pico y Placa’ which means peak and licence plate system. Under this system, vehicles with their licence plate number ending in certain digits are prohibited during peak hours.

Mexico introduced a ‘No Driving Day’ policy in November 1989 where driving was prohibited on one day during the week.

The government of the Republic of Korea has a number of policies in place to reduce the demand for private vehicle use. Government workers are required to leave their cars at home on one day out of five.[345]

Italy has adopted a policy which bans private cars from entering city centres. Similarly, some Swiss cities such as Zurich and Bern make it difficult for private motor vehicles to enter city centres.

Another method used to reduce congestion is to control the vehicle population, such as has been implemented in Singapore and China. The Singapore government introduced a vehicle quota system in 1990, whereby motor vehicles can only be purchased by acquiring a Certificate of Entitlement (COE). The COEs are obtained

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[342] Jonas Eliasson et al, ‘The Stockholm Congestion – Charging Trial 2006: Overview of Effects’ (2009) 43(3) *Transportation Research Part A* 240.
[343] Anthony Ockwell and Phil Bullock, ‘The Role of Road Pricing in the Australian Policy Context’ (Paper presented at Australasian Transport Research Forum 2010, Canberra, Australia, 29 September – 1 October 2010) 5.
[344] Ibid 8.
[345] International Energy Agency, above n 248, 67.

by bidding, and the government controls the number of COEs that are released each month. The COE has a life span of 10 years, after which it expires and can only be retained by paying an additional fee.

China has also introduced a system of auctioning licence plates. Shanghai officially started using auctions to issue licence plates in 1994. In 2011, Beijing commenced a lottery system to tackle the city's traffic problem, whereby applicants who qualify are able to try their luck in a draw to obtain a licence plate.[346]

Bridge and road toll policies can play an important part in controlling traffic congestion and can have an indirect effect on fuel consumption.[347] The government of the Republic of Korea has implemented pricing regimes for toll roads, parking lots and insurance policies that encourage the purchase and use of smaller cars.[348] Higher tolls are being used in some countries to maintain the number of motor vehicles that travel in a designated lane on the highway. In Atlanta, the Georgia Department of Transport is constructing a high-occupancy toll lane that will run 16 miles along Atlanta's heavily-used highway. The express lane will cost from USD0.10 to USD1.00 per mile to allow drivers to pay to avoid the traffic.[349]

Another incentive to encourage reduced driving is pay-as-you-drive insurance. In California, regulations have been put into place providing for the insurance on motor vehicles to be based on the vehicle's actual mileage, or pay-as-you-drive coverage. Under the regulations, the insurer could verify mileage by odometer readings, automotive repair records or a technical device used to collect mileage data.[350]

A discussion paper brought out in 2008–09 in the US by the Brookings Institution, entitled 'Pay-As-You-Drive Auto Insurance: A Simple Way to reduce Driving-Related Harms and Increase Equity', states that the current lump sum pricing of motor vehicle insurance is inefficient and inequitable. The paper compares the all-

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346 China.org.cn, '210,000 Apply for Vehicle License Plates in Beijing' (2 January 2011) *CCTV News* <http://www.china.org.cn/video/2011-01/12/content_21720642.htm>.
347 Bradbrook, above n 238, 10.
348 International Energy Agency, above n 248, 67.
349 Mike Billips 'Congestion Pricing in Atlanta' *TIME Magazine* (online), 23 January 2011 <http://www.time.com/time/specials/packages/article/0,28804,2026474_2026675_2032830,00.html>.
350 California Department of Insurance, 'Insurance Commissioner Poizner Sets Framework For Environmentally-Friendly Automobile Insurance, Increased Options For Consumers' (Press Release, 27 August 2008) <http://www.insurance.ca.gov/0400-news/0100-press-releases/0070-2008/release089-08.cfm>.

you-can-drive insurance to all-you-can-eat restaurants which encourages a person to eat more. The paper states that pay-as-you-drive insurance provides an incentive to drive less, but notes that the cost of monitoring the mileage is the biggest hurdle to widespread implementation of pay-as-you-drive insurance.[351] The paper estimated that driving would decline by eight per cent in the US, benefitting the nation about USD50 to 60 billion a year by reducing driving-related harm.[352]

Pay-as-you-drive insurance is being offered by some insurance companies in Australia, such as Pay-As-You-Drive (Real Insurance).[353] A minimum premium is paid and the insured then purchases a comprehensive cover based on kilometres they want to drive. If all of the kilometres are used up, the insurance cover reverts to a Third Party policy. On the other hand, if the kilometres purchased are not used up, they get transferred into the next year. The premium for the insurance is not based on kilometres measured by a GPS device, but on customers reporting their odometer readings and pre-paying for kilometres of travel. At the time of a claim, the odometer reading is verified to ensure the customers are within their purchased kilometre range.[354]

4.5.1 Lessons for Australia

In Australia, apart from toll roads and limited pay-as-you-drive insurance, there is no control or pricing over the distance driven in motor vehicles, so long as one is prepared to meet the vehicle acquisition and running costs. In other words, Australia does not have any demand management programs other than toll roads in some of the cities and limited pay-as-you-drive insurance.

There is a need for the Australian government to set a policy for a demand management program that is compatible across the whole of Australia, with a focus on reducing VKT, thereby reducing the consumption of oil and other associated costs to society. Australia should learn from the experiences of other countries that are

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[351] Jason E Bordoff and Pascal J Noel, 'Pay-As-You-Drive Auto Insurance: A Simple Way to Reduce Driving-Related Harms and Increase Equity' (Discussion Paper, Brooking Institution, 2008) 2 and 16.
[352] Ibid 2.
[353] See <http://www.payasyoudrive.com.au>.
[354] See <http://www.payasyoudrive.com.au/howitworks/paydworld.aspx>.

now using technology in the design of their demand management programs. The LET discussed in Chapter 6 incorporates demand management as part of the comprehensive reform of motor vehicle taxes and charges in Australia. The next part explores the reasons why countries have implemented compulsory inspection and retiring of motor vehicles.

4.6 COMPULSORY INSPECTION AND RETIRING OF MOTOR VEHICLES

Many countries have legislation requiring compulsory inspection of vehicles and retiring of vehicles after a fixed period of time.

In the US, the *Clean Air Act (1990)*[355] requires the metropolitan areas of each State to implement vehicle emission inspection programs, known as the 'I/M' programs, in order to reduce emissions from on-road motor vehicles.

The Periodic Vehicle Inspection called the Algemene Periodieke Keuring (APK) was also introduced in Netherlands during the 1980s. The periodic vehicle inspection of cars is commonly known as the Ministry of Transport test (MOT). EU Directive 77/143 EEC set the framework for the MOT in 1977, and this was amended in Directive 2009/40/EC, effective from 6 May 2009, requiring annual inspections for passenger vehicles with more than eight seats excluding the driver's seat and an inspection every two years after the first four years after purchase for passenger vehicles with not more than eight seats excluding the driver's seat. MOT is focused on the safety aspects of the motor vehicle and exhaust emissions.[356]

The Japanese motor vehicle inspection program is called 'Shaken' and requires inspection of passenger vehicles over 250cc in the first three years after purchase and then every two years to ensure that the vehicles meet the regulations and are safe.

[355] *Clean Air Act* 42 USC §7401 et seq. (1970). The Clean Air Act is a United States federal law enacted by the United States Congress to control air pollution at a national level. It was passed in 1963 and amended in 1970 and 1990.
[356] SWOV Institute for Road Safety Research Netherlands, 'SWOV Fact Sheet – Periodic Vehicle Inspection of Cars (MOT)' (Fact Sheet, SWOV, September 2009).

Singapore regulations require safety and emission inspections every other year for vehicles more than three years old and every year for vehicles more than 10 years old.

New Zealand vehicles with a gross mass of 3500kg and under are required to have a Warrant of Fitness (WOF) and are inspected annually until the vehicle is six years old and thereafter every six months.

In most jurisdictions, inspections are limited to safety and environmental issues. The laws with respect to inspection can be fine-tuned to include fuel efficiency criteria.

Some countries have legislation that requires a compulsory retiring of vehicles after they reach a certain age, often tied in with a government rebate. For example, the Japanese were entitled to a JPY250 000 subsidy if they handed in a vehicle more than 13 years old. Similarly Egypt has a scheme that provides a reduction of up to EGP25 000 towards the price of a new vehicle if the old vehicle is handed in for recycling and scrapping.[357] The compulsory retiring of vehicles can assist in reducing the age of the country's vehicle fleet and thereby improving the fuel efficiency of vehicles.[358]

Singapore imposes a road tax surcharge for vehicles over 10 years of age as shown in Table 4.13.

TABLE 4.13: Singapore: Road Tax Surcharge for Vehicles Over 10 Years

Age of Vehicle	**Annual Road Tax Surcharge**
More than 10 years	10%
More than 11 years	20%
More than 12 years	30%
More than 13 years	40%
More than 14 years	50%

Source: Land Transport Authority, 'Vehicle Ownership' (4 April 2012) *Singapore Government* <http://www.lta.gov.sg/content/lta/en/motoring/vehicle_ownership/vehicle_tax_structure/private_company_rentaltuitioncars.html>.

[357] Bradbrook, above n 238, 7.
[358] Ibid.

The Australian rules on vehicle inspection are different for each state, with vehicle inspections occurring mainly on registration, if cited for safety faults by police, if previously written off and re-registered, if transferred from interstate or if re-registered after a previous registration had expired.

There is a need for the Australian government to set a policy on vehicle retirement or inspection, so that the vehicle fleet in Australia remains fuel-efficient and safe. Once again, the policy on vehicle retirement and inspection can be combined with a LET, as discussed in Chapter 6.

4.7 CONCLUSION

This chapter addressed the third research objective of the thesis which is to examine tax policies and legislative options used by other countries that promote energy efficiency of passenger motor vehicles and influence the choice of passenger transportation. This chapter also provides information that addresses the second research question: What are realistic tax measures that can be implemented to reform design, choice and usage of motor vehicles for personal transportation in Australia? This is further explored in Chapter 6 of this thesis.

It is submitted in this thesis that a multiple-pronged approach is required in Australia through the use of regulatory and fiscal measures to reduce passenger motor vehicle oil use, and that these measures should be directed at both the manufacturers and the consumers. The reason for this is that it is not clear whether the manufacturers are simply supplying the consumer demand for large and powerful vehicles, or acting as the catalyst that drives the consumer demand. In reality it may be a mixture of both. Whether it is the manufacturers or the consumers, the government in Australia has a vital role to play in enacting legislation and regulations to control the consumption of oil in passenger motor vehicles. Moreover, the law should impose obligations on all parties — manufacturers, importers and consumers — in order to reduce the use of oil in passenger motor vehicles.

The Henry Tax Review in Australia commented that the current transport taxes in Australia are unlikely to meet Australia's future transport challenges. The Report to the Treasurer stated that the existing structure of fuel tax, annual registration and other road-related taxes is primarily designed to raise revenue. These taxes more than cover the direct costs of providing road infrastructure, but are not capable of providing specific prices that vary according to location or time of use. The Report also outlined as a principle for road transport taxes that transport-specific taxes should only be imposed where they improve the way that people, businesses and governments make decisions.[359]

The current taxation arrangements in Australia pertaining to passenger motor vehicles and fuel should be reformed from just being revenue raisers by incorporating principles that encourage behaviour change leading to a reduction in the use of oil in passenger motor vehicles. These principles should also be reflected in the setting of fuel economy standards and consumer awareness programs. The government of Australia should lead its people by making appropriate policy decisions and not just seek to raise revenue from its people.

Taking into consideration the regulatory and fiscal measures and the demand management programs implemented in various countries as discussed in this chapter, Chapter 6 addresses the fourth research objective stated in Chapter 1, ie the Australian tax policy reform and other regulatory reforms required to reduce the use of oil in passenger motor vehicles by utilising the lessons learnt from other countries. To assist in addressing the tax policy reforms in Australia, a detailed analysis of innovative tax reform exercises conducted in three jurisdictions, Norway, the Netherlands and the State of Oregon, is undertaken in Chapter 5.

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[359] Commonwealth of Australia, above n 293.

CHAPTER 5: CASE STUDIES

5.1 INTRODUCTION

As stated before, Australia needs to reduce the consumption of oil in passenger motor vehicles. This thesis explores various options for achieving this in Chapter 6 and proposes a framework for the design of the LET that aims to influence a person in choosing an appropriate motor vehicle for his or her personal transportation needs, while taking into consideration the vehicle's potential environmental impact. A case study of the motor vehicle taxes proposed or implemented in Norway, the Netherlands and the State of Oregon in the US was carried out to assist in developing the criteria for motor vehicle tax reform proposals and designing the LET for Australia.

These jurisdictions were chosen as they have either enacted unique motor vehicle or fuel taxation regimes or conducted parliamentary approved studies that involve innovative ways of taxing their motor vehicles and road user charges. The existence of motor vehicle tax studies sanctioned and funded by parliaments shows that these jurisdictions recognise the need to change the current way of taxing motor vehicles or road user charges, be it to influence consumer choices or just collect revenues. Although some of the studies, for example in the Netherlands, have been drawn out over a number of years resulting in the introduction of a bill into parliament, a lack of political will has resulted in an abandonment of their road user charge policy. However, lessons can be learnt for Australia from the innovative thinking applied in the studies conducted in these places, with the aim of bringing about change in motor vehicle taxation in order to reduce oil consumption and change the perception of passenger motor vehicles used for personal transportation.

Following this brief introduction, part 5.2 explores the motor vehicle taxation system in Norway. The studies undertaken in the Netherlands and Oregon are discussed in parts 5.3 and 5.4, followed by a short conclusion in part 5.5.

5.2 NORWAY

Norway was chosen as a case study because its government has implemented a unique motor vehicle taxation system. Norway's Government has long experience with environmental tax policy pertaining to the reduction of the use of oil in motor vehicles. Although Norway is an oil exporter, the Norwegian policy has been to reduce its own oil consumption. The New York Times reported in 2005 that no other major oil exporter has attempted to reduce its own fuel consumption with as much zeal as Norway. The political will in Norway is to keep the oil prices high in order to reduce consumption, and not succumb to critics like the Norwegian Automobile Association who have often called for a cut in the price of expensive gasoline. A radio announcer with the Norwegian Broadcasting Corporation, Torgald Sorli, has been quoted as saying that 'those critics are but voices in the wilderness ... We Norwegians are resigned to expensive gasoline. There is no political will to change the system.'[360] The Norwegian policies and Norway's strong political commitment have resulted in the country having one of the lowest car ownership rates in Europe, with more fuel-efficient Volkswagens and Peugeots on its roads compared with the big sports utility vehicles.[361]

Norway has an area of 323 759km^2 and in 2009 it had a population of 4 828 726 inhabitants with a passenger car population of 2 244 000 and 64 014 million kilometres of passenger-km by road. Compared with other European countries, Norway has the lowest number of passenger cars. Reported statistics reveal that at the end of 2003, there were 45 million passenger vehicles in Germany, 34.3 million in Italy, and only 1.89 million in Norway. During the period 1990 to 2003, the rate of increase of passenger cars, calculated per number of inhabitants, was the lowest in the Nordic countries, when compared with other European countries. Norway has a very low proportion of cars that are new, ie one to two years old,[362] and its transport infrastructure (roads, railways and airports) is also low compared with other European countries. In January 2005, Norway had 92 500 kilometres of public roads,

[360] Simon Romero, 'Oil-Rich Norway is Taxing on Cars' *The New York Times* (online), 30 April 2011 http://www.nytimes.com/2005/04/29/business/worldbusiness/29iht-norway.html.
[361] Ibid.
[362] Frode Brunvoll and Jan Monsrud, 'Transport and Communication: Transport' (Report No 2008/03, Statistics Norway, 12 April 2006) <http://www.ssb.no/transport_en/>.

74 400 kilometres of private roads and only 200 kilometres of motorways, the least among the Nordic countries.[363]

5.2.1 The History of Motor Vehicle Taxes in Norway

The history of Norway's motor vehicle taxation shows that, as early as 1959, it introduced a kilometre taxation system on diesel powered cars and trailers weighing over 2000kg. The tax rates were based on the distance covered and the weight of the vehicle. The rates increased regressively up to a certain weight and then increased progressively thereafter. In 1992, the rates ranged from NOK0.17 per kilometre for passenger vehicles and small delivery vans weighing under 2000kg to NOK1.58 per kilometre for heavier trucks. The kilometre tax was levied on vehicles of all nationalities, except Germany, France, Spain and Italy, with whom Norway had a bilateral treaty. In 1987, the Norwegian Government set up a working group to consider the discontinuance of the kilometre tax and to examine alternative taxation systems as the Norwegian transport companies were put at a disadvantage by Norway having to relinquish its requirement for certain other countries to pay kilometre tax. On the basis of the recommendations from the working group on the discontinuance of the kilometre tax, the Norwegian Government proposed to replace the kilometre tax effective from 1 January 1993 with an additional tax on diesel plus a weight-graduated annual tax on heavier vehicles, even though the kilometre tax was preferred by the Green Commission.[364]

The Norwegian Government commissioned several inquiries on the correct level of road user taxation. The Green Tax Commission was organised by the Norwegian Government in 1989 and the Commission examined the principles for imposing road user taxes. In the final report to the Minister of Finance in 1992, the Commission's report argued that environmental taxation should include a kilometre tax based upon the distance travelled as well as vehicle characteristics, and preferred a kilometre tax

[363] Ibid.
[364] Cavelle Creightney, 'Road User Taxation in Selected OECD Countries' (SSATP Working Paper No 3, Sub–Saharan Africa Transport Policy Program, World Bank and Economic Commission for Africa, August 1993) 80.

and a fuel tax.[365] The principles upon which these recommendations were made included:

- The kilometre tax was felt to be the best instrument for charging several types of environmental costs since it was based upon the distance travelled as well as vehicle characteristics;
- Fuel taxes were more appropriate where the environmental problems varied with fuel consumption;
- Fuel taxes became less appropriate where environmental damage varied with time and space;
- Fuel taxes became less effective in recovering costs when the discharge per consumed unit of fuel varied among different types of vehicles;
- Fuel taxes did not provide incentives for choosing more environmentally-friendly vehicles;
- To provide incentives for environmentally-friendly vehicles, fuel taxes should be combined with other instruments such as a differentiation of fixed road use according to vehicle characteristics.[366]

In spite of the recommendations by the Green Tax Commission that the kilometre tax was the best instrument for charging environmental costs, Norway abandoned it as part of the EC harmonisation of commercial vehicle taxes. The kilometre tax in Norway was an attempt to improve the link between road use and road taxes, to act as an explicit tariff for roads, and to promote efficiency by presenting users with the costs of road use.[367]

5.2.2 The Current Motor Vehicle Taxes in Norway

Norway has implemented two main categories of transport taxes: fuel and vehicle taxes as summarised in Table 5.1.

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[365] Ibid 78.
[366] Ibid 83.
[367] Ibid.

TABLE 5.1: Summary of Fuel and Vehicle Taxes in Norway

Category of Tax	Rate in 2010	Rate in 2011
Fuel Taxes		
Road usage tax on petrol, NOK/litre	4.54	4.62
Road usage tax on diesel - fossil	3.56	3.62
Road usage tax on diesel – biodiesel	1.78	1.81
CO_2 tax on petrol, NOK/litre	0.86	0.88
Motor Vehicle Taxes		
Motor Vehicle Registration Tax Passenger Cars		
Weight tax, NOK/kg		
Initial 1150kg	35.67	36.31
Next 250kg	77.74	79.14
Next 100kg	155.51	158.31
Remainder	180.85	184.11
Motor effect tax, NOK/kW		
Initial 65kW	55.10	0
Next 25kW	481.00	466.00
Next 40kW	1297.33	1320.68
Remainder	2702.77	2751.42
CO_2-emissions, NOK per grams/km		
Initial 115g/km	0	0
Next 20g/km	725.00	738.00
Next 40g/km	731.00	744.00
Next 70g/km	1704.00	1735.00
Remainder	2735.00	2784.00
Annual tax on motor vehicles, NOK/year		
Vehicles with factory installed particle filter	2790.00	2840.00
Diesel vehicles without factory installed filter	3245.00	3305.00
Annual weight-based tax, NOK/year	varies	varies
Re-registration tax	varies	varies

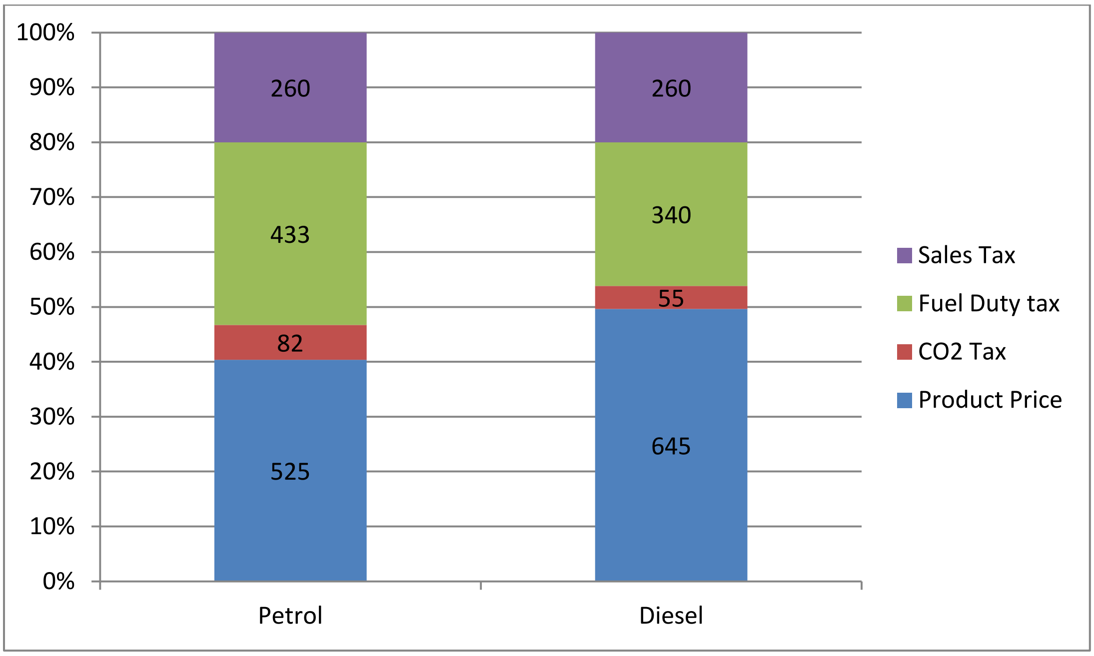
Source: Ministry of Finance Norway 2011 Budget[368]

[368] Ministry of Finance, *Budget 2011* (12 January 2011) Ministry of Finance <http://www.statsbudsjettet.no/english> 17–18.

a. Fuel Taxes

Fuel taxes in Norway are paid per litre of fuel and the rate is the same throughout the country. A motor vehicle that consumes more fuel due to being driven more or being energy inefficient attracts more fuel tax. Therefore the fuel taxes in Norway indirectly reflect the number of kilometres the vehicle has driven and the energy efficiency of the vehicle in question. Since 1991, Norway has also taxed the CO_2 component in the fuel. The fuel taxes on petrol and diesel are intended to price external costs related to car use. Norway has a policy favouring business activities that use diesel vehicles, and therefore the tax on diesel is lower than the tax on petrol, even though the external costs of using diesel have been estimated to be higher than petrol.[369] Figure 5.1 shows the gasoline and diesel prices as at 1 July 2008, indicating the product price, the CO_2 tax, fuel duty tax and sales tax.

FIGURE 5.1: Fuel Prices and Taxes in NOK as at 1 July 2008



Source: Norwegian Automobile Association[370]

[369] Tone Austestad, Ministry of Transport and Communications, 'Fostering Sustainable Urban Travel in Norway: New Urban Organization Models, Incentive Based Funding and Car Taxation' (Paper presented at ECMT-USDOT Workshop on Fostering Successful Implementation of Sustainable Urban Travel Policies, Washington DC, 5–7 November 2003) 17.

[370] Norwegian Automobile Association, *Fuel Taxes* (2008) Norwegian Automobile Federation <http://www.naf.no/en/>.

b. Vehicle Taxes

Vehicle taxes in Norway are associated with the purchase or ownership of vehicles and the tax base is a technical variable related to the vehicle. The vehicle tax depends less on usage than fuel taxes, and the tax bases are independent of kilometres driven. The vehicle taxes affect the price of the vehicle and the composition of the vehicle fleet. Norway imposes four motor vehicle taxes: purchase tax, annual tax, annual weight-based tax and re-registration tax.[371]

c. The Purchase Tax

Norway has a unique purchase tax system. The purchase tax was introduced as a pure fiscal tax, but it now depends progressively on weight, engine volume, engine power and CO_2 emissions. The tax encourages Norwegians to purchase smaller and lighter motor vehicles with lower the CO_2 emissions.[372] As demonstrated in Chapter 4, the purchase tax is quite high; if a Holden VE was purchased in Norway, the registration tax on purchase would be NOK434 999 which is equivalent to AUD79 078. A break-down of the tax shows the Norwegian Government's policy behind it.

The government has focused on each component of the purchase Tax — the unladen weight, the engine rating, and the CO_2 emissions — by setting a progressive rate on each component. This is demonstrated by using the Holden VE's specifications, which are: unladen weight: 1700kg; engine power output: 180Kw; and CO_2 emissions: 217g/km. The unladen weight of 1700kg attracts a tax of NOK114 195 which is equivalent to AUD20 762. This is based on the 2011 tax rates as shown in Table 5.2.

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[371] Tone Austestad/Ministry of Transport and Communications, above n 369, 16.
[372] Ibid.

TABLE 5.2: Unladen Weight Component of Purchase Registration Tax

Vehicle Weight	2011 Tax Rates in NOK	Tax in NOK
First 1150kg	36.31	41 756
Next 250kg	79.14	19 785
Next 100kg	158.31	15 831
Remainder 200kg	184.11	36 822
Total 1700kg		**114 194**

This demonstrates the policy in Norway that heavier vehicles pay more tax, which means the government encourages Norwegians to purchase lighter motor vehicles, thereby also having an impact on oil consumption. The power output of a motor vehicle's engine also plays a part in the consumption of oil. Thus the purchase tax is likely to discourage motor vehicles with an engine rating of more than 65kW. The engine power output of a Holden VE is 180kW and this would attract a purchase tax of NOK202 048 which amounts to about AUD36 736 as shown in Table 5.3.

TABLE 5.3: Engine Rating Component of Purchase Tax

Engine Capacity	2011 Tax Rates in NOK	Tax in NOK
Initial 65kW	0	0
Next 25kW	466.00	11 650
Next 40kW	1320.68	52 827
Remainder 50kW	2751.42	13 7571
TOTAL 180kW		**202 048**

The Norwegian policy also hopes to reduce motor vehicle CO_2 emissions and for that reason includes a CO_2 emissions factor in the purchase tax. If the CO_2 emissions data is not available, then the cylinder volume is used in calculating the tax, however, since 1 January 2008 this is no longer done. If motor vehicles do not have the required documentation for calculating fuel consumption based on CO_2 emissions, then the road authorities calculate the tax. The Holden VE's CO_2 rating is 217g/km, so based on this figure it would attract a purchase tax of NOK117 390, which amounts to AUD21 343 as demonstrated in Table 5.4.

TABLE 5.4: CO_2 Rating Component of Purchase Tax

CO_2 Rating	2011 Tax Rates in NOK	Tax in NOK
Initial 115g/km	0	0
Next 20g/km	738.00	14 760
Next 40g/km	744.00	29 760
Remainder 42g/km	1735.00	72 870
TOTAL 217g/km		**117 390**

d. Annual Taxes

It is not only the initial purchase of the motor vehicles that attracts taxes; Norway also imposes the following annual taxes throughout the ownership period of the motor vehicle: the annual tax; the annual weight-based tax; and the re-registration tax.

The annual tax was also introduced to raise public revenue. It is levied at four different rates on vehicles weighing up to 12 US tons (10.8862 tonnes), with the highest rate applied to passenger vehicles.[373] The annual weight-based tax is levied on vehicles with a total weight of more than 12 US tons (10.8862 tonnes) and consists of a weight-graded annual tax and an environmental-differentiated annual tax. The weight grading system is to account for the road wear and tear. It has an environmental aspect and imposes an additional charge on diesel vehicles depending on the EU emission standards.[374]

The re-registration tax is purely fiscal and is intended to cover costs related to re-registration.

[373] Ibid.
[374] Ibid.

e. Norwegian Tolls

In addition to fuel and motor vehicle taxes, Norway also uses tolls as a financial instrument to fund their main road projects. There are rings in three major cities, Oslo, Trondheim and Bergen. Due to Norway's topography, road-building is a very expensive exercise. Norway has a number of fjord crossings and tunnel projects with substantial construction costs, and toll financing supplements the government constrained funding, enabling projects to be implemented earlier than would be the case if they relied on government funding alone.[375]

Thus the toll systems in major Norwegian cities have been used as a solution to the infrastructure crisis that prevailed in the 1980s. Since the 1980s, tolls have emerged almost everywhere in Norway, in the cities, on inner-urban roads and on trunk roads serving smaller communities.[376] In January 1986, the first toll ring was opened in Bergen, the second-largest city in Norway. The experience from the Bergen ring made way for the Oslo ring in 1990 and the Trondheim ring in 1992.[377]

Norway's toll system has been successful due to its organisational framework, and lessons can be drawn from this. The framework involves the local community, local authorities and private interests, as well as the government through the Ministry of Transport. Projects commence with local initiative, but the National Public Road Administration (NPRA) is responsible for the planning, construction, maintenance and building of roads and toll collection facilities. A two-step political process is followed in the planning process, ie the principal acceptance of toll financing and the approval of the financing scheme by the Norwegian parliament.[378] Toll financing is usually a mixture of private and public funding and loan capital, where local authorities guarantee the loans. A non-profit limited liability company is then responsible for the toll collections. The Ministry of Transport, Public Works and Water Management establishes the operating regulations, including the toll charges and discounts. Usually the local authorities affected by the road construction control the toll company as owners.

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[375] James Odeck and Svein Bråthen, 'Toll Financing in Norway: The Success, the Failures and Perspectives for the Future' (2002) 9 *Transport Policy* 254.
[376] Ibid.
[377] James Odeck and Svein Bråthen, 'On Public Attitudes Toward Implementation of Toll Roads – The Case of Oslo Toll Ring' (1997) 4(2) *Transport Policy* 73.
[378] Odeck and Bråthen, above n 375, 254.

Since the toll projects commence with local initiatives and are used to finance the toll construction costs, public attitudes towards the toll payments are positive. Moreover, the tollbooths have been removed in certain areas after the roads are paid for. This strong connection between user payments and perceived benefits increases public confidence. In most other countries, tolls are used for traffic demand management purposes and the attitude towards the payment of tolls is negative. It has been argued that the reason for public resistance against road pricing schemes may be that people expect to be charged for things they wish to acquire and not the things they want to avoid, ie congestion.[379]

Since the Norwegians are used to the toll system, the question that is being debated is whether the current toll rings in the congested Norwegian cities should be transformed to resolve environmental problems such as congestion. Congestion imposes a major social cost on society, and it has been argued that the current tolls should be transformed into a congestion pricing scheme in order to improve the environment. Surveys carried out in Norway indicate a latent positive attitude towards using toll rings for traffic regulation purposes, eg congestion pricing.[380] It has been said that remarkable economic benefits may be gained by converting the cordon toll systems for road financing into congestion pricing schemes. This can succeed with sufficient public involvement and the establishment of an organisational framework.[381]

5.2.3 Lessons for Australia

Many lessons can be learnt from the case study on Norway's motor vehicle taxation system. Norway's government has recognised that although it currently has sufficient oil resources to export them, oil resources are not unlimited and therefore it has shaped its policies influencing environmental choices, especially in the reduction of motor vehicle oil consumption and CO_2 emissions. This recognition should be an important consideration for the Australian government in reforming its passenger motor vehicle taxation policies.

[379] Ibid 256.
[380] Odeck and Bråthen, above n 377, 78.
[381] Odeck and Bråthen, above n 375, 260.

Norway's government has shown political will in implementing its policies and fighting off criticism from organisations such as the Norwegian Automobile Association. Its fuel taxes and the motor vehicle taxes are among the highest in Europe and the effect of these taxes has been the lowest car ownership rates in Europe. Such a political will is also required in Australia in order to bring about the hard reforms highlighted in this thesis.

The Australian government should heed the foresight of the Norwegian government and its long history of funding studies on the imposition of appropriate road user charges. Since 1959, the Norwegian government has recognised the need for a user pays system to cover external marginal costs, namely road maintenance, congestion, capacity, accident and environment and had introduced the kilometre tax system for diesel-powered motor vehicles and trailers weighing over 2000kg. This policy indicates that the government was targeting consumer choice regarding the amount of road driving they undertake. Fuel taxes in Norway are quite high to deter unnecessary driving. There is also a small CO_2 component and a further NOx component added in 2012 in Norwegian fuel taxes, in order to educate the public about the environmental harm caused by excessive fuel use.

Norway's policy on purchase and ownership of vehicles is directed towards encouraging the purchase of small, light, compact vehicles as opposed to large-engined sport utility vehicles. The purchase tax prompts Norwegians to consider the vehicle weight, engine power and CO_2 emissions, as tax rates increase on a sliding scale corresponding to an increase in each of these factors. Moreover, the purchase taxes are quite high, influencing Norwegian motorists in their motor vehicle purchase decisions. These factors have an impact on oil consumption and CO_2 emissions, as Norwegians are encouraged to choose vehicles that consume less oil and emit less CO_2. Norway's annual weight-based tax also discourages ownership of heavy vehicles that consume more fuel. The Australian motor vehicle taxation policy needs to be based on similarly defined principles, rather than just being used for raising revenue.

Norway's unique motor vehicle taxes, ie the fuel tax, purchase taxes and annual ownership taxes are uniform throughout the country and not based on states or provinces. This removes any complexity in bringing about changes to the system.

Similarly, Australia's federal and state taxes relating to passenger motor vehicles need to be considered together in order for reforms to be effective.

The organisational design of Norway's toll system is also unique as it commences with a local initiative and the toll payments are classified as perceived benefits. A positive public attitude has allowed the Norwegian government to overcome its topography problem by extensively using tolls to finance the expensive exercise of building roads. This is an important lesson for Australia as public acceptance is the key to successful reforms.

The main drawback of the Norwegian system is that although the unique purchase tax discourages the purchase of heavy and powerful motor vehicles, the same characteristics are not reflected in the fuel tax. The fuel tax does not directly reflect the motor vehicle characteristics recognised in the purchase tax, as the fuel price is the same for all vehicles. There is therefore no incentive for owners of heavy and powerful motor vehicles to reduce the number of kilometres they drive in those vehicles; the fuel tax does not impose a penalty for using a heavier, more powerful vehicle that emits more CO_2. If government policy were to focus on preserving the limited global oil resource by encouraging the purchase and use of small and light motor vehicles, then the factors that the Norwegian Government has included in the purchase tax should also be reflected in the other costs throughout the ownership of the vehicle, ie in the fuel costs, annual registration charges and the costs of vehicle disposal.

5.3 THE NETHERLANDS

The Netherlands has been chosen as a case study following the Dutch cabinet's attempt to introduce new and unique principles for road pricing in the Netherlands not implemented anywhere else. The principles involved were:

- The motorist pays for using the car instead of owning the car;
- The charges occur for use of the car throughout the Netherlands, even if driving does not occur on roads;

- A basic rate per kilometre is set, differentiated according to environmental characteristics (CO_2) in consultation with the stakeholders;
- A rush-hour surcharge applies for busy times and places;
- The system uses satellite technology;
- Fixed motor taxes abolished, ie motor vehicle tax, provincial surcharges and purchase tax; and
- The revenue from the road pricing goes to the Infrastructure Fund for road maintenance and construction of new roads and improving public transport.[382]

5.3.1 The Situation Prior to the Intended Kilometre Charge Regime

With the increasing number of motor vehicles on Dutch roads, the Dutch government has been concerned about mobility and congestion and wished to implement a national road pricing network where charges would vary by driving distance, location and environmental factors, such as emissions and vehicle size.[383] The mission of the government was to replace the existing transportation taxes and fees with a new national road pricing program that covered 134 000 kilometres of roads and over eight million vehicles, with the resulting revenue to support the economy. The scheme would help minimise road congestion, address environmental concerns and result in a more equitable distribution of costs.[384]

In 2001, the Dutch government initiated the process to convert fixed government charges on motor vehicles to a payment per kilometre charge. The Dutch Cabinet notified the Lower House of Parliament of its position on kilometre charges (Parliament Documents II 27 455, no 6).[385] A progress report on the pay per kilometre charge together with the Kilometre Charge Bill was sent to the Council of

[382] Ministerie van Verkeer en Waterstaat, 'Road Pricing in the Netherlands: Lessons Learned' (Presentation, 21 April 2010) 7.
[383] Petrouschka Werther, 'Kilometer Pricing in the Netherlands' (Project Notes, Ministry of Transport, Public Works and Water Management, 2009).
[384] Ibid.
[385] Ministry of Transport, Public Works and Water Management, 'Pay Per Kilometre Progress Report' (Dutch National Traffic and Transport Plan (Nationaal Verkeers- en Vervoersplan), November 2001).

State in 2002. Seven years later in November 2009 the Cabinet in the Netherlands decided to introduce the kilometre charge, with charges of three euro cents per kilometre in 2012, rising to 6.7 cents in 2018.[386] However, the Bill required the approval of the Dutch Parliament before it could be implemented and this did not occur.

Prior to 2002, there were three components in the Dutch system for taxing motor vehicles:

1. A fixed charge on new cars referred to as BPM (45 per cent of net price less deduction depending on type of fuel);
2. An annual charge for every car owner referred to as MRB (depending on the weight of vehicle, to be paid each quarter);
3. Fuel tax (the only variable component depending on the use of the vehicle).

Similarly to Norway, Dutch motor vehicle taxes are premised on charging principles. The existing vehicle taxes in the Netherlands consist of eight charging principles, aimed at achieving fiscal and non-fiscal objectives. The principles are: weight, fuel type, emissions, quantity of fuel, fuel consumption, catalogue price, type of vehicle and province. The proposed new kilometre charge system in the Netherlands was premised on the use of motor vehicles instead of ownership, and encompassed only six charging principles, being distances, weight, fuel type, vehicle type, emissions and province.[387]

5.3.2 The Abandoned Kilometre Charge System

The Dutch government intended to abolish fixed motor taxes, ie motor vehicle tax, provincial surcharges and the purchase tax, and replace these taxes with a basic rate per kilometre of driving. There was room for this rate to be differentiated according to environmental characteristics (CO_2) and a rush hour surcharge for certain roads at busy times. Thus, two extra charging principles could be added to the new system – time and place. The payment was intended to capture the cost of driving throughout

[386] Ibid.
[387] Ibid 3.

the Netherlands, even if the driving did not occur on the roads in the Netherlands. The revenue from road pricing was intended to go the Infrastructure Fund to be used for the maintenance of infrastructure, new road construction and improvements to public transport. The system was meant to operate using satellite technology, in-vehicle tolling and GPS to locate vehicles on the road network.[388]

The Dutch government expected to implement a national road pricing program that covered 134 000 kilometres of roads and over 8 million vehicles and that would support the economy, minimise road congestion, address environmental concerns and result in a more equitable distribution of costs. The new system was meant to be revenue-neutral by replacing existing transportation taxes and fees, and it was expected to bring about a reduction of as much as 60 per cent of travel times during congested periods.[389]

There were a number of criteria that the kilometre charge had to satisfy, which were:

- The support of the people, organisations and the politicians. This was intended to be achieved through consultation and collaboration.
- The protection of road user privacy. This could be achieved by ensuring that only the information necessary for the collection of the kilometre charge was transmitted.
- The technological design to be reliable, fraud-proof and manageable at acceptable cost levels.
- The income to central government to remain the same. Thus the kilometre charge system was intended to be revenue-neutral.
- The replacement of fixed vehicle taxes, the euro vignette[390] and proportion of duties to be the primary objective, and differentiation of charges based on place and time to be secondary objectives.
- A goal of positive contribution to road safety.
- The development of open standards for the design of the mobimeter,[391] whereby various suppliers could produce and market them, thereby enhancing its technological development.

[388] Ministerie van Verkeer en Waterstaat, above n 382, 9.
[389] Werther, above n 383, 1.
[390] The euro vignette is a charge for driving on motorways for trucks of 12 tonnes and more.

- The effective and efficient management of the overall traffic infrastructure network on a permanent basis.
- Goods transport to be included in the system and comply with European regulations.
- Parliamentary approval by implementing legislation, giving the kilometre charge system a legal framework.[392]

The kilometre charge system would operate by making the licence holder of the vehicle liable for the payment of the kilometre tax, by requiring the licence holder to periodically declare the number of kilometres driven by the vehicle. To achieve this, it was intended that a special meter, called the mobimeter, would be fitted to the vehicle.[393]

The operation of the kilometre charge system required a new technical system to be developed for registering the number of kilometres driven. The 2001 Mobimeter report indicated that the various technical components to develop the kilometre charge system were already available on the market. The Dutch Cabinet gave approval for the development of the kilometre charge system that required the following:

- Policy development to determine rates and specifications for the development of equipment such as the mobimeter.
- The submission of the declaration by the registered holder, requiring the measurement of the kilometres driven, the calculation of the amount payable and transmission to the service provider.
- Development of rules for enforcement and supervision of the system.
- Development of equipment and software to enable the provision of additional services.
- Supervision of market action, privacy and implementation.

The development of a mobimeter was an essential step in the development of the kilometre charge system. The specified requirements of the mobimeter were that it

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[391] The mobimeter was intended to be an onboard vehicle unit fitted in the motor vehicle to record the mileage driven by the vehicle.
[392] Ministry of Transport, Public Works and Water Management, above n 385, 2.
[393] Ibid 3.

should not only collect the data for the kilometre charge, but the data collected must be stored and transmitted in a tamper-proof manner. The mobimeter should also calculate the charge to be paid. This would require the seller of the mobimeter to program into the mobimeter the rates for the locations where the kilometres were to be driven. Possible solutions included roadside beacons or the use of a global positioning system (GPS). The mobimeter would have to identify the road section where the vehicle had travelled and match the applicable rate to that route.

The mobimeter was intended to be secure and protect the privacy of the individual. The data gathered in the mobimeter was to be stored in a tamper-proof charge card installed in the mobimeter, similar to a SIM card in a mobile telephone. The system would operate by not allowing the vehicle to be driven without the mobimeter registering the trip on the charge card. The information recorded on the charge card also had to be tamper-proof to prevent fraud. The requirement was for the charge card to be developed in such a way that information, once recorded, could not be altered or deleted. To protect the privacy of the driver, it was necessary that the mobimeter only communicate through secure protocols with parties outside the vehicle.

From a motorist's perspective, the only task would have been for the driver to check that the mobimeter was functioning properly before the commencement of the journey, and to report a malfunctioning mobimeter to the service provider. The driver would not be aware of the calculations carried out inside the mobimeter, but would have been able to see at a glance the kilometre charge incurred for the journey. The mobimeter would have been required to automatically transmit information to the tax department periodically, eg once a month or after every 1000 kilometres driven. The registered holder would have received an overview of the kilometres driven and the associated kilometre charges. The details about each journey were to be kept securely in the mobimeter and not revealed to the service provider. This would have enabled the registered holder of the vehicle to check the assessment against the detailed information contained within the mobimeter, and if necessary appeal the charges imposed by the taxation office. Additional services provided to the driver by the service provider were to be separately invoiced to the registered holder.

The following issues were taken into consideration in designing the pay per kilometre system.[394]

a. Equity and Fairness

The key objective of the new system was to address the insufficient link between the costs and benefits to road users under the existing taxes based on vehicle purchase. Direct charges improve equity across users of the road network by charging those users who create congestion, and motivate investments. Under the new system, charges were intended to vary by vehicle type, allowing environmental costs to be recouped directly from polluting users.

b. Privacy

The use of onboard units (OBUs) such as the mobimeter through the GPS system highlighted concerns about privacy issues. The protection of the driver's privacy is an issue of importance throughout Europe. The European Union has issued Directive 95/46/EC for issues relating to the protection of individuals with regard to the processing of personal data and the free movement of such data. The functional requirement of the charging system had to comply with this directive.

c. Technology and Operation Cost

The kilometre program initiated an aggressive investigation of system design and costs that took advantage of extensive industry knowledge throughout Europe. The Dutch government required that the implementation costs of the kilometre charge system be lower than EUR3 billion and operating costs to be not more than five per cent of implementation cost. For the system to be credible, the invoices generated through the system were required to be at least 99 per cent accurate. The system was meant to be scalable and flexible to support state-wide implementation of a

[394] Werther , above n 383, 1.

multidimensional tariff structure, with technical trials scheduled to aid in the development of final system specifications.

d. Public Viability

Successful implementation of the system was premised on public viability with large-scale consultation with citizens and the private sector so as to extract the best information upon which to base key policy and design decisions. The Dutch Cabinet made decisions on how to implement the kilometre charge and the parties that would be responsible for undertaking the various tasks. The Government identified three clusters of tasks: Government tasks which belonged in the public domain; tasks to be subcontracted; and private tasks.[395]

The Cabinet decided that the kilometre charge was a form of taxation and therefore the Minister of Finance was required to be responsible for the collection of the tax. However the development and implementation phase would have been the joint responsibility of the Minister of Finance and the Minister of Transport, Public Works and Water Management. These ministers would have been responsible for supervising market action, privacy and performance of private service providers. The government would direct the process, but market contribution was considered essential.[396]

Tasks that could be subcontracted included the processing of declarations, sending out bills and carrying out the frontline settlement of customer reactions. These tasks were intended to be undertaken by service providers who would have been authorised and made responsible for developing and implementing reliable and safe communication through the mobimeter, using secure communication channels. The service providers would have been allowed to also factor in additional services such as traffic information, route selection, safety and breakdown services, weather conditions, road works, accidents, entertainment, business services such as dictating e-mails and instant messages, convenience services such as reserving and paying for parking or providing any information sought, eg where is the nearest pizza store.

[395] Ministry of Transport, Public Works and Water Management, above n 385, 10.
[396] Ibid 10–11.

These services would have acted as attraction points to lure customers, since each citizen would have been free to use the service provider of his or her choice.[397]

Private tasks were meant to involve the production, distribution and installation of certified mobimeters. These mobimeters were required to be developed within an open standard, which had the potential to become an international standard, similar to the Global Standard for Mobile Telephony (GSM). Private entrepreneurs would have developed the mobimeters, tested them and obtained certification.[398]

The implementation of the kilometre charge would only have been undertaken after thorough testing and trials. Alternatively, a full rehearsal would have been conducted using a number of volunteers in order to test the whole system.

A market orientation was conducted to determine the feasibility, risks, willingness to participate and conditions of participation amongst 30 potential suppliers of one or more components of the kilometre charge system. The market orientation in the Netherlands demonstrated a positive response concerning the feasibility of the kilometre charge system and the provision of additional services. However, the companies were seeking strong government commitment before investing in any supplies related to the kilometre charge system. The companies were not willing to bear the development risk alone.[399]

The cost of the kilometre charge project was estimated to be EUR5.6 billion, made up of an estimated EUR3.8 billion for implementing an OBU such as the mobimeter in each vehicle and EUR1.8 billion for establishing communication between the OBU and back office.

Conclusions derived from traffic studies in the short and long term indicated that the outcome of the new kilometre charge system would have been a decrease in the number of vehicle kilometres driven by seven to ten per cent, resulting in reduced congestion. This is because heavy road users would have been required to pay more under the new kilometre charge system. The number of vehicle hours per 24-hour period was likely to fall between 20 and 25 per cent, leading to a positive effect on

[397] Ibid 15.
[398] Ibid 12.
[399] Ibid 17.

safety and the quality of the living environment. Accident risk and emissions, particularly CO_2 and NOx, were predicted to fall by ten per cent. There would also have been a reduction of noise nuisance by 0.5DBA per 24 hour period. However the size of the vehicle fleet was unlikely to change.[400]

After nine years of effort in consultation, design and testing of the kilometre system, it was abandoned. On 11 March 2010, the new government of the Netherlands declared that the mobility project was controversial and therefore the project should be abandoned. However, lessons can still be drawn from the Dutch study on the kilometre charge system. The Ministry of Infrastructure and the Environment pointed out the elements necessary in order to successfully implement the kilometre charge project:

- Societal support is the key driver to the success of the project;
- It is imperative to weigh up political ambition versus realistic planning;
- The planning process needs to be thought through, ie whether it should it be parallel or serial;
- It is necessary to think backwards, ie the last step first – exploitation, expansion, testing, building and developing;
- It is necessary to incorporate corresponding stakeholders to carry out tasks;
- Define the basic principles for paying for use, revenue neutrality and refunding the revenues to the infrastructure fund; and
- Focus on the communication strategy with a clear message about why the system is necessary.[401]

5.3.3 Lessons for Australia

The first lesson that can be drawn from the Dutch case study is problem recognition. The problem of the unsustainability of passenger motor vehicles needs to be recognised, and it is recognition of the problem that will provide the drive to seek solutions. The seven year Dutch study involved innovative thinking on the part of the Dutch government and recognised the need to change the current policy pertaining to

[400] Ibid 6.
[401] Ministerie van Verkeer en Waterstaat, above n 382, 12.

the taxation of motor vehicles. The government of the Netherlands recognised that there is a problem with sustaining the current number of motor vehicles on Dutch roads, and intended to use taxation as a tool to influence the Dutch people in changing their travel behaviour. The purpose of changing over to the kilometre charge system was to minimise road congestion and address environmental concerns. The system was expected to bring about a reduction of 60 per cent in travel time, which would mean a reduction in fuel consumption and other social costs, including the use of oil in passenger motor vehicles.

The Dutch policy was premised on the principle that increasing motoring costs per kilometre mitigates road traffic growth and thereby reduces congestion. Moreover, the pricing policy was intended to raise additional revenue that could be used to build additional infrastructure that would further assist in reducing congestion. Similarly, revenues generated from Australian motor vehicle taxation reform can also be set aside for much-needed improvements to the public transport infrastructure.

In the Netherlands, the effect of paying more per kilometre was an expected decrease in both commuter and leisure travel, and over time commuters would seek work and leisure activities closer to home. The kilometre charge was also expected to lead to reduced car journeys and an increase in the use of other modes of transport such as the rail.[402]

The indirect effect of the Dutch policy would have been upon the consumption of oil, especially by including vehicle weight in the charging principles. In addition, improvements in public transport would have led to a reduction in driving, further reducing the use of oil in motor vehicles.

The proposed Dutch kilometre charge system also had a number of shortcomings. It required the licence holder of the vehicle to become responsible for the payment of the kilometre tax by way of an invoice. The licence holder would receive a periodical bill, similar to a utility bill. This would have brought about a public outcry. Moreover, unpaid invoices would have given rise to enforcement proceedings, thereby imposing high costs of administration. In addition, the task of sending out bills and carrying out the front line settlement were intended to be undertaken by

[402] Ministry of Transport, Public Works and Water Management, above n 35, 5.

service providers, and the service providers would have been reluctant to invest in such a business without a guarantee of returns. The design of the new LET system in Australia in Chapter 6 should avoid these shortcomings.

The kilometre charge system was premised on the development of the mobimeter, and it was left in the hands of the market to develop a business model. This may not have successfully occurred without government commitment, as entrepreneurs would have been unwilling to bear the development risks alone. The mobimeter was expected to operate under open standards similar to the GSM and these standards were expected to be developed by the market. Setting standards such as the GSM involves a commitment of time, effort and money into research and development, and there would be a time lag of several years between research and system development. There would be disagreements amongst entrepreneurs in the criteria for the framework of such standards, leading to problems finding a consensus.

The design of the kilometre system in the Netherlands did not have any provisions for charging foreign vehicles for using Dutch roads, as it would not be possible to expect foreign vehicles to have a mobimeter installed.

The Dutch study identified three clusters of tasks – government tasks, subcontracted tasks and private tasks – and that it would cost EUR5.6 billion for the project. However, the study did not identify how the funding for the full system in operation would be obtained, including the means of paying for the use of the system, revenue neutrality and refunding the revenues to the infrastructure fund. Thus the lesson for Australia is to ensure that appropriate impact studies are conducted as part of the reform process.

Effective reform requires involvement of all interested parties. The Dutch study did not mention the involvement of motor vehicle manufacturers who were likely to have a vested interest in developing accessories for their vehicles, however, it indicated the involvement of new players in developing information technology, tax collection and designing the network. The new players from the market would only show a commitment to be involved if there was a financial incentive to do so.

The abandoned kilometre charge system in the Netherlands only focused on the user pays principle with regard to driving the vehicle. It had no focus on influencing the choice of vehicle in order to reduce oil consumption. and thus had no provisions for influencing the types of motor vehicles to be driven on Dutch roads. A comprehensive reform is likely to bring about a better policy outcome than patched-up reforms. Therefore the lesson for Australia is to examine comprehensively the motor vehicle taxation regime in order to draw up the principles for reform.

Although the kilometre charge system was not implemented in the Netherlands, many lessons can be learnt from the study for Australia, including the fact that without a strong political will, long-term planning in the area of motor vehicle taxation and road user charges, although necessary, may not be achievable.

5.4 OREGON

The state of Oregon in the United States has played a leading role in igniting a national debate on the future of transportation funding in the 21st century. There is a current debate in the United States about the need to supplement or replace the current fuels tax that funds federal and state roads. The Executive Director of the American Association of State Highway and Transportation Officials (AASHTO) testified on behalf of the Departments of Transportation from the 50 American states at the National Surface Transportation Policy and Revenue Study Commission in March 2007 that the federal highway program in the United States faces a funding crisis and a large increase in gasoline tax rates would be required to sustain the program.[403] He also commented that the Oregon study on the mileage-based fee system could be an alternative means of resolving the funding crisis, and urged congress to fund additional pilots and studies so that by 2021 enough research has been conducted on how a Vehicle Miles Travelled user fee can best be configured to supplement or replace the cents per gallon fuels tax by 2025. He emphasised that it would be desirable if consensus could be reached between the states and the federal

[403] National Surface Transportation Policy Revenue Study Commission, ‘Improving the Performance of the Surface Transportation System: Revenue Options’ (Testimony of John Horsley, Executive Director American Association of State Highway and Transportation Officials, 19 March 2007) 2–6.

government about which system to adopt, so that US motorists will only have to adjust to one approach at the pump.[404]

This part examines the alternative approach taken in the Oregon study, so that lessons can be drawn for Australia in designing the LET. It is divided into seven parts. Part one identifies the problem Oregon faces with its fuel taxes. To find solutions to the problem, Oregon's Legislative Assembly appointed a Road User Fee Task Force and mandated it with the mission 'to develop a design for revenue collection for Oregon's roads and highways that will replace the current system for revenue collection.'[405] This is discussed in part 5.4.2. Part 5.4.3 explores the Road User Fee Task Force proceedings with a detailed discussion of the mileage fee concept. Part 5.4.4 examines the strategy to move the mileage fee concept to the design framework. The results of Oregon's Road User Fee pilot program are discussed in part 5.4.5 followed by critical analysis and pathway to implementation of the program in part 5.4.6. Finally, part 5.4.7 draws out lessons for Australia.

5.4.1 Identification of the Oregon Problem with Fuel Taxes

The fuel sold in Oregon attracts both federal and state gas taxes; the current rate is 48.4 cents per gallon, being 30 cents for the state tax and 18.4 cents for the federal tax. The state gas tax rate for Oregon was 24 cents a gallon from 1993 until 2009, when it was increased by six cents to 30 cents per gallon. The federal gas tax rate was last raised in 1993 and is not indexed to inflation. The problem Oregon is faced with is that with no voter support to increase the fuel tax, it is viewed as a declining revenue source to fund Oregon's road system.

The report of the National Surface Transportation Infrastructure Financing Commission established by US Congress states that from 1980 to 2006, the total number of miles travelled by motor vehicles increased by 97 per cent, whereas the total number of highway lane miles grew by only 4.4 per cent over the same

[404] Ibid 10.
[405] House Bill 3946, 2001 (71st Oregon Legislative Assembly) s 2 (2).

period.[406] The Commission's report states that the federal Highway Trust Fund faces a near-term insolvency crisis, and the problem will worsen with reduced federal motor fuel tax revenues.[407] The Commission recommended a transition from a fuel tax-based system to one based more directly on use of the highway system measured by miles driven.[408]

The Oregon highway system has also not grown quickly enough to meet the needs of Oregon's motoring population. In 1960, Oregonians drove 4.9 billion miles on 18 478 lane miles of the state highway system. Forty years later, in 2000, Oregonians' driving has quadrupled to 20.5 billion miles, but the number of lane miles in the state highway system has increased by only 4 percent, to 19 200 lane miles.[409]

Oregon fuel tax revenue is expected to decline further as Oregonians are likely to have a reduced need for fuel due to a number of reasons: increase in the hybrid electric vehicle population; increase in price of oil as more expensive oil extraction technologies are employed; or a shift into the use of alternative fuels.[410] It is this problem, together with the fact that a long lead time is necessary to bring about any change, that has provided the state of Oregon with the impetus to investigate a new revenue system for road funding.

In 2001, Oregon commenced a government-backed study into replacing Oregon's gas tax with a mileage tax. The final report of Oregon's Mileage Fee Concept and the Road User Fee Pilot Program was released by the Oregon Department of Transport (ODOT) in November 2007. The report states that the current gas tax system in Oregon has the inherent flaw of not having a direct nexus to road use. Oregon's Constitution mandates this nexus to determine the funding allocation for its roads. It

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406 National Surface Transportation Infrastructure Financing Commission, 'Paying Our Way: A New Framework for Transportation Finance' (Executive Summary Report, 21 February 2009) <http://financecommission.dot.gov> 1.
407 Ibid 2.
408 Ibid 12.
409 Oregon Department of Transportation, 'Road User Fee Task Force Report to the 72nd Oregon Legislative Assembly On Possible Alternatives to the Current System of Taxing Highway Use through Motor Vehicle Fuel Taxes' (Report, March 2003) 13.
410 Ibid 15.

is anticipated that in 10 to 15 years, the gas tax will have failed its original intended purpose of being a reliable source of revenue for the state's road system.[411]

The advantages and disadvantages of the gas tax as identified by ODOT are stated in Table 5.5.

TABLE 5.5: Advantages and Disadvantages of the Gas Tax in Oregon

Advantages	Disadvantages
Raises substantial revenue, ie 60% of road revenue in 2007	Not directly connected to the burden the vehicle places on the highway system
Ease of payment by consumer as part of the fuel bill	Vehicle fuel efficiency improvements result in reduced tax payments per vehicle mile travelled
Ease of collection within the commercial transaction from the distributor	
Easy to administer as the tax is collected by a small number of distributors	
Low cost of administration	
Minimal evasion potential	
Protects privacy as consumer is not revealed	
Minimal burden on retail businesses	

Source: Oregon's Mileage Fee Concept and Road User Fee Pilot Program

Although the Oregon mileage fee concept is premised on a funding crisis for their highway system and not aimed at reducing oil use or emissions, the study is still important for this thesis in designing the LET principles, as lessons can be drawn from the manner in which decisions were made, and the work and the time involved in bringing about a change in Oregon's fuel tax system.

[411] Oregon Department of Transportation, 'Oregon's Mileage Fee Concept and Road User Fee Pilot Program Final Report' (Final Report, Oregon Department of Transport, November 2007) 4.

5.4.2 The Mission Statement and Formation of the Road User Fee Task Force

The Oregon Legislative Assembly enacted a House Bill to create a Task Force to conduct the mileage fee study. The aim of the Task Force was to develop and design a revenue collection system for Oregon's roads and highways, being an alternative to motor fuel taxes, on the basis that an efficient transport system is critical for Oregon's quality of life and the revenues available for highways and local roads are inadequate to preserve and maintain existing infrastructure, reduce congestion and improve service. The current gas tax in Oregon is anticipated to become a less effective mechanism for meeting its long-term revenue needs as cars become more fuel efficient and alternative sources of fuel are identified, and there is no direct relationship between the gas tax and the use of roads and highways.[412]

The Task Force in Oregon had the approval of its government. It comprised 12 members who were appointed for a term of four years as follows: two members appointed from the House of Representatives and appointed by the Speaker of the House of Representatives; another two members from the Senate, appointed by the President of the Senate; four members appointed by the Governor, the Speaker and the President acting jointly from representatives of the telecommunications industry, the highway user group, the Oregon transportation research community and the national research and policy-making bodies; one member to be an elected city official; one member to be an elected county official and two members from the Oregon Transport Commission.[413]

The purpose of the Task Force as stated by the Oregon Legislative Assembly was to study alternatives to the current taxation of highway use through motor vehicle fuel taxes. The Task Force was commissioned to gather public comments and make recommendations to the Department of Transportation and the Transport Commission on the design, evaluation and implementation of pilot programs. It was required to report to the Legislative Assembly on its work at each regular session.

[412] Alternatives to Motor Vehicle Fuel Taxes, 71st Oregon Legislative Assembly – 2001 Regular Session, House Bill 3946 (March 2003) Appendix A, 1.
[413] Ibid 2.

Any official action by the Task Force required the approval of the majority of the Task Force members.

5.4.3 Proceedings of the Road User Fee Task Force and the Mileage Fee Concept – March 2003

The proceedings of the of the Road User Fee Task Force mileage fee concept, including the criteria to develop the mileage fee concept, the issues in designing the mileage fee concept and the various options or scenarios in collecting the fee, are examined in detail in this part, as they highlight the areas that would need to be examined in developing the LET concept in Chapter 6.

The Road User Fee Task Force held eight meetings from 30 November 2001 to 15 November 2002. During these meetings, the Task Force adopted a public outreach process and received comments from a number of stakeholders.[414] The Task Force released its first report to the 72nd Oregon Legislative Assembly in March 2003. The report described a new vision of the mileage fee concept being a distance-travelled charge based on the amount a vehicle owner/operator uses the road system, and recommended the criteria for developing the mileage fee concept including the critical issues to be resolved in designing the mileage fee. The Task Force commissioned research consultants from the Oregon State University (OSU) and Portland State University (PSU) to develop scenarios for collection of the mileage fee.

The Task Force recommended that the configuration of a mileage fee should be developed according to the following criteria:

- **Accuracy:** The configuration of any mileage fee mechanism should facilitate accurate determination of distance travelled.
- **Reliability, Security and Technological Feasibility:** The technology used for a mileage fee must be reliable, secure and technologically feasible.
- **Minimal Evasion Potential:** The configuration of any mileage fee mechanism should allow minimal opportunities for evasion or fraud.

[414] Oregon Department of Transportation, above n 409, 19.

- **No Charge for Mileage outside Oregon:** The mileage fee should be state-based and not apply to mileage travelled by Oregonians outside the borders of Oregon.
- **Minimal Burden on Private Sector:** The capital expenditures and the costs of collection for a mileage fee should minimally burden the private sector.
- **Retrofitting Affordability:** Any retrofitting of new technology into older vehicles should be affordable.
- **Seamless Transition:** Transition to a mileage fee should be essentially seamless, with no more than an incidental loss of fuel tax revenue.
- **Privacy:** Oregonians must be assured that the technology used for any mileage fee is not used to violate the level of privacy expected by the general public.
- **Cost of Administration:** Operating costs for administration of a mileage fee should not be a substantial percentage of the revenue raised.[415]

It should be noted that such criteria will need to be examined for the LET in Chapter 6.

The Task Force recognised that several issues had to be resolved in designing a mileage fee.[416] Similar issues will also arise for the LET and will need to be resolved.

- **The technology:** The technology supporting the mileage fee must perform the following functions: Calculation of mileage travelled only within Oregon; data storage; data transmission; data processing and calculation of fee owed. According to the Task Force, the GPS device and the Audio Video Interleave (AVI) with odometer tag device, both combined with radio frequency mileage data transmission, offer the most functional and reliable technology upon which to base a mileage fee. The data recorded by the technology needs to be weighed against privacy. The Task Force recommended that only the summary mileage data should be transmitted and not the data on continuous vehicle locations, in order to provide a technological safeguard to Oregonians.

[415] Ibid 27.
[416] Ibid 28.

- **The expense of retrofitting:** The technology choice must be viewed in relation to its cost. The Task Force recognised that retrofitting GPS devices into every Oregon passenger vehicle was cost prohibitive over a short time frame and although the retrofitting of AVI devices is affordable, the AVI devices have a limited application. The Task Force concluded that retrofitting of odometer tag devices is more affordable than GPS.
- **Phasing:** The Task Force recommended that the mileage fee only apply to new or newly registered vehicles. This would entail a long phase-in period of about 20 years as a practical necessity. This implies that during the phase-in period, it would be necessary to retain both the fuel tax and the mileage fee. However, the owner or operator of a passenger motor vehicle in Oregon should not be assessed on both a fuel tax and a mileage fee without receiving a credit for one of them.
- **Public versus Private Administration:** The Task Force recommended a private fee collection mechanism as more likely to be cost effective and administratively efficient.

The aim of the Task Force was to come up with alternatives to gradually replace the current fuel tax system. Under the current fuel tax system, payments to the revenue authorities for the tax do not occur at the retail service station level but rather at the first point of wholesale distribution in the state (ie ‘at the rack’). Retail stations then reimburse the gasoline distributor, and the motorists in turn reimburse the retail stations. The current fuel tax system and the new mileage fee system would be required to operate together during the phase-in period, but without a duplication of charges. This was taken into consideration in the six mileage fee collection scenarios that were developed by research consultants from the Oregon State University (OSU) and Portland State University (PSU), each scenario being differentiated by mode of fee collection and payment as discussed below.

- **Scenario One:** Under this scenario, actual mileage data would be uploaded to a central data and fee collection centre for fee calculation and monthly billings to owners of passenger vehicles using Oregon’s road system. The user receives credit for gas tax paid.[417] The cost of an electronic odometer in

[417] Ibid Appendix O, 1.

the form of a GPS was estimated to be about USD500 compared with USD125 if an odometer tag is used.

The main advantages of Scenario One are: technology exists for the accurate gathering of VMT data; the mileage travelled could be precisely calculated; independent billing allows complete separation from gas tax collection; and it is possible to phase in congestion tax or other rate adjustments. The disadvantages include: a long phase-in period; high start-up, overhead and data transmission costs; erratic fee collection leading to increased collection costs and a moderate change in user tax payment habits.[418]

- **Scenario Two:** Under this scenario, mileage fee application would occur at the point of sale at the service station, whereby the service station would collect the user fee. However, the gas tax would continue to be collected at the distributor level. Actual mileage data would be uploaded to the service station's computer for fee calculation and payment. All operators of vehicles containing an electronic odometer would be charged a fee based on vehicle miles travelled since last fuelling. The user would receive a credit for estimated fuel tax paid. Mileage data collection would occur via electronic odometer, either GPS or odometer tag technology. The transmission of summary mileage data (and not vehicle location movements) would occur by radio frequency to local readers at the service station.

  The main advantages of Scenario Two are: technology exists for accurate gathering of VMT data; the mileage travelled could be precisely calculated; gas tax would continue to be collected at the distributor level whereas mileage fee payment would occur at point of retail gasoline sale and is thus associated with a necessary purchase; it requires no change in user tax payment habits; and it is possible to phase in congestion tax or other rate adjustments. The disadvantages include: a long phase-in period; high tax administration costs; possible public confusion and a high technological burden on service stations.[419]

[418] Ibid Appendix N, 1.
[419] Ibid Appendix N, 2.

- **Scenario Three:** Under this scenario, both the mileage fee and gas tax charges would occur at the point of sale at the service station. Actual mileage data is uploaded to service stations for fee calculation and payment. Switch at gas pump (electronic or manual) determines which user pays mileage fee and which user pays gas tax. Under this scenario, the incidence of gasoline sale tax is shifted from the distributor level to service station level. Service stations would charge the gas tax only to those taxpayers not subject to the mileage fee.[420]

  The main advantages of Scenario Three are: technology exists for accurate gathering of VMT data; the mileage travelled could be precisely calculated; mileage fee payment occurs at point of retail gasoline sale and is thus associated with a necessary purchase; it requires no change in user tax payment habits; and it is possible to phase in congestion tax or other rate adjustments. The disadvantages include: a long phase-in period; high tax administration, collection and enforcement costs as service station collects both the mileage tax and the gas tax resulting in a high technological burden on service stations.[421]

- **Scenario Four:** This scenario is the same as Scenario Two, except that the mileage data is estimated as a function of the amount of gasoline purchased and the EPA fuel efficiency rating for the vehicle. Under this scenario, the actual recording of mileage is not relevant. The user would receive credit for the gasoline tax paid. Gasoline stations would forward the fees collected to the Highway Fund minus an administrative charge. The incidence of gasoline taxation would remain at distributor level. The service station would apply a credit for gas tax paid against the mileage fee before forwarding the net amount to the Highway Fund. If gas tax paid exceeded the assessed mileage fee for any transaction, there would be no rebate of any portion of the gas tax paid.[422]

  The advantages under Scenario Four include: low cost of retrofitting vehicles with technology to gather estimates of VMT data; short phase-in period;

[420] Ibid Appendix Q, 1.
[421] Ibid Appendix N-3.
[422] Ibid Appendix R-1.

mileage fee payment occurs at point of retail gasoline sale and is thus associated with a necessary purchase; no change in user tax payment habits; and it is possible to phase in congestion tax or other rate adjustments. The disadvantages of Scenario Four include: low VMT accuracy; high tax administration costs; increased consumer confusion; no integration of congestion pricing; and significant technological requirements on service stations.[423]

- **Scenario Five:** Under this scenario, mileage data is uploaded to the Department of Motor Vehicles (DMV) locations for fee calculation and payment as a condition of registering passenger vehicles. User receives credit for gas tax paid. DMV would forward fees to Highway Fund.[424]

  The advantages of Scenario Five were identified as follows: technology exists for accurate gathering of VMT data; the mileage travelled could be precisely calculated; mileage fee payment occurs at DMV locations as a condition of registration renewal and not integrated with the gas tax collection, thus resulting in less consumer confusion; manageable increased enforcement and collection costs; and it is possible to phase in congestion tax or other rate adjustments. The disadvantages include: high phase-in period; there might be a loss of revenue to the state during the phase in period if registration fee payment schedule is maintained at two to four years. Residents moving into and out of state might avoid mileage fee payment; it requires a small change in user tax payment habits and the mileage fee assessed might not be charged in 'real time' (ie monthly) if registration fee payment schedule is maintained at two to four years and thus less likely to impact user behaviour.[425]

- **Scenario Six:** This scenario involves a state-wide spot tolling system through electronic onboard devices. All passenger vehicles would be equipped with inexpensive automatic vehicle identification devices. The 7500 mile state highway system would be equipped with approximately 2000 roadside reading gantries and an optical recognition system. Drivers of passenger cars would be required to display smartcards to pay for the toll that reflect

[423] Ibid Appendix N-4.
[424] Ibid Appendix S-1.
[425] Ibid Appendix N-4.

approximate VMT based on the AVI devices. The charge could vary by time of the day and the direction of driving to take into consideration congested areas. The smartcards would either contain prepaid electronic funds or engage a transaction involving credit or debit card or automatic withdrawal from a bank account. ODOT would authorise purchase of smartcards through the mail, at retail outlets or at toll plazas within Oregon's borders. ODOT would maintain a central computer that recognises violators through a licence plate recognition system.[426]

The advantages of Scenario Six include: the existence of technology for collecting high levels of revenue in this fashion; the collection can be kept independent of gas tax or replace gas tax; the phase-in period can be relatively short following construction of infrastructure for roadside reading devices; and congestion pricing can be easily implemented without additional infrastructure expense or phase-in. The disadvantages include: reduced VMT accuracy; start-up costs can be very high; administration costs could be moderate; it requires a large change in public tax payment habits; it would not allow for rate adjustment changes and it would not be possible to include all the roads within the system.[427]

The advantages and disadvantages of the six scenarios are summarised in Table 5.6.

TABLE 5.6: Advantages/Disadvantages of Proposed Scenarios

Advantages/Disadvantages	**Scenarios**					
	1	2	3	4	5	6
Advantages						
Technology: Exists for gathering accurate or a good estimate of VMT data in this fashion	√	√	√	√	√	√
VMT Accuracy: Mileage travelled could be precisely calculated	√	√	√		√	
Collection: Independent billing allows complete separation from gas tax collection	√				√	√

[426] Ibid Appendix T-1.
[427] Ibid Appendix N-6.

Advantages/Disadvantages	**Scenarios**					
Collection: Mileage fee payment occurs at point of retail gasoline sale and thus associated with a necessary purchase		√	√	√		
Public Acceptance: Requires no change in user tax payment habits		√	√	√		
Congestion Pricing: Enabled after full phase-in	√	√	√		√	√
Other Rate Adjustments: Allows other overlays (eg fuel efficiency)	√	√	√	√	√	
Phase-in Period: Relatively short				√		√
Enforcement: Manageable increased enforcement and collection costs					√	
Disadvantages						
VMT Accuracy: Mileage travelled would be approximated				√		√
Phase in Period: Long phase-in period	√	√	√		√	
Start Up Costs: Likely to be high	√					√
Overhead Costs: Likely to be very high	√					
Data Transmission Costs: Likely to be high, especially if cellular transmission is the preferred mode	√					
Collection: Erratic because non-payment is more likely than under the gas tax	√		√			
Enforcement: Dramatic increase in costs likely for enforcement and collection	√		√			
Public Acceptance: Requires change in user tax payment habits	√				√	√
Private Sector Burden: The technology requirements imposed on service stations could be significant		√	√	√		
Tax Administration: High to moderate cost		√	√	√		√
Congestion Pricing: Enables only a stand-alone system				√	√	
Public Behaviour: Less likely to impact on behaviour						
Tax Efficiency: Loss of revenue from residents moving in and out of state					√	
Other Rate Adjustments: Not possible						√
Partial Coverage: Not practical to cover all the roads						√

For purposes of pilot testing, the Task Force expressed a vision for the design of a mileage fee involving collection at either fuel service stations or at an independent centre as stated in Scenarios One and Two above. Mileage data would be gathered through an ‘electronic odometer’ such as a GPS or odometer tag. The mileage data from the electronic odometer would be uploaded to data readers via radio frequency transmission and forwarded to a computer for fee billing. The rate applied would be approximately 1.22 cents per mile driven, which is roughly equivalent to the current state fuel tax on gasoline.[428]

The vision would require all new vehicles to be fitted with electronic odometers with no retrofitting required for existing vehicles. Thus a long phase-in period of about 20 years would be necessary for the state to operate both the fuel tax and the mileage fee system. Motorists’ privacy would be protected by a design for the data transmission technology that would eliminate any possibility that their movements could be transmitted.[429]

From 2003 to 2005, the Task Force further developed the mileage fee and congestion pricing concepts of the new revenue system. The transformation from concept to design framework was reported to the 73rd Oregon Legislative Assembly in 2005.[430] This is discussed in the next part.

5.4.4 Strategy to Move the Mileage Fee Concept to the Design Framework: Report to the 73rd Oregon Legislative Assembly – June 2005.

The Task Force made recommendations on the design framework of the mileage fee system based upon the already determined policy objectives as discussed in 5.4.3 above.

The Task Force recommended that the mileage fee should be collected by the service stations since the ODOT requirement specified that the system developed should not require any additional actions on the part of motorists relative to what occurs currently. Under the Task Force recommendation, the motorist will purchase fuel as

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[428] Oregon Department of Transportation, above n 409, 2.
[429] Ibid.
[430] Oregon Department of Transportation, ‘Oregon’s Mileage Fee Concept and Road User Fee Pilot Program Report to the 73rd Oregon Legislative Assembly’ (Report On Proposed Alternatives to the Current System of Taxing Highway Use through Motor Vehicle Fuel Taxes, June 2005) 1–55.

they currently do. Those motorists with non-equipped vehicles will pay their state gasoline tax at the pump as they currently do. Those vehicles that are equipped for the mileage fee will be exposed to an electronic calculation whereby state gasoline tax is deducted and mileage fee is added to the price of fuel.[431]

The problem that the Task Force encountered was how the service stations would be able to account to ODOT the mileage fee collected from the owners of equipped vehicles, less the gas tax credited to those vehicle owners, without imposing an administrative obligation on the service station. To solve this problem, the Task Force developed an administrative system called Vehicle Miles Travelled Collected at Retail (VMTCAR). Under the VMTCAR system, the gasoline tax reimbursement from the retail station to the distributor at the point of distribution will remain the same. The only change will involve the information submitted to ODOT. The service station would need to provide the following information to ODOT:

- Amount of fuel purchased by customers at the station subject to VMT charges for a given period;
- The amount of mileage fees paid by mileage fee payers during the same period.

The service station retailer would not remit to ODOT the total mileage fee paid by the customer since the service station retailer has already reimbursed the distributor the gasoline tax and the distributor has already paid the gas tax to ODOT. The only amount the retailer would remit to ODOT is the difference between the prepaid gas tax and the mileage fee. This amount would be calculated by ODOT from the information provided to ODOT by the service station retailer, as stated above. ODOT would invoice the retailers monthly if the mileage fee collected is greater than the prepaid gas tax, but if refunds are owing to the retailer, than ODOT would pay the retailer on a weekly basis.[432]

The next issue for the Task Force was how the service station would calculate the mileage fee. ODOT required the system to indicate to the user the amount spent on

[431] Ibid 35–8.
[432] Ibid.

fuel and the amount of mileage fee paid. Two possible electronic scenarios for calculating the fee at fuelling stations were proposed.[433]

The first was a one-way communication from the vehicle's device to a host computer located at the service station through a wireless data reader that would read the stored mileage. The host computer would also request the prior paid zone mileage information from a central computer at ODOT and then compute the VMT fee. The host computer would then direct the service station's POS system to incorporate the proper fee into the fuel purchase transaction in lieu of the gas tax, and transfer the new latest 'paid for' zone mileage to the central ODOT computer for updating. The vehicle's mileage data is not updated in the one-way communication system.

The second scenario was a two-way communication from and to the vehicle's device. Wireless data readers at or near a fuel dispenser would read two mileage readings from the motor vehicle device, ie the total Oregon VMT and the paid-for Oregon VMT and pass it onto the host computer at the service station to calculate the difference between the two mileage readings. This data would be made available at the service station's POS and included in the purchase transaction. After completing the transaction, the vehicle's total paid for mileage data is updated via the two-way communication system.

Under the system recommended by the Task Force, the vehicles would need to be fitted with a device that calculates the mileage. This device had to be examined from the point of view of the cost and privacy issues. The service station would also need to be fitted with mileage fee collection technology and a database at the ODOT level to receive mileage information.

The Task Force recommended that the device to be fitted in the motor vehicle would use hybrid technology by applying the best attributes of odometer-based technology and GPS receiver-based technology. The hybrid technology uses the odometer's speed sensor to measure miles travelled and a GPS receiver to indicate which zone the vehicle is travelling in and thus which zone 'odometer' should accumulate the

[433] Ibid 34–5.

mileage. This technology would satisfy the ODOT requirement that the mileage data (VMT) collection within predefined geographic zones be accurate.[434]

Another requirement from ODOT was that the motor vehicle device must protect the privacy of Oregon's citizens and not track drivers to a greater degree than the existing payment systems required. The Task Force examined the privacy concern arising from the use of the GPS technology that the Government may use the mileage fee system to track motorists' movements. The Task Force noted that the GPS receiver recommended by ODOT and the Oregon State University (OSU) School of Engineering has the ability to generate location and time data, but cannot transmit this information wirelessly or save a large amount of this data. Therefore the Task Force intended to use the GPS receiver to only answer questions with a simple 'Yes' or 'No', the questions being, 'Is the vehicle travelling in Oregon?' and 'Is the vehicle travelling in a smaller jurisdictional area such as the city?' The Task Force would not use the device to save the location data or transmit the data to another entity, and the privacy of Oregon's citizens would thereby be protected.[435]

The data collected from the vehicle device had to be accurately transmitted to the service station. According to the Task Force, the mileage fee system requires the installation of the mileage fee collection technology at the service station and a central computer and database at the ODOT level. The Task Force proposed using short-range radio frequency for transmission of mileage data. As part of its overall and integrated set of privacy protection, the Task Force wanted to avoid systems with broad transmission range capabilities, such as cellular, that would enable tracking of vehicular movements. The OSU researchers reported that the maximum range for radio frequency technology was 300 feet but expected to refine this technology so that transmission would be limited to the particular reader aligned with the fuelling pump, thus preventing data theft.[436]

As regards the cost of state-wide implementation, according to the Task Force, the estimated cost of the on-vehicle prototype would be less than USD250. All service stations would require mileage data readers to be installed at an approximate cost of USD290 per pump. The cost of the mileage fee collection technology would depend

[434] Ibid 32–3.
[435] Ibid 30–1.
[436] Ibid 33–4.

upon the nature of the existing POS system and some may only require an inexpensive software upgrade. The cost of the central computer database would be less than USD35 million state-wide as estimated by an ODOT economist.[437]

The Task Force had to address numerous policy issues in setting the rate structure. According to the Task Force analysis, if the mileage fee is designed as a true user charge, then a flat rate should apply to all vehicles, since all vehicles require the same level of service from the road system, eg bridges, signs, pavements, exits, lighting, etc. However, the Task Force considered that the environment and energy policy point towards a higher rate to emphasise user responsibility, eg emissions. Social equity concerns were also required to be taken into consideration, such as the types of vehicles driven by less affluent people and the impact of the rate structure upon them. The Task Force considered that a graduated rate structure could be the answer, whereby a base rate similar to a flat fee could apply to every passenger vehicle and then a premium fee structure could apply to provide a disincentive for use of vehicles with particular characteristics, eg fuel, efficiency rating, weight, size and emissions rating.

The Task Force also considered that the fees could be varied to take into consideration the zones and times of day with the aim of reducing congestion. However, the Oregon constitution has an equal protection clause, and therefore peak period pricing cannot be legally implemented until all vehicles are equipped to come within the mileage fee system.[438]

As regards the auditing of the mileage fee system, the Task Force accepted that effective audit would include observation, inspection and random tests at both the retail station level and the individual vehicles level.[439]

These Task Force recommendations of the technical, operational and administrative features of the mileage fee strategy are summarised in Table 5.7.

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[437] Ibid 41–2.
[438] Ibid 43–4.
[439] Ibid 40–1.

TABLE 5.7: From Concept to Design Framework: System Recommendations for Incorporating Oregon's Policy Objectives into a Mileage Fee Strategy

How the Mileage Fee System Works **(Key Technical, Operational and Administrative Features)**	**Related Elements of Oregon Policy Framework**
How does the new mileage fee system ensure that everyone pays fairly for Oregon's roads? What about out-of-state vehicles?	
- All motorists will contribute to Oregon's roads. A mileage fee will be collected from motorists operating new vehicles equipped with manufacturer-installed instruments that meet prescribed specifications. Motorists with older vehicles will continue to pay the fuels tax at the pump.	Minimum Evasion Potential.
- Proven technology ensures that only in-state miles will be subject to mileage fee – the VMT data would be collected electronically by zone (eg state) through combined odometer and global positioning system (GPS) technology.	Differentiation of State Boundaries.
How is a vehicle's mileage data collected, used and stored? How does the system balance the need for accuracy and auditing with privacy concerns?	
- No tracking or storage of motorist movements will be required for system compliance and accuracy. The on-vehicle device's GPS receiver generates location data only for the purpose of identifying zones where mileage accumulates. VMT data and vehicle identification would be read from vehicles by readers at retail fuelling stations via short-range radio frequency communications. There would be no transmission of travel location points at any time to anyone. Only private sector entities would be involved with installing and maintaining the on-vehicle device, and operating the service station equipment for receiving the transmitted VMT data.	System Accurate and Reliable. Protection of Privacy.
How will motorists pay the new mileage fee?	
- No behaviour change required of motorists. Motorists would experience no change in payment process.	Ease of Use by Motorists.
What will the new mileage fee mean to fuel retailers or distributors?	
- Negligible change in administrative burden to fuel retailer. There will be no more employee involvement in collecting the mileage fee than for the existing gas tax system, other than issuing one monthly cheque to ODOT.	Minimal Burden on Private Sector.
How will the transition be handled?	
- Transition will not result in any revenue disruption. The new system could take close to 20 years for full	Seamless transition must ensure stable

How the Mileage Fee System Works (Key Technical, Operational and Administrative Features)	Related Elements of Oregon Policy Framework
phase-in. - The state fuels tax would be maintained for non-equipped vehicles and for system redundancy.	transportation revenues for Oregon's roads. A reliable back-up system should be built into the new system.
Is the system and its related technologies reliable and affordable? - Oregon State University (OSU) research specialists select from proven technology. - Capital and administrative costs are minimised through appropriate policy and technology choices. State-wide capital costs for fuelling station equipment and computing technology will be less than USD35 million.	Technology that is feasible, reliable and secure. System affordability.

Source: Oregon Department of Transportation Office of Innovative Partnerships and Alternative Funding (May 2005).[440]

In April 2006, ODOT launched a 12-month pilot program to test the technological and administrative feasibility of the mileage fee concept. The program included 285 volunteer vehicles, 299 motorists and two service stations in Portland. The key findings of the pilot program[441] are discussed in the next part.

5.4.5 The Oregon Pilot Program

The Road User Fee Task Force directed ODOT to test the real world feasibility of the Oregon Mileage Fee Concept. The Federal Highway Administration (FHWA) funded the bulk of the project with three targeted grants totalling USD2.1 million over six years and the state of Oregon contributed USD771 000 in matching funds.[442]

The project partners were: Oregon State University, Portland State University and Leathers Fuels, who permitted ODOT to replace POS systems and install mileage reading equipment. ODOT developed a recruitment plan incorporating print and radio advertising, press releases, and an informational website. ODOT registered 285

[440] Ibid 26–8.
[441] Oregon Department of Transportation, above n 411, 21–5.
[442] Oregon Department of Transportation, above n 430, 49.

participant vehicles, offered participants USD300 per vehicle for their full participation in the pilot program, payable as shown in Table 5.8.

TABLE 5.8: Compensation to Participants of Pilot Program

Milestone	Compensation USD
Installation Complete	50
Beginning Independent Mileage Read #1	25
Middle Independent Mileage Read #2	25
Final Independent Mileage Read #3	25
De-installation and Final Survey Complete	175

Source: Oregon Department of Transport

The actual pilot program had three phases: the control phase; the test phase and wrap-up phase.

The first phase was the control phase that was scheduled for the first five months of commencing the pilot program. The purpose of the control phase was to establish a baseline of participant driving behaviour. Participants had to purchase fuel from the two service stations that were equipped with mileage readers at least twice a month, but continue to pay gas tax. This phase also involved working through difficulties. Difficulties identified in the first few months included ODOT receiving complaints from some participants about batteries draining unexpectedly. ODOT responded with a program-wide bulletin detailing the problem, offering the temporary cautionary solution of unplugging the on-vehicle device if a vehicle would be unused for several days, and replacing the spent batteries.

The second phase occurred in months six to ten of the program and was called the test or experimental phase. The participants were divided into three different groups during this phase: the control group, the Vehicle Miles Tax (VMT) group and the Rush Hour group. The control group continued paying the gas tax. The participants in the VMT group were charged a mileage fee of 1.2 cents per mile less the gas tax of 24 cents per gallon. Participants in the rush hour group paid a fee of 10 cents per mile for driving during the rush hours of 7–9AM and 4–6PM Monday through to Friday, excluding holidays within the Portland metropolitan area.

The participating motorists did not actually pay the mileage fee or rush hour fee at the pump during the field test, regardless of group. Instead, ODOT charged the mileage fee or rush hour fee to an endowment account. Based on the driving history during the control phase, ODOT established individual endowment accounts to pay for the fees, so that the endowment account would equal zero at the conclusion of the field test.

ODOT notified participants of their endowment balances every few weeks, giving them information that could help them modify their driving habits in order to reduce the mileage fee charged to their account balance and maximise their reward at the completion of the pilot program. Any endowment balance remaining at the end was granted to the participant, thus providing an economic incentive that was intended to mimic real-life incentives to save money by driving more consciously.

The final stage of the pilot program was the field test wrap up. ODOT held a pizza party to thank those participants who had completed the field test. Approximately one-fifth of the final 260 participants attended, giving both ODOT and motorists a chance to discuss one-on-one the successes and difficulties of the pilot program.

The pilot program results were evaluated using criteria established by ODOT, being administration, cost, net revenue generation potential, hardware and software, systemic precision, evasion potential, usefulness for phasing and partial implementation, adaptability to congestion pricing and public acceptance. Some of these evaluation criteria have been used in Chapter 7 of this thesis against which the LET has been evaluated.

As regards administration of the mileage fee, the pilot program successfully demonstrated that the mileage fee could be implemented alongside and integrated with the gas tax collection system.[443]

The pilot program demonstrated that the mileage fee differential collected at the service stations involves the addition of a fairly inexpensive automated transaction

[443] Oregon Department of Transportation, above n 411, 26–31.

recording using VMTCAR and this automated system would greatly minimise the administrative burden to the state and the service stations.[444]

The mileage fee system would satisfy its potential to generate revenue for road funding as the revenue would not be eroded with an increase in electric and alternative fuel vehicles or improvement in fuel efficiency of the vehicle fleet.[445]

As regards the hardware and software evaluation, there was a three per cent or 18 days of malfunction of technology between the two service stations, where the mileage fee transactions could not be calculated due to a variety of component failures including: problems with POS system, lost power, not knowing that the cable or equipment were accidentally disconnected, DSL communications problems and OSU web-server downtime. There were two main types of on-vehicle devices used in the field test to collect the mileage data. One device used speed data from the vehicles' On-Board Diagnostics-II (OBD-II) port. The second device used a GPS receiver to compute mileage from vehicle position data derived after sufficient GPS satellite signal acquisition. Overall accuracy of the on-vehicle devices was on average within two per cent and this was considered very high. However the on-vehicle devices retrofitted into participating vehicles created some difficulties during the pilot program. Sixty-eight participants reported that the on-vehicle devices drained their car batteries. In the pilot program the participant motorists were occasionally charged the gas tax instead of the mileage fee. However, it was noted that although the vehicle-to-pump association was not sufficiently reliable, once the association was successfully made, the system was completely reliable in downloading the mileage information from the on-vehicle device.[446]

The pilot program demonstrated that the mileage fee could be calculated and collected with sufficient precision. The evasion potential was noted to be minimal. The system was ideally suited for phasing and partial implementation and was adaptable to congestion pricing.[447]

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[444] Ibid 31–3.
[445] Ibid 33.
[446] Ibid 35–6.
[447] Ibid 33–9.

An evaluation against public acceptance showed that the public would accept the implementation of the on-vehicle devices as the cost was embedded in the purchase price of the vehicle. As regards the convenience of the mileage fee system, the pilot program results showed that participants believed the mileage fee system to be convenient and the statistics were as follows:

- 71 per cent of the participants were satisfied with the requirements;
- 25 per cent of respondents had problems with equipment function;
- Six per cent needed reimbursement when the experimental prototype equipment failed; and
- 91 per cent of the participants agreed to keep the equipment and stay with the same fee structure if the program was extended to include all service stations.

It was noted that participants on both the motorists and service station side were sceptical at first about the mileage fee. Concerns included:

- worry about damage to vehicles from equipment installation;
- lack of knowledge about the mileage fee;
- mistrust of the technology; and
- doubts about its utility and overall acceptance.

Participant concerns about protection of personal information during the course of the study started low and satisfaction with privacy safeguards remained high throughout the project. At the study wrap-up discussion it was noted that participants expressed an understanding of the fairness of the mileage fee system and that the more one drives, the more one pays. As regards transparency, it was noted that participants found the receipts from the service stations provided a second check on mileage recorded, and provided a detailed breakdown (in certain experimental groups) of charges per zone and time. The on-vehicle mileage screen provided a real time alert for when a vehicle changed zones. Participants knew ahead of time what the fee rates were for each of the zones. Seventy per cent of motorists were satisfied with the accuracy of the equipment, and of those who were not, 14 percent could readily compare the accuracy of the pilot technology's mileage count against their car's own odometer to provide an easy check to ensure the system's accuracy.[448]

As part of the pilot program, participants agreed to take part in three surveys. The owner and managers of the service stations agreed to be interviewed regarding their experiences with the program. Three surveys were conducted at the beginning, midpoint and end of the field test and they provided ODOT with an insight into the experience of the participant motorists. The results of these surveys are stated in Appendix 2 of this thesis.

The next part explores ODOT's critical analysis of the motorist and station operator response-behaviour and the pathway to implementation of Oregon's mileage fee concept.

5.4.6 ODOT's Critical Analysis and Pathway to Implementation

ODOT was able to conduct a limited analysis of participant behaviour. Surveys and interviews provided ODOT with direct information on how volunteers perceived the technology and their changes in travel behaviour. This information provides useful insights into behaviour change that could occur from the implementation of a LET.

ODOT's behavioural research objectives for the pilot program included the following:

1. Determine whether switching from the gas tax to a mileage fee would cause motorists to change their driving behaviour; and
2. Determine whether motorists would change their behaviour in response to differential pricing associated with congestion.[449]

The answers to both the objectives were found to be in the affirmative. On the first objective it was noted that the VMT group showed a surprising 12 per cent reduction in total miles or more than three miles per day. The price per mile for the VMT group was set to approximate the gas tax, so little change in behaviour was

[448] Ibid 39–40.
[449] Ibid 41.

anticipated for this group. Surprisingly, however, 10 of the households in the VMT group reported that someone in the household started taking the train, took up biking, or began walking to save money through the program. Comments in the surveys and in a focus group session indicate that some of the participants in the VMT group did indeed reduce their driving based on more awareness of the number of short trips being taken and the number of miles driven.[450]

On the second objective it was noted that the reduction in total miles for the rush hour group was even larger than the reduction for the VMT group and, as expected, this group also reduced the number of peak miles driven. ODOT and the research team had initial concerns that the lower off-peak charge would encourage rush hour motorists simply to shift into the 'shoulders' of the peak periods. Not only did this not happen, but notably, the reduction in peak miles was accompanied by further reductions in off-peak miles. Twelve of the 84 households in the rush hour group reported that someone in the household began using alternative transportation modes to save money. Twenty-six also reported that someone in the household changed either the time or distance of travel to save money. Mostly this was by avoiding driving in the congestion zone during rush hour. This occurred in 23 households, although four households reported grouping errands or consolidating trips and one reported using a carpool.[451]

The overall conclusion of the surveys as reported by ODOT was that although there were a few glitches, the system worked well. A major purpose of the survey effort was to identify problems that could be corrected. Several issues with the on-vehicle devices were noted by the participants, though most were pilot-specific issues that would not affect real world program deployment. It was noted that the service station owners and operators would require substantial improvements in several areas, the most important being the creation of a POS system. Owing to the practical limitations only one POS system could be used for the pilot program. It was also noted that if the system were mandated state-wide, additional costs for new fuel pumps with the required communication capabilities would have to be addressed in some cases, but most station owners should already be equipped with the appropriate fuel pumps. However, costs associated with accommodating the mileage fee system,

[450] Ibid 41–9.
[451] Ibid 41–9.

such as re-establishing coordination with internal accounting systems would have to be addressed.

The key findings of Oregon's mileage-fee-concept and the road user fee pilot program were:[452]

1. The concept is viable by using existing technologies in new ways and with 91 per cent of the participant program agreeing to continue paying the mileage fee instead of the gas tax if the program were extended state-wide.
2. The payment of the mileage fee as part of the fuel bill at the petrol station is comparative to the gas tax when it comes to processing and administration fees.
3. The mileage fee can be phased, in taking into consideration the expense of retrofitting vehicles with mileage-calculating equipment.
4. The new point-of-sale system can easily be integrated with the current gas tax collection by the State.
5. The mileage fee concept can support congestion and zone-oriented pricing. The pilot program revealed a 22 per cent decline in driving during peak periods.
6. Privacy is protected whereby the only centrally stored data needed to access mileage fees were vehicle identification, zone mileage and amount of fuel purchased.
7. The system would place minimal burden on gas businesses as the administration is easily automated.
8. On-vehicle engineering and penalties would ensure minimal tampering with the on-vehicle device.
9. The cost of implementation and administration is likely to be low, with service stations required to install mileage reading equipment, and operating costs including communications of the mileage information with a central database in order to calculate mileage fees and modifications to the station's point of sale system.

The next step would occur within the next 10 years, and involves additional development and testing, working with technology firms and motor vehicle

[452] Ibid vii.

manufacturers to refine on-vehicle technology and incorporate home fuelling and multi-state integration of the system.[453]

The Final Report also noted the following timeline for broad scale implementation:

- Necessary technology refinements for the on-vehicle devices and fuel pump collections, as well as revenue systems integration, may take up to five years to complete development after allocation of sufficient funding;
- Without the lead of the US Department of Transport or the State of California, industry acceptance, manufacturing integration and service station installations may take over 10 years;
- Without effective and consistent messaging by officeholders and other policymakers across the nation, the experience of disasters may be necessary for the public to accept the change to per-mile charges;
- In the absence of a large, widely-supported effort, broad scale implementation might be feasible in 10 to 12 years, on a phased basis; and
- If only new vehicles are fitted with the required technology, then complete implementation would occur over a 30 to 35 year period, from start to finish.

These timelines indicate the time it could take to reform the motor vehicle taxation system in Australia with the proposed implementation of the LET. The objective of the Oregon project was to trigger a national debate on the future of transportation funding in the 21st century and ODOT succeeded in this task. The Oregon representatives learnt that other states faced the same problems as Oregon and demonstrated a genuine interest in the Oregon approach. Oregon's pilot program has often been cited by American state departments of transportation as a key case study to match the states' infrastructure needs against revenues.[454] Alabama researchers used Oregon's program as their proxy model for their state road funding and finance option called the vehicle mileage road user fee (VMRUF). While ultimately recommending short term fixes, Alabama researchers recommended additional study

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[453] Ibid.

[454] Caroline Lundquist Noblet et al, 'Sustainable Transportation Funding for Maine's Future' (Research Report in response to Transportation Research Problem and Statement, Maine Department of Transport, 20 January 2006) <http://mcspolicycenter.umaine.edu/files/pdf/SustainableTransportationFunding01-06.pdf> 15.

of the per-mile charge and opined that implementation of such a system 'should be given great attention by government officials, financial analysts and the public, because it has the best potential for the future.'[455] The Oregon example has also been considered in other countries such as the Netherlands, Switzerland and the UK.[456]

5.4.7 Lessons for Australia

Government commitment is the first essential step required to initiate reform. Even though the Oregon project is supported by their Legislative Assembly, it takes time to investigate and develop a new system. The Road User Fee Task Force in Oregon had to investigate 28 different potential revenue sources to design the central feature of the new system. The Task Force recommended that the new revenue collection system that would replace the fuel tax should be based on road use, directly connecting to the burden each user of the road places on the road system. Thus the amount paid by the road user would be classified as a fee for service, rather than general taxation unrelated to use. According to the Task Force, the new system also paves the way to price congestion and manage traffic during peak periods by creating multiple zones.[457]

Another lesson for Australia is that developing a new concept would require the involvement of many organisations, including research institutions. In Oregon, six mileage fee collection scenarios were developed by research consultants from Oregon State University and Portland State University.

A lesson that could be learnt for Australia from the Oregon study is that a well-defined pilot study can assist in ironing out implementation problems and increasing public acceptance by taking uncertainty out of the proposals. In Oregon, the Road User Fee Task Force recommended that ODOT should conduct a pilot program to study two strategies in the Oregon Mileage Fee Concept. These two strategies were:

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455 Virginia P Sisiopiku et al, 'Alternative Financing Sources for Alabama Highways' (UTCA Report Number 05114, August 2006) <http://utca.eng.ua.edu/files/2011/08/05114fnl.pdf>.

456 Stephen Potter, Graham Parkhurst and Ben Lane, 'European Perspectives on a New Fiscal Framework for Transport', in Reggiani A, Schintler L (eds), *Methods and Models in Transport and Telecommunications: Cross Atlantic Perspectives* (2005) 9.

457 Oregon Department of Transportation , above n 411, v.

Study the feasibility of replacing the gas tax with a mileage-based fee that is collected at fuelling stations; and study the feasibility of using this system to collect congestion charges. ODOT launched a 12-month pilot program in April 2006, involving 285 volunteer vehicles, 299 motorists and two service stations in Portland, Oregon.[458]

An important step in designing a new system is to draw up a set of defined criteria within which the system should be designed. The Task Force in Oregon identified eight principles as the criteria for designing the new revenue system to implement the gas tax. These criteria were:[459]

- User payment to directly relate to use of road infrastructure and services;
- The revenue to remain within the local government control;
- The ability to collect sufficient revenue required to replace the gas tax;
- The payment under the new system to be transparent to the public;
- There should not be substantial burden on taxpayers or private entities to collect fees and data;
- The system must be readily enforceable with minimum evasion;
- The new system should be capable of supporting the entire highway and road system;
- The new system should be acceptable to the public.

The Oregon case study gives an insight into the factors that would need to be taken into consideration in designing the new LET system in Australia. However, the Oregon study is only applicable to the state of Oregon and not the whole country. There does not appear to be coordination between federal and state policies pertaining to energy and infrastructure.

The situation that initiated the Oregon study was insufficient and declining revenue from the current gas tax to support Oregon's road system. The mileage tax proposed in Oregon certainly addresses this problem. The problem is also premised on the fact that the Oregon fuel tax revenue is expected to decline further as Oregonians are likely to have a reduced need for fuel due to an increase in the hybrid electric vehicle population, increase in the price of oil as more expensive oil extraction technologies

[458] Ibid vi.
[459] Ibid 2.

are employed, or a shift into the use of alternative fuels. Although the problem of reduced oil supply is anticipated, the mileage tax does not directly address this problem. The mileage tax certainly encourages a reduction in the kilometres driven and also encourages the use of public transport. However, the kilometre charge has no bearing on the types of motor vehicles on the roads and the amount of fuel they consume or the emissions they produce. The motor vehicle fuel consumption problem in the US is being addressed by the federal government through regulations, ie CAFE standards, as discussed in Chapter 4. A better result could be achieved by synchronising federal and state policies. A lack of a truly national energy policy has become apparent in the recent campaign for the presidential election to be held on 6 November 2012. Media reports in the US indicate that a national energy policy is difficult to achieve in the US due to the fear of losing votes.[460]

It is argued in this thesis that an effective approach for Australia is for the Australian government to first identify the problem. The problem identified for Australia in this thesis is to reform motor vehicle taxes on passenger motor vehicles in order to reduce the use of oil. The problem should then be resolved on a national basis and this may require changing both state and federal laws. A combined Australian reform is required, impacting on both state and federal laws on purchase of the vehicle, annual road use, fuelling and the disposal of the vehicle.

5.5 CONCLUSION

Important lessons have been drawn from the case studies in Norway, the Netherlands and Oregon that will assist in designing the tax framework for the LET in Chapter 6.

The study in Norway points towards political commitment to a system that impacts on the purchase of motor vehicles based on the weight, engine power and CO_2 emissions. The failed project in the Netherlands shows the recognition of a problem with the existing taxation regime pertaining to road use, but the lack of political will can hinder the successful implementation of the required changes. The Oregon study

[460] Kent Moors, *Who is to Blame When the Next Energy Crisis Hits* (24 February 2012) Oil & Energy Investor <http://oilandenergyinvestor.com/2012/02/the-other-elephant-in-the-room/>.

gives an insight into the principles and protocol required to implement a new road pricing system. A successful policy change requires long-term planning, clear objectives and realistic foresight of costs and consequences.

Lessons from these three case studies and the review of global policies in Chapter 4 have provided enough information to examine in the next chapter the choices available to Australia to resolve the problems identified in Chapters One, Two and Three of this thesis.

CHAPTER 6: RECOMMENDATION OF TAX FRAMEWORK FOR THE LUXURY ENERGY TAX

6.1 INTRODUCTION

This chapter draws on the lessons from the findings presented in Chapters 2 to 5, and proposes a luxury energy tax (LET) framework that answers the second research question: What criteria should the design of a tax framework take into account to reform the choice and usage of motor vehicles for personal transportation in Australia in order to reduce oil consumption?

This chapter is divided into five parts. Following this introduction, part 6.2 reiterates the problem that needs to be resolved, followed by a critical examination of some of the policy options for Australia in part 6.3, with reference to the materials discussed in Chapters 2 to 5. Part 6.4 then outlines a five-part proposal for the LET system, addressing the core environmental tax principles, the framework, the design, the operation and administration and the implementation of the LET. This is followed by a short conclusion in part 6.5.

6.2 THE AUSTRALIAN PROBLEM REITERATED

The problem that needs to be resolved commenced over 200 years ago with the invention of the internal combustion engine in 1807 by Francois Isaac de Rivaz, the discovery of oil in 1846 by Dr Abraham Gesner,[461] the invention of the first petrol motor vehicle in 1886 by Karl Benz and the invention of the constant moving assembly line in 1907 by Henry Ford.

[461] See discussion in Chapter 2. The discovery of oil can be traced back to 1846 when Dr Abraham Gesner managed to extract oil and other petroleum products, including kerosene from albertite rocks. In the 1850s Ignacy Lukasiewich achieved a way to distil seep oil into products. He constructed the first real oil refinery.

A rapid increase in motor vehicle ownership as discussed in Chapter 3 of this thesis has encouraged the improvement and spread of the road system, thereby influencing urban land use and bringing about ancillary problems such as the use of valuable land for road building, and the extra costs associated with road lighting and road policing. The increased road use by motor vehicles also increases accidents, congestion, pollution and many other indirect costs to the public, the courts and health systems.

Not only has the abundant supply of oil impacted on the increase in the number of motor vehicles and influenced the shape and size of our cities, but we have also come to rely on oil in many products we need in our daily lives. Many governments and international organisations have recognised this, as discussed in Chapter 2. Even in Australia, the Chartered Institute of Transport voiced its concerns in 1998, as follows:

> A shrinking supply of cheap oil will characterise the next century and confront us with one of the greatest transformations of human affairs. The signs are already there. Risks of chaos, disorder and conflict will arise unless we face up to this great challenge and make the difficult decisions essential to the future wellbeing of us all. These decisions must be based on the care of people and of the environment if we are to proceed down the path of constructive change.[462]

It is important to recognise that the era of cheap oil is over and it is the Australian government's responsibility to educate the people of Australia that oil is a valuable commodity and should be used wisely. The best place to start this education process is where the wasteful use of oil is the greatest and where a policy change can ensure the next 100 years of sustainable living. The greatest wastage of oil is from motor vehicles used for personal transportation. Motor vehicles have become larger, heavier and more powerful as illustrated by the model creep of the Holden family car described in Chapter 3 of this thesis.

Ignoring the other indirect costs, passenger motor vehicles used for personal transportation are considered expensive in terms of energy use. Buses and trains are

[462] Laird et al, above n 8, 87.

far more energy efficient than a personal passenger motor vehicle. Newman and Kenworthy note that a fully loaded electric train is five times more energy efficient than a car.[463] Even the weight allocation per passenger of a personal passenger motor vehicle can be far greater than for a train, bus or even an aeroplane. Compared with aeroplanes, trains or buses where the weight allocation per passenger is 300 to 350kg, motor vehicles weighing between 1000 and 2500kg are often used by one or two passengers at a time on a journey. The Airbus A340-600 aircraft has an operating empty weight of 130 200kg and can carry between 295 and 440 passengers, resulting in a weight allocation per passenger of between 295 and 441kg.[464] Transperth 'A series' two-car trains weigh 94 000kg and each car has the capacity to carry 72 seated and 82 standing passengers. This results in a weight allocation of 305kg per passenger. A natural gas bus weighs 18 000kg and is licensed to carry 59 passengers, resulting in an allocation of 305kg per passenger. In order to obtain an average of 300kg per passenger for a passenger motor vehicle that carries four passengers, the motor vehicle should not weigh more than 1200kg. However, an average family car, the Holden VE introduced in July 2008, weighs 1700kg and the Toyota Land Cruiser 200 GLX weighs 2635kg.[465]

In order to reduce the use of oil in passenger motor vehicles, it is necessary to shift the focus from motor vehicles being a symbol of financial success and social status to being simply a means of transportation. James Sallee in his recent study on the taxation of fuel economy notes there is a strong relationship between wealth and ownership of personal vehicles.[466] The basic question to address is whether we as a society can afford to waste our precious oil resource by allowing passenger motor vehicles weighing 2640kg[467] to carry between 100 and 400kg of passenger weight. The question to also ask is whether Australians who drive energy-guzzling motor vehicles for personal transportation know the impact of their choice on the depletion of oil and the future ramifications. An effective way to educate Australians about choosing suitable motor vehicles for personal transportation is through an

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463 Ibid 85.

464 Airbus, *A340-600 Global Performer* (March 2012) <http://www.airbus.com/aircraftfamilies/passengeraircraft/a340family/a340-600/>.

465 Toyota, *Land Cruiser 200 Specifications* <http://www.toyota.com.au/landcruiser-200/specifications/gxl-petrol?WT.ac=VH_LC200_RangeSpecs_GXL_Specs>.

466 James M Sallee, 'The Taxation of Fuel Economy' in Jeffrey R Brown (ed), *Tax Policy and the Economy* (National Bureau of Economic Research, 2011) vol 25, 2.

467 Based on the weight of Toyota Land Cruiser. See Toyota, above n 465.

appropriate motor vehicle taxation policy. The Australian Institute of Engineers recommended in their report on sustainable transport that taxation and fiscal policy instruments should encourage sustainable transport.[468]

It is important for the Australian government to act whilst there is still time to do so. If the Australian population were suddenly prevented from driving their motor vehicles due to a lack of oil, as happened during the 1970s oil embargo, how would the cities cope with the transportation needs of the people? It is submitted in this thesis that a new policy approach is needed in Australia that would steer the Australian population towards energy-efficient passenger transportation. This would require a change of behaviour in favour of the use of smaller and lighter vehicles accompanied by an increase in the choice and usage of public transport. The ideal goal is to minimise the oil used in passenger transportation by encouraging walking and cycling for very short trips. For short, medium and long trips to major centres, public transport should be encouraged and cars actively discouraged. The new policy approach proposed in this thesis is the introduction of a LET that would encourage the choice of a smaller, lighter motor vehicle that use less oil and emits less CO_2. The LET would also encourage a reduction in the use of motor vehicles for personal transportation. Moreover, the revenues raised from the LET could assist the government in improving and expanding public transport services.

Before exploring the principles of the LET, the next part critically examines the potential effects of Australia adopting some policy options that have been proposed or implemented by other countries.

6.3 CRITICAL EXAMINATION OF SOME POLICY OPTIONS FOR AUSTRALIA

Taking into consideration why other countries around the world are changing their transportation tax policies as discussed in Chapter 4, and the case studies undertaken in Chapter 5 on the proposed motor vehicle tax reforms in Oregon, the failed reform in the Netherlands and the unique motor vehicle system in Norway, this part

[468] Laird et al, above n 8, 88.

critically explores some policy options for reform in Australia. This may be viewed as a continuum with maintenance of the status quo at one end and the introduction of a LET at the other. These options are now considered in more detail.

6.3.1 Maintaining the Status Quo

If the Australian government does nothing to change the current taxes and charges relating to passenger motor vehicles in Australia and the oil resources dwindle as predicted in Chapter 2, then there may not be sufficient time to carry out the necessary reforms in an orderly manner, with the possible result being the same sort of chaos experienced in the 1970s during the time of the oil embargo.

In Australia, both the Commonwealth and the states impose a variety of taxes relating to passenger motor vehicles, as discussed under 'Lessons for Australia' in parts 4.4.1 and 4.4.2. The Commonwealth government levies the luxury car tax (LCT), import tariffs on passenger motor vehicles and fuel excise on petrol and diesel that are uniform throughout the whole of Australia. The states impose taxes on vehicle purchase, transfer of ownership and annual motor vehicle registration fees, and these taxes vary from state to state. It is submitted that the current motor vehicle taxes in Australia are not based on the environmental tax principles which will be discussed in part 6.4.1, being the precautionary principle and the polluter-pays principle. It is also submitted that the existing motor vehicle taxes are not sufficiently high to impact on motorists' choice of motor vehicle and have little impact on the sustainability of oil as they were mainly designed with the specific objective of raising revenue. The existing motor vehicle taxes have not halted the increase in demand for larger cars including ATW-SUVs as discussed in part 3.4.

The problem with existing motor vehicle taxes is that they do not discourage the common attributes that cause excessive oil usage in a passenger motor vehicle, being the weight of a vehicle, the size of the engine or engine capacity and the engine power as discussed under 'The Framework of the LET System' in part 6.4.2 below. Although some state taxes are based on these characteristics — for example, New South Wales and Western Australian annual registration charges are based on weight, South Australian charges depend on the number of cylinders and the Northern Territory and Victorian charges are based on the engine size — these taxes have a very low impact on a person's choice of passenger motor vehicle. Furthermore, these taxes are not imposed at the time of making a vehicle purchase. In order to influence the purchase of a motor vehicle in a way that has an impact on the use of oil, a tax based on these characteristics should be imposed at more than one taxing point, ranging from the time of purchasing the vehicle to the disposal of the motor vehicle. The Commonwealth government in Australia does impose the LCT at the time the vehicle is purchased, but the tax is based on the purchase price and not the characteristics of the motor vehicle that cause excessive oil use or emissions. Also, the current fuel excise imposed by the Commonwealth government is not sufficiently high to influence motorists' choice and usage of passenger motor vehicles. It is submitted that the fuel excise should be based on the common attributes that cause excessive oil usage in a motor vehicle, being the vehicle weight, the size of the engine or engine capacity and the engine power, and be part of the comprehensive motor vehicle tax reform.

The proposal to reform Australia's motor vehicle taxes is in line with recommendations made by the Henry Tax Review, which noted that the existing road transport taxes in Australia are not appropriate to meet Australia's future transport challenges, and that transport taxes should be designed to correct market failures in the transport sector.[469] In this respect, this thesis proposes that priority should be given to the reduction of oil usage in passenger motor vehicles and this could be best achieved if there was a harmonious relationship between the Australian energy, transportation and tax policies in order to promote the choice of passenger vehicles that consume less fuel or use cleaner fuels, encourage a reduction in the use of vehicles, and lead to a reduction in congestion. Instead of having a variety of taxes with no specific objectives other than raising revenue, a comprehensive tax on motor vehicles should be introduced that targets the attributes of a motor vehicle that cause excessive oil use.

By carrying out an orderly reform of passenger motor vehicle taxes, the government of Australia can educate its people to seek motor vehicles that consume less oil. It is

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[469] Commonwealth of Australia, *Australia's Future Tax System: Final Report* (2 May 2010) <http://taxreview.treasury.gov.au/content/Content.aspx?doc=html/pubs_reports.htm>.

argued that this can be achieved by reforming the current motor vehicle taxes in Australia and introducing a more targeted tax such as the LET discussed in parts 6.3.5 and 6.4. The extra revenues collected as a result of this tax reform can be utilised in building sufficient infrastructure for public transport, as better public transport is likely to be demanded as the LET policy takes effect.

Employing motor vehicle tax reform to reduce oil use in passenger motor vehicles is necessary, as the Australian government has predicted that the demand for oil in motor vehicles used for personal transportation will not change at least until 2035.[470] Thus it is submitted in this thesis that maintaining the status quo is not an option that the Australian government should follow as it may take 15 to 20 years or even longer to successfully implement all the necessary motor vehicle tax reforms. To change the perception of the passenger motor vehicle from being a status symbol to a basic means of transportation will require time, both to educate the community and to influence manufacturers to make and sell appropriate motor vehicles. It will also take time to enhance the public transport system infrastructure and capacity so that it can cope with the proposed changes.

The possibility of simply increasing the current passenger motor vehicle taxes and charges in Australia without changing the structure of the taxation system is also not recommended in this thesis, as only a comprehensive reform of motor vehicle taxes is likely to effect a lasting change. The next part explores the impact of moving one step away from maintaining the status quo, by replacing the LCT in Australia with a purchase tax similar to that in Norway.

6.3.2 Replace the LCT in Australia with a Purchase Tax Similar to that in Norway

If the Australian government maintains the status quo but only replaces its LCT with a comprehensive purchase tax similar to that in Norway, then the 'Lessons for Australia' discussed in part 5.2.3 would apply. The Norwegian government's purchase tax is quite high with progressive rates of tax imposed on three components

[470] Department of Resources, Energy and Tourism, 'Draft Energy White Paper: Strengthening the Foundations for Australia's Energy Future' (Commonwealth of Australia, December 2011) 31.

of a motor vehicle, ie the weight, engine power and CO_2 emissions, as discussed in part 5.2.2. The purchase tax in Norway does not include the engine capacity, and as this factor can also cause excessive oil use in a motor vehicle, it should be included in the purchase tax calculation. Omitting this factor from the purchase tax could leave room for policy gaming by motor vehicle manufacturers. Therefore it is proposed that if the LCT were to be replaced by a purchase tax in Australia, then the purchase tax would have to be high enough to make an impact and would need to include motor vehicle characteristics such as vehicle weight, engine capacity, engine power and CO_2 emissions. Moreover, the rate should increase on a sliding scale as each of these factors increases, in order to satisfy the environmental tax polluter-pays principle discussed in part 6.4.1.

The disadvantage of this action for Australia would be that the purchase tax would only focus on the purchase of the motor vehicle and not its use. The fuel excise in Australia is not high enough to discourage the use of motor vehicles for personal transportation. Increasing fuel cost by simply increasing the fuel excise is inelastic and therefore may not be very effective in the short run. It is therefore argued in this thesis that a comprehensive tax reform for passenger motor vehicles through the LET is a much better option, where common attributes that cause excessive oil usage in a motor vehicle, being vehicle weight, engine size or engine capacity and engine power, are included in taxes imposed at the time of purchase, annual registration, fuel excise and disposal of the vehicle. Although CO_2 emissions do not have an impact on oil use, they are included in the LET to support broader environmental objectives. The need for a comprehensive motor vehicle tax reform was demonstrated in 2006 by a Norwegian study on the alteration of the car taxation system in Norway as part of its government's plan to include the CO_2 component in the purchase tax. Interviews were carried out as part of this study and the interviewees pointed out that a single change in the basis for calculating the non-recurrent fee (purchase tax) is rather a small but necessary step in a long process and is not regarded as a sufficient measure on its own. The interviewees expressed that the revision of the motor car taxation system in Norway should be integrated in a larger package of policy instruments that affect the purchase, ownership and use of cars.[471] One of the interviewees, the Director of the 'Car-Importers National Association' (Bilimportorenes Landsforening) expected the new car tax system in Norway to be comprehensive, saying in an interview:

> It would be really nice if we now made the system comprehensive. We are world champions in patching. It is always these improvised solutions. To make the system comprehensive, we must reconsider all the elements in the car taxation system and ask ourselves what we can do if we want more environmentally friendly cars, safer cars, faster replacement of the car fleet and so on. We have to do something about these taxes simultaneously.[472]

Similarly another interviewee, Karstein Farstad from the 'Norwegian Automobile Association' (Norges Automobil-Forbund) said that a full reconsideration of the tax system was necessary, encompassing a comprehensive evaluation of the purchase, ownership and the use of cars as part of Norway's motor vehicle tax reform.[473]

Although replacing the LCT in Australia with a comprehensive purchase tax would be a step in the right direction, it is submitted in this thesis that it is better for Australia to examine all the components of the motor vehicle taxation system and reconsider not only the purchase, but also the use of the vehicle. This is discussed under the LET in part 6.4.

The next part explores the option of introducing a kilometre tax in Australia, similar to the proposed kilometre/mileage tax in the Netherlands and Oregon.

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[471] Erlend Andre Tveiten Hermansen, *Governing a Technological System: The Alteration of the Car Taxation System in Norway* (Masters Thesis, University of Oslo, 2006) 46.
[472] Ibid 41.
[473] Ibid 42.

6.3.3 Supplement Motor Vehicle Taxes in Australia with the Introduction of a Kilometre/Mileage Tax as was Proposed in the Netherlands and Oregon

If Australia supplements its current motor vehicle taxes with the introduction of a kilometre tax, it will see similar advantages to those discussed in Chapter 5 in relation to the Dutch and Oregon studies, in particular under 'Lessons for Australia' (parts 5.3.3 and 5.4.7). As discussed in those parts, having to pay more per kilometre travelled is likely to bring about a decrease in commuter and leisure travel and an increase in work and leisure activities closer to home. It is also likely to lead to a reduction in car journeys and an increase in the use of public transport, thereby reducing congestion and other indirect car-related costs.

The kilometre fee, if implemented should only be imposed on private passenger vehicles and not on commercial vehicles. Commercial vehicles should be treated differently from private passenger vehicles as commercial vehicles are often chosen to satisfy a need rather than being purchased for prestige or a display of wealth. Secondly, businesses pass on their costs to consumers where possible and thus the increased cost to a business from a kilometre tax on commercial vehicles is unlikely to have much impact.

The main disadvantages of a kilometre tax system include: the cost of infrastructure required to collect the kilometre fee; privacy issues; difficulty in collecting the tax; no direct relevance to use of oil in the choice of a motor vehicle; and its regressive nature if the same rate applies to all vehicles, large and small. A kilometre tax system might be set up as a revenue raiser rather than having its roots in environmental tax principles such as those discussed later in part 6.4.1.

As regards the infrastructure for collecting the kilometre fee, the Dutch study proposed the development and use of a mobimeter for collecting and transmitting the data to the tax department. However, the study emphasised the need to protect taxpayer privacy in data collection, especially with respect to the details of commuting routes. The development of the mobimeter was left in the hands of the market.

The mileage fee technology recommended by the Oregon Task Force was a GPS receiver fitted to each motor vehicle and an odometer tag device to calculate and collect the mileage data and transmit the data to fuel stations using a radio frequency mileage data transmission device. Under the Oregon concept, the service station would account for the mileage fee to ODOT using the 'VMTCAR' administrative system. The Oregon study also emphasised the protection of privacy so that only limited location details relating to the mileage information collected through the GPS receiver would be transmitted to the government or another entity.[474]

A disadvantage of introducing a kilometre fee system in Australia is the time it would take to develop the necessary technologies for calculating and collecting the kilometre fee. Cost, accuracy and privacy issues would also need to be taken into account.

Another consideration is that a kilometre fee system has no direct relevance in promoting the choice of motor vehicle characteristics that lead to reduced oil consumption, such as vehicle weight, engine capacity and engine power. The kilometre fee system has also no direct relevance in promoting motor vehicles that emit less CO_2. The kilometre charge is based on the kilometres driven and has no bearing on the types of passenger motor vehicles on the roads, the amount of fuel they consume or the emissions they produce. A kilometre fee system that does not differentiate between the cost per kilometre for large and small cars will not encourage the purchase of a smaller, lighter and less powerful motor vehicle, and may even end up penalising small car owners. It could be argued, therefore, that a kilometre fee system would not be considered an effective means of encouraging the choice and usage of motor vehicles that consume less oil. A more comprehensive motor vehicle tax reform is required in Australia, as suggested in part 6.4, with the introduction of a LET aiming to cause motorists to change their behaviour in terms of both choosing an appropriate vehicle and the way they drive. The proposed LET design discussed in part 6.4 will not be as costly to implement as the kilometre fee system and will not have the same privacy concerns.

The next part explores the option of supplementing motor vehicle taxes in Australia with mandatory fuel economy/CO_2 standards.

[474] See discussion in part 5.4 in Chapter 5 of this thesis.

6.3.4 Supplement Motor Vehicle Taxes in Australia with Mandatory Fuel Economy/CO_2 Standards

The current Australian government as part of its election commitment of 24 July 2010 intends to introduce mandatory CO_2 emission standards that will apply to new light vehicles as from 2015 and that will form part of its Clean Energy Future Plan.[475] This part explores why the Australian government's intention to implement CO_2 standards for light motor vehicles needs to be supplemented by a comprehensive motor vehicle tax reform in order to resolve the problems identified in part 6.2 above. Since the amount of CO_2 a car emits is directly related to the amount of fuel it consumes, the problems associated with fuel economy standards such as the CAFE standards in the US discussed in part 4.2 under 'Lessons for Australia' would also apply to the proposed CO_2 standards in Australia.[476]

The Australian government's election commitment was to set a target for new light vehicles at 190g CO_2/km by 2015 and 155g CO_2/km by 2024. Accordingly, in August 2011 the government released a discussion paper entitled 'Light Vehicle CO_2 Emission Standards for Australia' in order to obtain views from interested parties on the emission targets to be established under the proposed standards and the most appropriate regulatory framework for implementing the standards.[477] The discussion paper states that light vehicles, which comprise passenger vehicles, SUVs and light commercial vehicles, are responsible for 64 per cent of Australia's transport emissions and between nine and ten per cent of total emissions, and mandatory CO_2 standards will therefore contribute to the reduction of CO_2 in the light vehicle fleet. This is particularly the case since the Australian government has decided to permanently exclude transport fuels for light vehicles from the recently implemented carbon tax legislation.[478] The setting of these standards should bring about technological benefits for the Australian vehicle fleet, however, many studies have

[475] Department of Infrastructure and Transport, above n 30, 1.
[476] Under the EU standardised test procedure, a petrol car that emits 130g of CO_2 per kilometre would consume approximately 5.6 litres of petrol per 100 kilometres. See Transport & Environment, *Briefing Car CO_2 Standards: FAQ* (December 2011) <www.transportenvironment.org/cars-and-co2>.
[477] Department of Infrastructure and Transport, above n 30, 9.
[478] Ibid 3.

pointed out that the standards should be complemented with direct tax measures to make the resulting vehicles more attractive to potential purchasers.[479]

Steven Plotkin examined the fuel economy and carbon standards for light vehicles in his discussion paper prepared for the OECD Joint Research Transport Centre in 2007 and he states that there is strong opposition to fuel economy standards from motor vehicle manufacturers, motor vehicle unions, motor vehicle enthusiasts and the economics community generally due to the limitations of the standards and their impact on oil use, public safety, consumer choice, vehicle markets and the economy.[480]

Austin and Dinan argue that fuel economy standards are economically inefficient and have costs to consumers and producers that greatly exceed their benefits. Studies undertaken by Austin and Dinan in 2005 and Jacobsen in 2010 estimate CAFE standards cost two to three times more per gallon conserved compared with an increase in fuel tax.[481]

Another possible problem with the fuel economy standard is the rebound effect caused when greater fuel economy lowers the cost of driving, leading to an increase in the vehicle miles travelled (VMT).[482] This causes increased external costs, such as air pollution, congestion, accidents and other costs associated with increased road use.[483]

The problem with the fuel economy/CO_2 standards is that they apply directly to motor vehicle manufacturers or importers and not the consumers. The aim of these businesses is to maximise profits. The normal ethos of any business is to identify the need, supply the need and make a profit. If a government regulation incurs a cost on the business, the business would want to minimise the cost in order to maximise their profit. Thus a mandatory fuel economy standard arguably creates a tension between

479 Steven E Plotkin, 'Fuel Economy Policy for Australia: Policies that Complement Fuel Economy Standards' (Paper presented at 50 By 50 Global Fuel Economy Initiative, Improving Fuel Economy in Australia, Melbourne, 2 March 2011) 171.
480 Stephen E Plotkin, 'Examining Fuel Economy and Carbon Standards for Light Vehicles' in International Transport Forum Round Tables, *The Cost and Effectiveness of Policies to Reduce Vehicle Emissions* (OECD Publishing, 1st ed, 2009) 5.
481 Soren Anderson et al, 'Automobile Fuel Economy Standards: Impacts, Efficiency and Alternatives' (Discussion Paper No RFF DP 10-45, Resources for the Future, October 2010) 13.
482 Fischer, above n 236, 3116.
483 Plotkin, above n 480, 5.

the government and the motor vehicle industry. This is evident in the USA where each manufacturer must meet the requirement for each of its fleets, even though it is more expensive for that manufacturer to do so. Thus manufacturers have to sell enough small vehicles to ensure they comply with the fleet average requirement, and in order to do this, some manufacturers end up selling smaller vehicles at little or no profit.[484] As a result, these small motor vehicles may need to be manufactured cheaply and this may have consequences for the safety and durability of the vehicle.

Manufacturers often use 'policy gaming' to overcome the standards set by government. According to a US study undertaken by James Sallee, motor vehicle manufacturers often take advantage of the fuel economy standard by making small changes such as redesigning vehicles and relabelling a passenger car as a light truck in order to improve the tax treatment by achieving a generous regulatory classification. Under the fuel economy standards for cars and trucks in the US, large cars are taxed and small trucks are subsidised. This classification may have contributed to the rising use of minivans and SUVs as family cars, as they qualify as trucks.[485] This is known as policy gaming whereby the business carries out an action that improves the tax status or complies with the regulation, but has little or no impact on improving the overall fuel economy. Another example of policy gaming is the practice of manufacturers increasing their motor vehicle range strategically to comply with the standards. For example, the small Fiats are now being sold under the Ferrari badge. According to the US National Traffic Highway Safety Administration, motor vehicle manufacturers practice policy gaming with costly technologies such as cylinder deactivation, turbo-charging, engine downsizing, conversion to dual-clutch transmissions and start-stop engine technology, and other modifications such as weight reductions without causing deterioration in power, acceleration or other attributes.[486]

Policy gaming also occurs if the fuel economy standards are not uniform, but have an incremental scale or a notch. Motor vehicle manufacturers boost fuel economy around an incremental notch by modifying the vehicle in the short term to improve its fuel economy, for example by light-weighting, where vehicle parts are substituted

[484] Fischer, above n 236, 3118.
[485] Anderson et al, above n 481, 6–8.
[486] Ibid 10.

to reduce weight; engine recalibration, where the engine is reprogrammed to operate in a different gear at certain speeds; use of low-friction lubricants; modification of tyres; or small aerodynamic changes such as the addition of a spoiler, side skirts, air dam reshaping or the installation of belly pants that smooth air flow by covering parts underneath the vehicle.[487]

Fuel economy standards may also not reduce the overall oil use in a country's motor vehicle fleet as the motor vehicle fleet may in fact increase, since there is no cap on the number of motor vehicles on the road. The standards normally require the manufacturer or the importer to maintain average fuel consumption. Thus increased sales of larger motor vehicles have to be balanced by a greater increase in sales of smaller vehicles in order to maintain the manufacturer or importer's average. Since there is no cap on the number of motor vehicles on the road, the overall oil consumption of the motor vehicle fleet may in fact increase.

Other shortcomings of fuel economy/CO_2 standards are that they only affect new cars. On the other hand if fuel taxes are increased, the increased fuel prices affect all motor vehicles, new and used.[488] Moreover, the standards are set when the motor vehicle is new and its fuel economy is at its peak. The vehicle fuel economy may deteriorate due to wear and tear of tyres, poor engine maintenance, driving style and the speed at which the motor vehicle is driven. To overcome these problems, Sallee states that a Pigouvian tax can be a more efficient policy option.[489]

Fuel economy standards have not succeeded in stopping the model creep or the demand for SUVs. Plotkin notes that in the US over the past 20 years, fuel efficiency technologies have been applied to the vehicle fleet, however the potential to improve fuel economy has been cancelled by other changes in vehicle attributes desired by vehicle buyers, especially higher performance, larger size and increased weight due to the larger vehicle size and increase in luxury and safety equipment. Plotkin states that the new fuel economy standards may constrain the trend towards larger, heavier and more powerful vehicles, but vehicle manufacturers (through vehicle advertising and design decisions) and the government through its ability to influence the public

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[487] James Sallee and Joel Slemrod, 'Car Notches: Strategic Automaker Responses to Fuel Economy Policy' (EI @ Haas Working Paper No WP-212, Energy Institute at Haas, December 2010) 9.
[488] Sallee, above n 466, 13.
[489] Ibid 2–3.

have a strong role to play.[490] Anderson et al also confirm this in their discussion paper on automobile fuel economy standards, stating that CAFE may have improved engine efficiency during the last two decades; however, motor car manufacturers have sacrificed potential improvements in fuel economy to make bigger, more powerful vehicles, probably in response to consumer preferences.[491]

Taking into consideration the arguments raised above, it is submitted that **the Australian government should focus its policies on consumers and not just manufacturers and importers of motor vehicles,** regulating consumer preferences for passenger motor vehicle transportation through appropriately designed motor vehicle taxes such as the LET. The public's perception of the motor vehicle as a means of transportation and the energy or oil use associated with it can best be influenced by imposing appropriate taxes. The fuel economy/CO_2 route is an indirect way of influencing consumers, whereas a direct tax on consumers would influence both the consumers and the motor vehicle manufacturers. If, as a result of the LET, consumers choose appropriate motor vehicles based on characteristics that result in less oil consumption, the motor vehicle manufacturers would supply that demand in order to make a profit. Manufacturers have the capacity to build such motor vehicles, however the government has to initiate that drive through the proposed LET system as discussed below.

6.3.5 Comprehensive Reform of Motor Vehicle Taxes and Charges in Australia and the Introduction of a LET System

A comprehensive reform of all motor vehicle taxes in Australia is suggested in this thesis to resolve the problems described in part 6.2 above. The next part of this thesis proposes a new LET system for passenger motor vehicles in Australia and explains how it would function, and how the current taxes and charges relating to passenger motor vehicles can be reformed.

The proposed LET system can be designed with the aim of influencing the purchase of an appropriate passenger vehicle, its use and its disposal. The proposed LET is

[490] Plotkin, above n 480, 30.
[491] Anderson et al, above n 481, 8.

also aimed at influencing the design of future passenger motor vehicles. If consumers demand appropriate motor vehicles as a result of the introduction of the LET as well as the new fuel economy/CO_2 standards set by the Australian government, motor vehicle manufacturers will supply that demand, thereby creating a new motor vehicle industry, which could potentially expand to an international market. The creation of new jobs for Australians could thus be an indirect impact of the LET.

The proposed LET is aimed at providing revenues to the government that could be used to improve public transport infrastructure and create an efficient public transport system that would be suitable for the next 100 years. This would both meet the expected increased demand for public transport resulting from the introduction of the LET, and create job opportunities for Australians.

As the LET policy takes effect, ownership and use of motor vehicles for personal transportation should decline, resulting in a corresponding decline in government revenues. However, the increased income from the improved public transport system should then supplement the government's loss of LET revenue (if the government has not privatised the public transport system).

The next part explains the details of the proposed LET system.

6.4 THE LET SYSTEM

The proposed LET system is discussed in five parts. Part 6.4.1 explains the core environmental tax principles upon which the LET is based. Part 6.4.2 explains the framework for the LET followed in part 6.4.3 by the design of the LET system. Part 6.4.4 explores the operation and administration of the LET design framework followed in part 6.4.5 by implementation of the LET system.

6.4.1 The Principles of the LET System

The main principle of the proposed LET is to reduce oil consumption by passenger motor vehicles in Australia and reduce CO_2 emissions. The proposed LET is an environmental tax based on two underlying principles that are commonly used by policymakers, which are:

- The precautionary principle; and
- The polluter-pays principle.[492]

a. The Precautionary Principle

The origin of the precautionary principle traces back to the German concept of 'Vorsorgeprinzip', which literally means 'foresight principle'. The precautionary principle is now widely used in international environmental law and received strong endorsement in the Rio Declaration on Environment and Development, adopted in 1992 by the United Nations Conference on Environment and Development in Rio de Janeiro.[493]

The precautionary principle has been described as a decision-making approach which ensures that, even without conclusive scientific proof, a substance or activity that poses a threat to the environment should be curbed.[494] The principle, both in its conceptual core and its practical implications, is preventative and provides the philosophical authority to make decisions in the face of uncertainty. It is symbolic of the need for change in human behaviour towards sustainability, and in this thesis, the emphasis is on change in behaviour for the sustainability of oil, by using tax measures to reform the choice and usage of motor vehicles for personal transportation. The proposed LET is an environmental tax developed by applying the precautionary principle with the aim of preventing the depletion of oil that is required

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[492] There are many prestigious books and refereed articles published on the precautionary principle and the polluter-pays principle, for example, see: Sharon Beder, *Environmental Principles and Policies* (University of New South Wales Press, 2006); Nicolas de Sadeleer, *Environmental Principles From Political Slogans to Legal Rules* (Oxford University Press, 2005); Richard Moules, *Environmental Judicial Review* (Hart Publishing, 2011); J F de Carvalho, Sonia Seger P Mercedes and Ildo L Sauer, 'Precautionary Principle, Economic and Energy Systems and Social Equity' (2010) 38(10) *Energy Policy* 5399; Peter Dorman, 'Evolving Knowledge and the Precautionary Principle' (2005) 53(2) *Ecological Economics* 169; Katie Steele, 'The Precautionary Principle: A New Approach to Public Decision-Making' (2006) 5(1) *Law, Probability and Risk* 19.

[493] Paul L Stein, 'Are Decision-Makers Too Cautious With The Precautionary Principle?' (Paper presented at the Land and Environment Court of New South Wales Annual Conference, Blue Mountains, 14–15 October 1999) 3.

[494] Ibid 5.

for transportation and other needs, and reducing Australia's dependence on foreign oil.

The precautionary principle does not provide guidance as to how the government should make its policy choices between environment and economic values, but lack of scientific certainty should not be used as a reason for postponing measures. The precautionary principle requires policies to be considered in the broader context of ecologically sustainable development (ESD). ESD was defined in the 1987 Brundtland Report of the World Commission of Environment and Development as having to '[meet] the needs of the present without compromising the ability of future generations to meet their own needs.'[495] The question as to whether the Australian oil position requires any action under the precautionary principle can be answered by examining the Australian government's statement on the matter in the Draft Energy White Paper that was released in December 2011. This paper states that:

- Australia is increasingly dependent on foreign oil and therefore needs to halt the demand for liquid fuel that has steadily risen over the past decade and is projected to grow at a rate of 1.2 per cent a year over the long term;[496]
- Australia's liquid fuel demand will increasingly be met by imports of crude and refined products and Australian refineries will source around 80 per cent of crude oil needs from overseas;[497]
- The transport sector is the largest final consumer of liquid fuels, accounting for around three-quarters of Australia's final use;[498] and
- Oil will remain the primary energy source for the transport sector to 2035 and changing policies and technologies could result in a demand-induced peak in global production after 2020. The risk of major supply disruptions remains an unknown, but ever-present factor.[499]

[495] Gro Harlem Brundtland, *Our Common Future* (World Commission on Environment and Development, 1987) <http://www.earthsummit2012.org/about-us/historical-documents/92-our-common-future> (The Brundtland Report). Also see John Drexhage and Deborah Murphy, 'Sustainable Development: From Brundtland to Rio 2012' (Background Paper prepared for consideration by High Level Panel on Global Sustainability at its first meeting, United Nations Headquarters, 19 September 2010).
[496] Department of Resources, Energy and Tourism, above n 470, 113.
[497] Ibid 111.
[498] Ibid 113.
[499] Ibid 31.

The precautionary principle therefore implies that there is a responsibility on the part of the Australian government to intervene and protect the public from harm where scientific investigation discovers a plausible risk. As discussed in Chapter 2, many organisation and government reports indicate the status of Australian and global oil reserves and confirm the need to reduce oil consumption. By applying the precautionary principle, the Australian government bears the responsibility for reducing the wastage of oil. The word 'precaution' is defined in the Shorter Oxford English Dictionary as a measure taken beforehand to ward off an evil. The evil that needs to be warded off is an abrupt halt in the oil supply and the consequences of a lack of preparation for a life without oil, especially for the personal transportation needs of the Australian people. Using the precautionary principle, the Australian government needs to educate and prepare its people for life without cheap, abundant oil. This thesis proposes that the first step in achieving this purpose is the introduction of the LET.

b. The Polluter-Pays Principle

The polluter-pays principle (PPP) was first advocated by the OECD Council on Guiding Principles concerning International Economic Aspects of Environmental Policies as: 'The principle to be used for allocating costs of pollution prevention and control measures to encourage rational use of scarce environmental resources and to avoid distortions in international trade and investment.' It then went on to elaborate: 'This principle means that the polluter should bear the expenses of carrying out the above-mentioned measures decided by public authorities to ensure that the environment is in an acceptable state.'[500] The PPP is today one of the fundamental principles of the environmental policy of the European Community and at the international level.

An environmental tax designed using the PPP allocates the cost to the polluter, and can be set at a level that covers the cost of the defined pollution. However, a higher

[500] Organisation for Economic Co-operation and Development, *Recommendation of the Council on Guiding Principles concerning International Economic Aspects of Environmental Policies,* C(72)128 (26 May 1972).

rate could also be set, not just to cover the cost of the defined pollution, but to achieve a desired behaviour change.[501]

It is proposed that the LET should adopt the PPP by imposing taxes on motorists who purchase or use passenger motor vehicles that are energy guzzlers, in order to provide an incentive to modify their behaviour. The suggested rates for the LET should not only cover the cost of the defined pollution, but should be set at a rate that motivates behaviour change.

Based on the above principles, the next section explores the criteria for shaping the framework of the LET.

6.4.2 The Framework for the LET System

Similar to Oregon, the configuration of the LET system should be developed according to set criteria. It is proposed that the framework of the LET system should reflect the common attributes of a motor vehicle that cause excessive oil usage, which are: the weight of the vehicle; the size of the engine or engine capacity; and the engine power. The LET should also reflect the CO_2 emissions, as discussed below.[502]

a. The Weight of the Vehicle

The weight of a vehicle reflects the energy required in moving that vehicle. This is because a vehicle's power at the wheels is required to overcome the force of inertia to accelerate from zero to the desired speed or from one speed to a higher one, overcome the forces of air drag and tyre friction, and overcome the force of gravity when climbing a grade. Plotkin notes that the weight of a motor vehicle affects two of the three primary sources of energy use in driving and therefore weight reduction

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[501] See Janet E Milne, 'Environmental Taxation: Why Theory Matters – Critical Issues in Environmental Taxation' in Janet E Milne et al (eds), *Critical Issues in Environmental Taxation: International and Comparative Perspectives* (Richmond Law & Tax, 2003) vol 1, 2–3. See also, Anuschka Bakker, *Tax and the Environment: A World of Possibilities* (IBFD, 2009) 7–10.

[502] These criteria are similar to those implemented in Norway as discussed in the case study in Chapter 5 of this thesis.

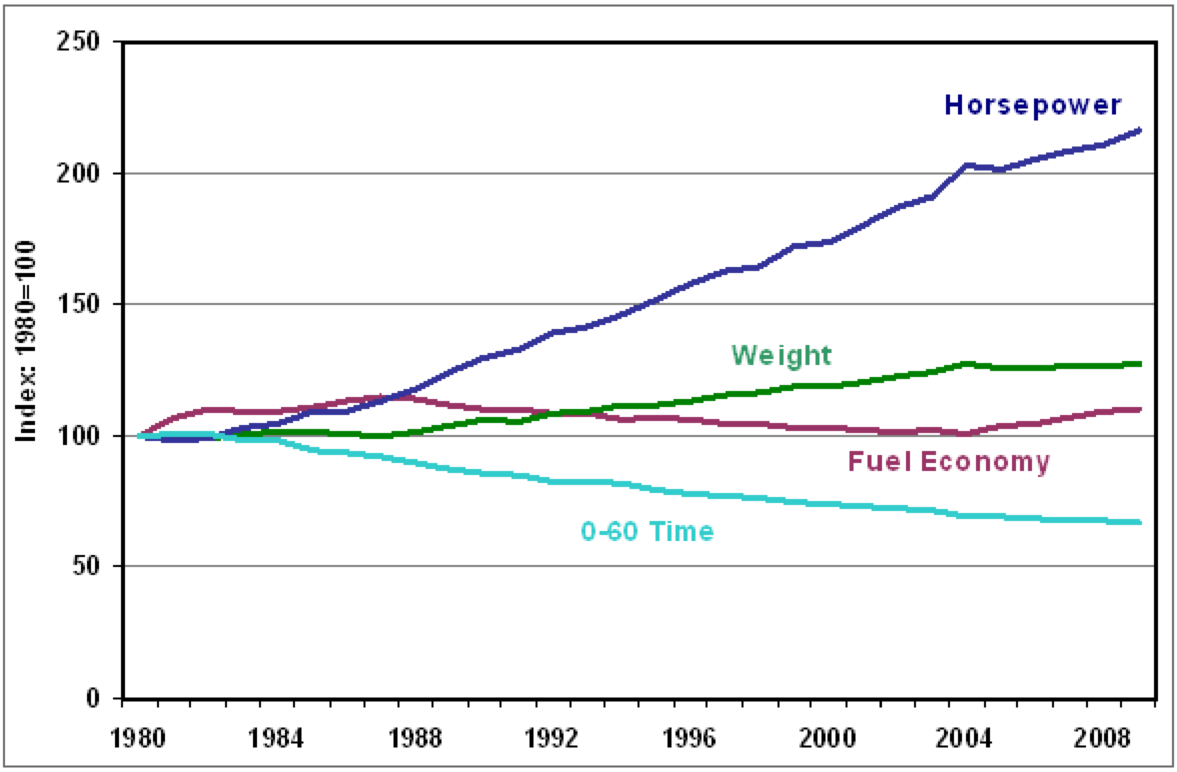
is an excellent way to reduce the energy needed by a vehicle. He states that the weight of the vehicle affects the inertia required in accelerating the car as well as the rolling resistance from tyre friction.[503] Cheah states that every 100kg of weight reduction will yield a 0.39L/100 kilometre reduction in fuel consumption for the current average gasoline car in the US.[504] She states that as a general rule of thumb, for every 10 per cent reduction in vehicle weight, the fuel consumption of vehicles is reduced by five to seven per cent.[505] Plotkin also states in his discussion paper that if a vehicle designer achieves a weight reduction of 10 per cent and maintains constant performance by using a slightly smaller engine, fuel economy will be improved by about six to seven per cent, measured by the standard EPA fuel economy test, which assumes that 55 per cent of driving is in the city and 45 per cent on the highway.[506]

In the US, the average weight of passenger motor vehicles has been steadily increasing at a rate of 1.2 per cent per annum over the past two decades, levelling off at 1730kg in 2009. Data released by the US Environmental Protection Agency show that the only occasion in the past four decades where the vehicle weight decreased significantly was in the late 1970s in response to the oil crisis and the introduction of the CAFE program.[507] The Australian position is very similar to that of the US, if not worse.

The question to ask is what has caused the average vehicle weight to increase and how can the vehicle weight be reduced? The US Department of Energy states that the increase in vehicle weight has been primarily caused by an increase in vehicle size as well as reinforced structures and added safety equipment.[508] The US new light vehicle characteristics from 1980 to 2009 are shown in Figure 6.1.

[503] Plotkin, above n 480, 38.
[504] Lynette W Cheah, *Cars on a Diet: The Material and Energy Impacts of Passenger Vehicle Weight Reduction in the US* (Thesis, Doctor of Philosophy in Engineering Systems, Massachusetts Institute of Technology, September 2010) 32.
[505] Ibid 13.
[506] Plotkin, above n 480, 38.
[507] Environmental Protection Agency, 'Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 through 2009' (Technical Report, EPA420-R-09-014, US Environmental Protection Agency, November 2009) 14.
[508] Energy Efficiency and Renewable Energy, above n 263.

FIGURE 6.1: New Light-Weight Vehicle Characteristics 1980–2009



Source: US Department of Energy, *Energy Efficiency and Renewable Energy: Vehicles Technologies Program*.

In the Australian context, Chapter 3 discussed how the Holden family car has increased in weight, engine size, engine power and emissions between 1948 and 2008.[509] When the engine size and engine power are increased, the motor vehicle parts increase in size and strength, thus adding weight to the motor vehicle. On average, 40 per cent of the vehicle weight is allocated to the body, 24 per cent to the chassis and 16 per cent to its power train.[510] The balance of the weight comes from added accessories. Kågeson notes that reducing the mass of the frame and the body makes it possible to reduce the size of the engine.[511]

The problem of excessive weight has been recognised by governments in many countries as reflected in their fuel economy standards or their motor vehicle tax policies. The Japanese and the Chinese fuel economy standards are weight-based,

509 See Table 3.2.
510 Cheah, above n 504, 33–4.
511 Per Kågeson, 'Reducing CO_2 Emissions from New Cars: A Progress Report on the Car Industry's Voluntary Agreement and an Assessment of the Need for Policy Instruments' (European Federation for Transport and Environment, January 2005) 18.

discouraging excessive weight. The US Department of Energy's Vehicle Technologies Program has established the ambitious goal of reducing the weight of the vehicle structure and subsystems by 50 per cent by 2015.[512] The motor vehicle tax structure in Norway emphasises weight, as discussed in Chapter 5. The LET should also recognise that weight is directly related to a motor vehicle's energy or oil use, and the assessment for the LET should allocate a greater rate for a heavier motor vehicle, compared with a lighter motor vehicle. By recognising the vehicle weight as one of the characteristics in the design of the LET, users will have a choice between purchasing and using lighter motor vehicles or paying the tax.

Basing the LET on vehicle weight would also encourage manufacturers to build lighter vehicles. Cheah states that reductions in vehicle weight can be achieved by replacing heavy materials with lighter materials such as high-strength steel, aluminium or magnesium, and by vehicle redesign and vehicle downsizing. She states that creative redesign can be employed by motor vehicle manufacturers to reduce vehicle size and weight whilst maintaining the same interior space. Another way of reducing weight is to consolidate, eliminate or downsize parts or remove some optional content from the motor vehicle.[513]

Many critics argue that a reduction in vehicle weight may jeopardise the safety of a motor vehicle. Plotkin argues that this is not so and quotes studies by Van Auken and Zellner in 2003 showing that reducing the average weight of the light duty vehicle fleet would actually lead to improved safety if average vehicle size measured by wheelbase and track width remained unchanged. Plotkin also quotes Ross and Wenzel's 2002 study which concluded that vehicle design plays a more critical role in vehicle safety than weight. Their study also concluded that pick-ups and SUVs are about twice as dangerous as cars to the vehicles that they collide with because of their high bumpers and rigid frames.[514] More recently, Cheah has argued that it is possible to design and build small vehicles with safety standards similar to larger vehicles by reinforcing the structural stiffness of the vehicle at critical points and

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[512] Plotkin, above n 480, 12; Also see US Department of Energy, *Vehicle Technologies Program: Goals, Strategies, and Top Accomplishments* (December 2010) <http://www1.eere.energy.gov/vehiclesandfuels/pdfs/pir/vtp_goals-strategies-accomp.pdf>.
[513] Cheah, above n 504, 33–4.
[514] Plotkin, above n 480, 8.

introducing crumple zones to absorb energy in case of a collision.[515] Kågeson noted American data stating that SUVs are nearly three times more likely to kill drivers of other vehicles than other mid-sized cars. This is due to their stiff frames and their height. Occupants of SUVs are also more likely than car occupants to die in a rollover. The death rate in crashes per million SUVs on the road is six per cent higher than the death rate per million in cars.[516]

The recognition of weight as an element of the LET design is further discussed in part 6.4.3 below. The design of the tax should penalise weight on an incremental basis, similar to the Norwegian system, but with more bands in order to reduce policy gaming around a notch and to satisfy the environmental tax principles, in particular the PPP. The LET design illustrated in part 6.4.3 has 30 bands of weight ranging from 600kg to 3000kg. A vehicle weighing more than 3000kg should require special approval or a certificate of entitlement similar to the situation in Singapore. In this way, consumers have the choice between purchasing and using a lighter vehicle which does not attract LET, or a slightly heavier vehicle that does attract some LET, or a very heavy vehicle that attracts a large amount of LET or requires special approval.

b. The Size of the Engine or Engine Capacity

Engines with greater capacities are usually more powerful and provide greater torque at lower revolutions per minute (rpm). A bigger engine will also weigh more, creating more rolling resistance. Therefore an engine that is larger in cubic centimetres has the capacity to increase power and in the process consume more oil.

Engine capacity refers to the swept volume by the pistons of the engine's cylinder. The engine cylinder sits at the core of the engine and is the space in which the piston moves up and down, working as a stopper that compresses air and fuel to make mechanical energy. Thus a two litre engine capacity means that an engine has the capacity for two litres of compressed air and fuel mixture to fill the cylinders if all

[515] Cheah, above n 504, 45.
[516] Kågeson, above n 511, 36.

the pistons are at the bottom of the cylinders. If a two litre engine has four cylinders, then each cylinder has a half-litre capacity. More cylinders mean a greater potential to produce power and in the process more fuel can be consumed. In Australia, the engine capacity is measured in cubic centimetres (cc).

Motor vehicle manufacturers often use a large engine capacity as a marketing point to sell more vehicles, in that a model with a larger engine capacity is more powerful and has the capacity to reduce time at take-off when accelerating from zero to 100 kilometres per hour. The Holden family car in 1948 had a 2.15 litre engine and it took 20 seconds to accelerate from zero to 100 kilometres. However, the Holden family car now has a 3.6 litre engine and takes only 8.6 seconds to accelerate from zero to 100 kilometres.[517] The question is whether a large engine capacity is necessary if motor vehicles are viewed simply as a means of transportation and whether this desire for a rapid take-off speed comes at a high cost in terms of fuel efficiency.

Plotkin explains this concept by stating that petrol engines are most efficient at high loads, in that petrol engines are most efficient when the power demanded of them is a substantial fraction of their maximum power. A large engine would accelerate faster at take-off but consume a substantial amount of fuel or oil. This power is not required during normal driving and would therefore pay a large penalty on fuel.[518] This is because of the volume of combustible mixture introduced into the cylinders. The engine requires a richer mixture of around four parts of air to one part of fuel by weight when starting the vehicle from cold, compared with about 14 parts of air to one part of fuel by weight during normal driving.

Plotkin states that a small engine that uses its substantial power most of the time with a facility to artificially boost its power when required is better than a large engine that only uses its substantial power on take-off.[519]

The design of the LET recognising engine capacity as a characteristic of the tax is further elaborated in part 6.4.3 below. It is proposed that the design of the LET should penalise the engine capacity on an incremental basis. The LET design

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517 See discussion in Chapter 3 of this thesis.
518 Plotkin, above n 480, 39.
519 Ibid.

illustrated in part 6.4.3 has 30 bands of engine capacity ranging from 600cc to 6000cc. A vehicle with more than 6000cc of engine capacity should require special approval or a certificate of entitlement similar to the system in Singapore. In this way, consumers have the choice between purchasing a car with a 600cc engine which does not attract LET, or car with a slightly bigger engine capacity that does attract some LET, or a car with a very large engine capacity that attracts a large amount of LET.

c. The Engine Power

The design of the LET should also take into consideration the power generated by a motor vehicle since engine weight, engine capacity and engine power are interrelated and if one of the factors is omitted from a tax scheme, it can encourage policy gaming. A smaller motor vehicle engine can be made to produce more power in a number of ways such as forced air induction. For example, the Subaru Impreza WRX with its two litre engine capacity produces more power than a Ford Falcon with a four litre engine capacity by the addition of a turbocharger. A turbocharger increases the amount of airflow into the engine cylinders. This allows an increased amount of fuel to be burnt, thereby producing more power. However, this increases the fuel consumption as demonstrated in Table 6.1 where the Subaru WRX STI is compared with the Subaru 2.5i Sports Premium Wagon.

TABLE 6.1: Specifications of Subaru WRX STI Compared with Subaru 2.5i Sports

	Subaru WRX STI	**Subaru 2.5i Sports Premium Wagon**
Engine Specifications	Turbocharged horizontally-opposed Boxer 4-cylinder, petrol engine	Horizontally-opposed Boxer 4-cylinder, petrol engine
Capacity (cc)	2457	2457
Power	221kW @ 6700rpm	123kW @ 5600rpm
Torque	350Nm @ 2400rpm	229Nm @ 4400rpm
CO_2	249g/km	193g/km
Fuel Economy – combined	10.6L/100km	8.3L/100km

Source: Subaru (2012) <http://subaru.com.au>.

Both the Subaru WRX STI and the Subaru 2.5i Sports Premium Wagon have the same engine capacity. However, the turbocharged engine in the Subaru WRX STI produces power at 221kW @ 6700 rpm whereas the naturally aspirated engine in the Subaru 2.5i Sports Premium Wagon produces power at 123kW @ 5600rpm. Turbocharging can improve fuel efficiency. However, the fuel consumption also increases in the process as demonstrated above.

Imposing a LET on the engine power would encourage consumers to seek motor vehicles with engines that do not produce excessive power, and such motor vehicles may drive a little slower, resulting in reduced air drag. Air drag varies according to the speed of the car; increase the speed, square the amount of air drag. Thus reducing the speed of the motor vehicle can reduce drag, and since greater drag requires more energy to overcome it, reducing the drag means a reduction in oil consumption.

The recognition of engine power as an element of the LET is further elaborated in part 6.4.3 below. It is proposed that the design of the LET should penalise engine power on an incremental basis, similar to how it is done in Norway, but with more bands. This should not affect the benefits of turbocharging as smaller engines can be turbocharged to obtain efficiency. Modern engines have come a long way in the past few decades, and now feature technologies such as direct fuel injection, variable valve timing, and variable intake length to maximise performance while minimising fuel consumption and emissions output. Modern engines can have higher compression ratios which minimises the need for a substantial amount of boost to make reasonable power.[520]

The LET design illustrated in part 6.4.3 recognises this, and allows for 30 bands of engine power ranging from 40kW to 340kW. A vehicle with more than 340kW would require special approval or a certificate of entitlement. In this way, consumers have the choice between purchasing a vehicle that does not attract LET, or a vehicle with a more powerful engine that attracts more LET.

d. CO_2 Emissions

In addition to the three characteristics of weight, engine capacity and engine power, the LET should also discourage passenger motor vehicles with high CO_2 emissions. A study undertaken in 2002 by the European Commission's Directorate-General for Environment on fiscal measures to reduce CO_2 emissions in new passenger cars concluded that a CO_2 component in car taxation systems with significantly progressive tax rates could provide a solid incentive for consumers to choose a car with low CO_2 emissions. The report concluded that the more progressive the curve, the larger its effects would be.[521]

As discussed in Chapter 5, the taxation system in Norway has a CO_2 component as part of its purchase tax. The rates of tax in Norway are on a sliding scale with no tax being attracted for CO_2 emissions of 115g/km and the rate increasing with increasing emissions thereafter. Many European countries impose motor vehicle taxes based on CO_2 emissions.[522]

The LET design recognising CO_2 emissions as an element of the tax is further elaborated in part 6.4.3 below. It is proposed that the design of the tax should penalise CO_2 emissions on an incremental basis. The illustration of the LET design

[520] Kurt, *Huge Growth in Turbocharged Cars Expected* (8 February 2011) TopSpeed <http://www.topspeed.com/cars/car-news/huge-growth-in-turbocharged-cars-expected-ar113421.html>.
[521] European Commission's Directorate-General for Environment 'Fiscal Measures to Reduce CO_2 Emissions from New Passenger Cars: Main Report' (Final Report, January 2002) 114.
[522] See Appendix 1.

in part 6.4.3 shows 30 bands of CO_2 emissions ranging from 80g/km to 320g/km. A vehicle emitting more than 320g/km would require special approval or a certificate of entitlement similar to the requirement in Singapore. In this way, consumers would have the choice to purchase a car that emits less CO_2/km and pay a lower LET.

e. The Taxing Points

The LET should be a comprehensive tax in order for it to have an impact on influencing people to make appropriate choices of passenger motor vehicles for personal travel, thereby reducing oil consumption.

Norway’s car taxation system does this to a limited extent in its design of the purchase tax as discussed in Chapter 5. Norway’s motor vehicle tax system would have been more comprehensive if the same thinking as for the purchase tax had been applied to other taxing points, ie the annual registration and fuel excise, although Norway does have a separate annual weight-based tax. The proposed design of the LET system in Australia should encompass the four characteristics of the motor vehicle, being its weight, engine capacity, engine power and CO_2 emissions, and to make the system comprehensive, the same characteristics should be taxed at four taxing points being:

- the purchase of the vehicle;
- the annual registration;
- the fuelling of the vehicle; and
- the disposal of the vehicle.

Including the same motor vehicle characteristics at each of the proposed taxing points makes the LET system comprehensive, and the impact of purchasing a particular motor vehicle is reflected throughout the ownership of the vehicle. The reason for imposing the LET at each of the taxing points is discussed further below.

f. Taxing Point: The Purchase of the Vehicle

Vehicle purchase and one-off registration taxes can have an impact on a motorist's choice about whether or not to purchase a motor vehicle and about which type of motor vehicle to purchase. However this influence would depend on the structure of the tax and the tax rate. As discussed in Chapter 4, many countries impose one-off motor vehicle taxes on the purchase of a motor vehicle based on fuel efficiency, CO_2 emissions, vehicle weight and engine power. Many European countries have one-off motor vehicle taxes on the purchase of the vehicle that differ for small, medium and large vehicles.[523] Singapore and China control the purchase of motor vehicles by releasing COEs or auctioning licence plates.[524]

In Australia, the purchase of a new motor vehicle attracts state government stamp duty or vehicle registration duty as follows.

TABLE 6.2: Stamp Duty / Vehicle Registration Duty on Car Purchases

	Value of Car / Private Motor Vehicle (AUD)			
	10 000	20 000	40 000	80 000
New South Wales	300	600	1200	3100
Victoria (new cars)	250	500	1000	4000
Queensland	300	600	1200	2400
Western Australia	125	550	2300	5200
South Australia	340	740	1540	3140
Tasmania	300	600	1600	3200

Source: 'Buying a Car in Australia – What You Need to Know' (2012) *Living in Australia* <http://www.livingin-australia.com/buying-a-car/>.

These taxes are rather low to make any impact on a person's decision about whether or not to purchase a motor vehicle and the type of motor vehicle to purchase. A new vehicle may also attract the Commonwealth government's 33 per cent LCT if the cost of the motor car is more than the luxury car tax threshold of AUD57 466 for the

[523] See Chapter 4, Figure 4.6.
[524] See Chapter 4, part 4.5.

2011–12 financial year.[525] For a fuel-efficient car, meaning a car with a combined cycle fuel consumption of less than seven litres per 100 kilometres, the LCT threshold is AUD75 375. The LCT is based on the price of the motor vehicle with only one threshold of fuel consumption, being consumption in excess of seven litres per 100 kilometres.

The proposed design of the LET discussed in part 6.4.3 would replace the LCT on purchase of a new motor vehicle with a purchase LET based on the four motor vehicle characteristics discussed above, ie its weight, engine capacity, engine power and CO_2 emissions. The new purchase LET has the potential to be quite high depending on the four characteristics of the chosen vehicle and the tax rate. The LET payable on the purchase of a new motor vehicle would differ for each vehicle as the four characteristics would differ for each vehicle. Therefore the purchase LET is likely to make an impact on the choice of the vehicle and the characteristics that impact on the use of oil in a passenger motor vehicle.

The working design of the purchase LET is discussed in part 6.4.3, the means of collecting the purchase LET is described in part 6.4.4 and the compliance and administration cost of the purchase LET is discussed in part 6.4.5.

g. Taxing Point: The Annual Registration Tax

Many countries charge annual registration or road licence fees as discussed in Chapter 4. In Australia, the states charge annual registration or licence fees and the basis of the charge differs from state to state. The licence fees in New South Wales, Victoria, Western Australia and Australian Capital Territory are based on the weight of the vehicle. In Queensland, South Australia, Tasmania and the Northern Territory they are based on the number of cylinders and engine capacity. In Western Australia, the annual registration fee for the year ended 30 April 2011 was made up of three components:

[525] Commissioner of Taxation, *Luxury Car Tax Determination LCTD 2011/1 – Luxury Car Tax: What Are the Luxury Car Tax Threshold and the Fuel-Efficient Car Limit for the 2011–12 Financial Year?* (20 June 2011) Australian Taxation Office <http://law.ato.gov.au/pdf/pbr/lcd2011-001.pdf>.

- Vehicle licensing fee worked out per 100kg of vehicle mass at the rate of AUD17.53 if the gross weight of the vehicle is less than 4.5 tonnes;
- Compulsory third party injury insurance premium of AUD245
- Recording fee of AUD13.05.

For example, the Western Australian Department of Transport imposed the following annual taxes on a six cylinder Holden Commodore weighing 1695kg:

TABLE 6.3: Annual Motor Vehicle Licence Fees for Holden Commodore for 2011

	Family Use Fees	**Business Use Fees**
Licence Fee	202.55	269.55
Insurance	222.73	236.45
GST on Insurance	22.27	23.65
Stamp Duty on Insurance	24.50	26.00
Recording Fee	13.05	13.05
Total Due	**485.10**	**568.70**

Source: Licence and Third Party Insurance Policy First and Final Account for Holden Commodore Dated 19 September 2011

The state annual registration fees in Australia are too low to make any impact on the choice of motor vehicle. Under the proposed LET design discussed in part 6.4.3, the states would continue to impose the above fees on each vehicle, but would include an additional annual registration LET charge. It is proposed in this thesis that the calculation of the annual registration LET would be based on the same four motor vehicle characteristics that were reflected in the purchase LET, ie the vehicle weight, engine capacity, engine power and CO_2 emissions. The reason for this is to allow the proposed LET design to influence not only the purchasing decision, but to have that decision be reflected right throughout the ownership of the vehicle, including the annual registration charges, as well as the fuelling of the vehicles (discussed next).

The working design of the annual registration LET is discussed in part 6.4.3, the collection of the annual registration LET is outlined in part 6.4.4 and the compliance and administration cost of the annual registration LET is discussed in part 6.4.5.

h. Taxing Point: The Fuelling of the Vehicle

Many countries including Australia charge excise duty on the fuel used in running vehicles. The current fuel excise rate in Australia is 38.143 cents per litre. As discussed in Chapter 4, the excise on petrol in Australia has in fact decreased by 36.86 per cent in the ten years to 2010.[526]

In order to bring about a reduction in the use of motor vehicles for personal transportation, it is necessary to increase the rate of fuel excise. The proposed LET design discussed in part 6.4.3 sets the excise rate based on the four motor vehicle characteristics, being weight, engine capacity, engine power and CO_2 emissions. Thus each motor vehicle attracts a different excise rate depending on the four characteristics of that motor vehicle. In this way, the decision to purchase a particular motor vehicle is reflected in the ongoing use of the vehicle, including the price of fuelling that vehicle.

Since oil is considered a luxury, a person who chooses to drive a motor vehicle that has the potential to use more oil should have to pay for fuel at a higher rate, the aim being to deter motorists from choosing such motor vehicles. The reasoning behind this concept is that a person who chooses to drive a large and heavy motor vehicle that consumes more oil is depleting the oil resources faster and thereby taking away from future generations the opportunity to access energy from oil. Imposing a higher tax rate for such vehicles does not deny motorists the choice of such vehicles, but makes them aware of the implications of that choice through their hip pocket. High fuelling costs would certainly act to deter a person from choosing such a motor vehicle, and may even encourage someone to use public transport instead of using a passenger motor vehicle.

[526] See Chapter 4, part 4.4.2, Table 4.12.

The working design of the fuel LET is discussed in part 6.4.3, the collection of the fuel LET is described in part 6.4.4 and the compliance and administration cost of the fuel LET is discussed in part 6.4.5.

i. Taxing Point: The Disposal of a Vehicle

The reason for including the disposal of the vehicle as a taxing point under the LET is to extend the consideration of motor vehicle characteristics to the point of disposal and the energy required for that disposal. A disposal fee would promote car designs that both attract lower disposal fees and have a longer existence.

Motor cars should be built to last for a reasonable time. Buses last for at least 20 years.[527] Even aircraft used on long flights have a lifespan of at least 20 years or longer; some 747s last 25 to 30 years.[528] If aircraft that are exposed to extreme weather conditions are built to last at least 20 years, the question to ask is whether we are being extravagant in terms of energy usage by scrapping motor vehicles within 10 years. If motor vehicles were built to last, manufacturers might be inclined to use more expensive, energy-efficient materials in building the vehicle, for example, aluminium chassis and fibre glass bodies. Thus the cost of the vehicle would not increase over its lifespan.

Some may argue that building motor vehicles for increased longevity could destroy the Australian motor car industry, leading to loss of jobs. This does not have to be so, as the Australian government can encourage production of a new motor vehicle that satisfies the LET design criteria and that requires minimum repairs and is built to last. The government can also create employment by building on the public transport infrastructure and creating an efficient public transport system that is patronised by a greater number of people.[529]

Passenger motor cars should be seen as a means of transportation, rather than as a mark of prestige and wealth. If this display of wealth comes at a cost to society in

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[527] Sustainable Energy Association of Australia, 'Submission: Public Transport Plan 2031' (Sustainable Energy Association of Australia, October 2011) 5.
[528] Rebecca Maksel, 'What Determines an Airplane's Lifespan?' *Air & Space Smithsonian Magazine* (online), 1 March 2008 <http://www.airspacemag.com/need-to-know/NEED-lifecycles.html>.
[529] Laird et al, above n 8, 137.

terms of the depletion of our limited oil resource, then the Australian government should discourage the purchase and use of those types of vehicle by introducing the LET.

Before exploring the working design of a comprehensive LET system, the next section discusses the level of government in Australia that should ideally impose the LET and the constitutional justification of its power to do so.

j. Commonwealth or State Tax

Some of the current motor vehicle taxes in Australia such as the annual registration taxes are imposed by the states, whereas others such as the LCT and fuel excises are imposed by the federal government. Therefore it is important to establish the level of government that can and that should impose and collect the LET at the four taxing points discussed above, and how the revenues from the LET should be dealt with.

In order to determine which level of government can and should impose the LET, it is necessary to consult the Australian Constitution. Section 51(ii) of the Constitution allows the Commonwealth to impose taxation, and since this power is a concurrent power, the states can also legislate and impose taxation. However the states cannot impose excise, as s 90 of the Constitution gives exclusive power to the Commonwealth to impose duties of customs and excise. The High Court of Australia in the case of *Ha v New South Wales*[530] confirmed that duties of excise are taxes on the production, manufacture, sale or distribution of goods, that is, taxes on some step taken in dealing with goods.[531]

The first of the four taxing points is the purchase LET, which is to be imposed on the purchase of a passenger motor vehicle. Under the definition of the duties of excise established in the abovementioned High Court decision, the purchase LET would be considered to be an excise as it is a tax on the sale of a car. Therefore only the Commonwealth government would be able to impose the purchase LET.

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[530] (1997) 189 CLR 465; 97 ATC 4674.
[531] (1997) 189 CLR 465; 97 ATC 4674, 4679 and 4684 (per Brennan CJ, McHugh, Gummow and Kirby JJ). See Patricia Sampathy, 'Section 90 of the Constitution and Victorian Stamp Duty on Dealings in Goods' (2002) 4(1) *Journal of Australian Taxation* 133.

The annual registration LET is not intended to be a licence and insurance fee like the current licence and insurance fees imposed by the states, but is intended to be a tax on the ownership and use of that motor vehicle. For this reason, it would be classified as an excise as it is a tax on the possession of a good, and therefore only the Commonwealth government would be allowed to impose the annual registration LET.

Similarly to the current fuel excise, the fuel LET will also be an excise and therefore only the Commonwealth government will have the constitutional right to impose it.

Finally, the disposal LET is a tax to be charged on disposal of the passenger motor vehicle. Since it is not a tax on the service of disposal, but a tax on the disposal of the vehicle itself, it will be classified as an excise under the interpretation provided by the High Court of Australia in the case of *Ha v New South Wales*.[532]

From the above, it is apparent that only the Commonwealth government would have the constitutional right to enact the LET legislation. Moreover, since the desire is for the proposed LET to be a comprehensive tax with the same rules applicable to the whole country, a Commonwealth tax would be more suitable. Although the leadership of the Commonwealth government is required for implementation of the LET, liaison with state and local governments will be necessary as the LET revenues should be earmarked for the improvement of public transport infrastructure ahead of the anticipated decrease in reliance on imported oil. Transportation involves all three levels of government as well as private sector operators, as roads and railway can be owned and operated by the Commonwealth government, state governments, local governments or privately owned corporations. It may be necessary to set up a commission that deals with the distribution of the LET revenues on a need basis and with the goal of preparing the country for energy-efficient and modern 21st century passenger transportation.

The distribution of the LET revenues would require further investigation that is beyond this PhD as it involves Commonwealth and state relationships and may require an intergovernmental agreement. The distribution of the LET revenues should not follow 'The Intergovernmental Agreement on the Reform of

[532] 97 ATC 4674.

Commonwealth-State Financial Relations'[533] that was entered into when GST was introduced in Australia. Under the GST intergovernmental agreement, the Commonwealth government collects the GST and these revenues are then distributed to the states and territories, and even allow the states and territories to be involved in setting the GST rate. The LET intergovernmental agreement, if entered into, should deal with the states giving up their right to collect the stamp duty on purchase of a passenger motor vehicle and the state entitlement to funding for public transport infrastructure projects. The LET intergovernmental agreement should be different from the GST intergovernmental agreement as the backdrop of the GST intergovernmental agreement was a decade of vertical fiscal imbalance,[534] whereas the backdrop of the intergovernmental agreement for the LET revenues is preparation of public transport infrastructure for the LET objectives to operate effectively. Despite this difference, there is also an overlap due to the concept of horizontal fiscal equalisation[535] under which the states receive funding from the federal government from the pool of GST revenues to provide for the states' services and associated infrastructure. Therefore the Commonwealth and the state governments would need to work together as the LET should be considered a major national tax reform similar to the GST[536] and the LET applies to a large cross-section of the population linked by the common cause of reducing oil use in passenger motor vehicles.

Since the LET is proposed to be a Commonwealth tax, the collection of the LET at the four taxing points should be the responsibility of the Australian Taxation Office (ATO). However, the ATO may need to rely on state Departments of Transport and independent fuel stations in setting up revenue collection mechanisms. This is further discussed in part 6.4.4, which covers the administration of the LET.

The next part explores the working design of a comprehensive Commonwealth LET system.

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[533] *A New Tax System (Commonwealth-State Financial Arrangements) Act 1999* (Cth) sch 2.
[534] Peter Edmundsen, 'Intergovernmental Agreements and the Battle over GST Revenue' (Paper presented at the 2006 Constitutional Law Conference and Dinner, Art Gallery of New South Wales, 24 February 2006) <http://www.gtcentre.unsw.edu.au/events/2006-constitutional-law-conference-and-dinner>.
[535] See Commonwealth of Australia, 'GST Distribution Review' (Interim Report, March 2012) 1.
[536] State Government of Victoria, 'GST Distribution Review' (Victorian Supplementary Submission, March 2012) 5.

6.4.3 The Working Design of the LET System

This thesis proposes an innovative design for a LET system that could replace some of the current motor vehicle and fuel taxes in Australia relating to passenger motor vehicles. The comprehensive LET design structure involves an allocation of points for each of the four motor vehicle characteristics. The points are progressive, as seen in Table 6.4, which displays 30 progressive points for each of the characteristics. The progressive points are set in accordance with the polluter-pays principle discussed earlier. The points are calculated separately for each characteristic and then added up to reach the total points. Thus a motor vehicle that is light in weight, but has a powerful engine, ie a typical sports car, would attract only a few points on weight, but more points on power and CO_2 emissions as each of these factors are individually important in reducing oil consumption and CO_2 emissions. Also, to prevent policy gaming, it is necessary to include all four characteristics of the motor vehicle within the LET, ie its weight, engine capacity, engine power and CO_2 emissions.

The LET system would then operate by allocating the tax rate per number of LET points at each taxing point. The LET payable can be discounted over a 10 year period so that the introduction of LET is slowly phased in. The phasing-in of LET over a 10 year period will also allow manufacturers, importers and purchasers of motor vehicles to plan ahead. The proposed LET operating system is discussed in detail below.

a. The LET Points

Sets of suggested points for each of the four motor vehicle characteristics are stated in Table 6.4. Each characteristic is independently analysed to determine the point allocation for that characteristic.

TABLE 6.4: Calculation of Points to Determine Luxury Energy Taxable Value

Points	Weight (kg)	Capacity (cc)	Power (kW)	CO_2 Emissions (g/km)
0	600	600	40	80
1	680	780	50	88
2	760	960	60	96
3	840	1140	70	104
4	920	1320	80	112
5	1000	1500	90	120
6	1080	1680	100	128
7	1160	1860	110	136
8	1240	2040	120	144
9	1320	2220	130	152
10	1400	2400	140	160
11	1480	2580	150	168
12	1560	2760	160	176
13	1640	2940	170	184
14	1720	3120	180	192
15	1800	3300	190	200
16	1880	3480	200	208
17	1960	3660	210	216
18	2040	3840	220	224
19	2120	4020	230	232
20	2200	4200	240	240
21	2280	4380	250	248
22	2360	4560	260	256
23	2440	4740	270	264
24	2520	4920	280	272
25	2600	5100	290	280
26	2680	5280	300	288
27	2760	5460	310	296
28	2840	5640	320	304
29	2920	5820	330	312
30	3000	6000	340	320

The system works by ascertaining the points for each characteristic separately and then adding the points for all the four characteristics to form the total points for each motor vehicle. For example, the Holden VE would attract a total of 63 points as follows:

- Weight: 1700kg – would attract 14 points;
- Capacity: 3600cc – would attract 17 points;
- Power: 180kW – would attract 14 points; and
- CO_2 emissions: 217g/km – would attract 18 points.

The total of 63 points for a Holden VE would then be used to calculate the tax payable at each taxing point by applying the tax rate.

The suggested points for the LET system have not been set in a vacuum. They are set in order to influence the owner and end user of the motor vehicle as well the motor vehicle manufacturer and importer to promote motor vehicles that are close to 600kg in weight, with an engine size of 600cc, producing 40kW and emitting 80g $C0_2$/km. Such a motor vehicle would not attract any LET. It is possible for an Australian motor vehicle manufacturer to manufacture such a vehicle by using appropriate lightweight materials, reducing the size of the motor vehicle and incorporating an aerodynamic design that reduces wind and rolling resistance. An example of such innovation can be observed in some concept cars and the Lotus Elise with its 69.5kg extruded aluminium chassis. However the Elise is powered as a sports car with a 100kW engine.[537] If such a vehicle was designed with a less powerful engine, it could easily achieve a low level of LET points. Table 6.5 shows the specifications of some small motor cars that would attract low LET points, and indicates that it is possible to have lower LET points for both cheaper motor vehicles like the Tata Nano and the Chevrolet Spark as well as more expensive vehicles such as the Lotus Elise.

[537] Lotus Elise, *Chronology of Chassis Development* (1995) Sands Mechanical Museum <http://www.sandsmuseum.com/cars/elise/thecar/chassis/index.html>.

TABLE 6.5: Calculation of LET Points for Selected Vehicles

	Weight (kg)	**Engine Size (cc)**	**Engine Power (kW)**	**CO_2/Km**	**Total Points**
Tata Nano	580	624	24.6	92.7	
Points	**0**	**1**	**0**	**2**	**3**
Smart Fortwo	750	999	52	100	
Points	**2**	**3**	**2**	**3**	**10**
Chevrolet Spark	840	1000	46	150	
Points	**3**	**3**	**1**	**9**	**16**
Daewoo Matiz	853	796	38	161	
Points	**4**	**2**	**0**	**11**	**17**
Lotus Elise	876	1600	100	155	
	4	**6**	**6**	**10**	**26**
Holden Commodore Omega	1551	2986	190	210	
	12	**14**	**15**	**17**	**58**
Toyota Land Cruiser	2635	4664	202	273	
Points	**26**	**23**	**17**	**25**	**91**
Maybach	2750	6000	455	390	
Points	**27**	**30**	**COE**	**COE**	**COE**

Unlike the LCT, the imposition of LET does not reflect the price of the motor vehicle, but the energy or oil it consumes. Thus a small and light sports car like the Lotus Elise would attract 26 points compared with the Tata Nano attracting 3 points, the Smart Fortwo attracting 10 points, the Chevrolet Spark attracting 16 points and the Daewoo Matiz attracting 17 points. The popular family car, the six cylinder Holden Commodore Omega attracts 58 points compared with the 4WD Toyota Landcruiser 200 which attracts 91 points. The very expensive Maybach would need a Certificate of Entitlement as its engine power and CO_2 emissions are in excess of the specified limits. The government could also auction licences to purchase vehicles that are energy guzzlers and outside the point limits stated in Table 6.5.

The next section deals with the conversion of LET points into taxable value at each taxing point.

b. Conversion of LET Points to Tax Payable

The total points calculated for each motor vehicle would form the basis for calculating the tax payable at each of the four taxing points. The proposed formula for working out the tax payable has been set to not only generate revenue, but also to encourage motorists to purchase vehicles that would attract less LET, and make greater use of the public transport system. A detailed study and an economic analysis would need to be undertaken to set the rates at the correct level, which is beyond the scope of this thesis. However this thesis demonstrates a new and a unique way of taxing passenger motor vehicles.

The suggested rates for allocating tax payable at each taxing point are stated in Table 6.6. The LET legislation should provide for the rates to be indexed over time based on the consumer price index.

TABLE 6.6: Taxing Points Converted to Luxury Energy Tax

Imposition of Tax	Tax Payable per Point
Initial new purchase of vehicle	AUD500 per point
Annual road registration	AUD125 per point
Fuel consumption per litre	AUD0.25 per point
Disposal fee	AUD10 per point

Based on the Holden VE's 63 accumulated points the following LET would be attracted at each taxing point based on the above formula:

TABLE 6.7: Luxury Energy Tax Payable on Holden VE

Imposition of Tax	LET Points	Tax Rate per LET Point	Tax payable AUD
Initial new purchase of vehicle	63	500	31 500
Annual road registration	63	125	7875
Fuel consumption per litre	63	0.25	15.75
Disposal fee	63	10	630

A discount should be applied over at least a 10 year period to allow time for motorists to make their personal transportation arrangements and manufacturers to design new motor vehicles. The suggested discount that should be applied over a 10 year period is discussed next.

c. The Discount

The purpose of the discount is to gradually educate people about the impact of their choice of motor vehicle for personal transportation. The discount should also reflect the status of the economy and whether an effective public transport infrastructure is in place. This would include not only the availability of sufficient trains and buses, but also enough parking facilities at train stations. The discount rate would need to be worked out by the government, based on an economic analysis, which is beyond the scope of this research.

As a demonstration, the tax discount could be set as high as 98 per cent in the first year of implementation, decreasing to nil by the tenth year. Based on this discount schedule, the LET for a Holden VE is displayed in Table 6.8.

TABLE 6.8: Demonstration of Luxury Energy Tax for Holden VE

Year	Suggested Discount Rate AUD	Holden VE – LET Payable			
		Initial Purchase AUD	Annual Road Registration AUD	Fuel Per litre AUD	Disposal fee AUD
1	98%	630	158	0.32	13
2	96%	1260	315	0.63	25
3	94%	1890	473	0.95	38
4	92%	2520	630	1.26	50
5	90%	3150	788	1.58	63
6	85%	4725	1181	2.36	95
7	75%	7875	1969	3.94	158
8	50%	15 750	3938	7.88	315
9	25%	23 625	5906	11.81	473
10	0%	31 500	7875	15.75	630

As demonstrated in Table 6.8, the purchase of a Holden VE would attract LET at four taxing points. The first taxing point would occur on registration of the vehicle. If a Holden VE was purchased in the first year of LET implementation, the registered owner of the motor vehicle would have to pay AUD630 on the initial purchase of the car. On the other hand, if the Holden VE was purchased in year ten after the LET was implemented, the registered owner would have to pay AUD31 500 LET on the initial purchase price. The LET of AUD31 500 in Year 10 would not be considered high when compared with the existing purchase tax charges in Norway. As demonstrated in Chapter 5, Norway imposes a high purchase tax based on the vehicle weight, engine power and CO_2 emissions. Based on the rates in 2011, the Holden VE would have attracted a total purchase tax of AUD79 078 in Norway, broken down as follows:[538]

[538] See Chapter 5, part 5.2, Tables 5.2, 5.3 and 5.4.

TABLE 6.9: Norway Purchase Tax on Holden VE

Purchase Tax Criteria	Tax Payable – AUD
Weight	20 763
Engine power	36 736
CO_2 emissions	21 343
Vehicle scrap deposit	236

Source: Ministry of Finance, 'Budget 2011' (Ministry of Finance, Norway, 12 January 2011) <http://www.statsbudsjettet.no/english>.

In Norway, the rates are progressive in that the higher the weight, engine power and CO_2 emissions, the greater the tax.[539] By comparison, the progressive feature of the LET is found in the point system, whereby the higher the weight, the engine capacity, the engine power and the CO_2 emissions, the greater the LET points that would be allocated. Moreover, the accumulated points under the LET system are fixed at the outset when the vehicle is manufactured or imported and are reflected not just in the purchase tax, but also in the annual registration tax, the fuel cost and disposal of the vehicle.

The government in Australia could reduce the discount at the outset. However, this is not recommended as both the government and the people need time to adjust. The government needs to ensure that the tax policy is in line with other policies, ie energy, transportation and housing. The Australian people may need to change their travelling behaviour as well as deciding on an appropriate place of residence by living closer to where they work. Moreover, a slow education process is much better than a sudden imposition.

The second taxing point for the ownership of the Holden VE would occur annually over the period of vehicle ownership, being the annual registration LET. This would be payable in addition to the state registration or licence fees. In the first year of ownership, the annual registration LET payable by the registered owner of the vehicle would include an extra AUD158 per annum, increasing to AUD315 for the second year of ownership and increasing each year to AUD7875 in the tenth year.

[539] See Chapter 5, part 5.2, Table 5.1.

The third taxing point for the ownership of the Holden VE would occur every time it is refuelled at the petrol station. Instead of paying excise at the rate of AUD0.38, it would attract an excise of AUD0.32 in the first year, increasing to AUD0.63 in the second year and increasing each year to AUD15.75 in the tenth year. Although the rate of AUD15.75 per litre of oil for the Holden VE may currently seem excessive, it needs to be observed from the perspective of the future availability of global oil supplies and the growth, usage, design and choice of current motor vehicles as discussed in Chapters 2 and 3 of this thesis. A high excise rate on fuel can be avoided by choosing a motor vehicle that attracts fewer LET points.

A unique feature of the LET system is in the cost of fuelling a motor vehicle as a different fuel rate would apply to each motor vehicle depending on the number of points accumulated for that vehicle. It is an alternative to the kilometre fee and can be calculated and collected relatively easily without impacting on the privacy of the driver. This tax would be collected at the pump in a manner similar to that described in the Oregon pilot study. This is further discussed with relation to LET administration in part 6.4.4.

The fourth taxing point for the ownership of the Holden VE would occur on its disposal. The disposal fee attracted would be AUD13 in the first year, increasing to AUD25 in the second year and increasing each year to AUD630 in the tenth year. This would encourage consumers to purchase motor cars that are low on disposal charges and to keep the motor vehicles as long as possible to avoid paying the disposal fee.

By comparison to the Holden VE, the Smart Fortwo attracts 10 LET points. The LET payable for the Smart Fortwo is shown in Table 6.10.

TABLE 6.10: LET Attracted by Smart Fortwo

Year	Suggested Discount Rate AUD	Smart Fortwo LET Payable			
		Initial Purchase AUD	Annual Road Registration AUD	Fuel Per litre AUD	Disposal fee AUD
1	98%	100	25	0.05	2
2	96%	200	50	0.10	4
3	94%	300	75	0.15	6
4	92%	400	100	0.20	8
5	90%	500	125	0.25	10
6	85%	750	188	0.38	15
7	75%	1250	313	0.63	25
8	50%	2500	625	1.25	50
9	25%	3750	938	1.88	75
10	0%	5000	1250	2.50	100

As the Smart Fortwo has the potential to use less oil compared with the Holden VE, it attracts a lower LET. Although the LET attracted by the Smart Fortwo may seem high compared with the current motor vehicle and fuel taxes it attracts in Australia, the high rates are required to encourage the use of public transport instead of a motor vehicle for personal transportation.

The above formulas and rates suggested for the LET have been formulated based on the LET principles discussed above and a logical analysis. An economic analysis would need to be carried out to set the correct formulas and rates, which is beyond the scope of this research. However, the message from this thesis is for the Australian government to take control and comprehensively reform motor vehicle taxes in Australia in order to address climate change and reduction of oil usage by road transport vehicles with the aim of changing motorist behaviour. The purpose of the proposed LET in Australia is to impose a tax that would impact on a person's decision-making at the time of purchasing a vehicle, during its use, and at the point of its disposal.

The next part explores the administration and operation of the LET design framework.

6.4.4 The Administration and Operation of the LET Design Framework

The administration and operation of the LET design framework encompass a range of aspects, which are discussed below. The compliance and administration cost of the LET design framework are discussed in part 6.4.5.

a. The Registration for LET

Although the LET design should allow for a phasing-in period for existing vehicles, it is proposed in this thesis that all passenger vehicles would need to become registered for LET. However, the purchase LET would only apply to the purchase of new passenger vehicles in Australia and the purchase of used passenger vehicles that are road registered in Australia for the first time. All passenger motor vehicles should be liable for assessments of the annual registration LET, the LET fuel excise and the LET disposal fee.

The definition of a passenger motor vehicle for the purposes of the LET legislation could be adopted from the OECD Glossary of Statistical Terms that defines a passenger car as a road motor vehicle, other than a motor cycle, intended for the carriage of passengers and designed to seat no more than nine persons (including the driver).[540]

The LET legislation would need to provide for the correct measurement and quantification of the motor vehicle characteristics, ie weight, engine size, engine power and CO_2 emissions. It is recommended that this occurs at the same time that the vehicle is fitted with the compliance plate. Under the current Australian laws, before a road vehicle can be registered for the first time in Australia, it must meet the requirements of the *Motor Vehicle Standards Act 1989* (Cth). The Act requires all new and used imported vehicles to meet the Australian Design Rules (ADRs) and be

[540] Organisation for Economic Co-Operation and Development, *Glossary of Statistical Terms — Passenger Car* (14 March 2002) OECD Statistical Portal <http://www.oecd-ilibrary.org/economics/oecd-glossary-of-statistical-terms_9789264055087-en>.

fitted with a compliance plate. This is known as the vehicle certification process,[541] and it is recommended that this would be the appropriate stage at which the vehicle should be correctly measured and quantified for LET purposes, and its correct weight, engine capacity, engine power and CO_2 emissions certified and recorded on the compliance plate.

It is also recommended that the motor vehicle owner registers the motor vehicle for the LET. LET registration of a passenger motor vehicle should occur at the same time as the motor vehicle is licensed and the number plate is obtained. Under the existing system, the motor vehicle road licence and number plate are obtained by completing a form and sending it with the appropriate fee to the state Department of Transport.[542] This form would need to be amended to include details of the motor vehicle, ie its weight, engine capacity, engine power and CO_2 emissions, so that the motor vehicle could also be registered for LET.

LET registrations can be administered by the state Department of Transport working together with the Australian Taxation Office (ATO). One way is for the Department of Transport to calculate the LET points and the purchase tax payable before the department releases the number plate and the road licence, and then inform the ATO of the LET registration details. Alternatively, the Department of Transport can forward the details of the motor vehicle and the registered owner to the Australian Taxation Office (ATO), which would then calculate the LET points and the purchase tax. The ATO would then collect the purchase tax from the registered owner and inform the Department of Transport of the calculated LET points. Under this alternative, the Department of Transport should only release the motor vehicle registration and number plate to the registered owner after receiving confirmation from the ATO that the purchase tax has been paid.

It is proposed that the motor vehicle number plate be designed to display the LET points, such that the registration number and the LET points can be read and recognised using appropriate vehicle recognition technology as discussed below.

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[541] Department of Infrastructure and Transport, *Vehicle Certification in Australia* (December 2008) Commonwealth of Australia <http://www.infrastructure.gov.au/roads/motor/standards/certification/index.aspx>.

[542] Department of Transport, *Application to Licence a Vehicle Form MR17* (19 December 2011) Government of Western Australia <http://www.transport.wa.gov.au/mediaFiles/LBU_F_VL_MR17_LicenceVehicle.pdf>.

Existing vehicles that have already been road registered before the implementation of the LET legislation would also need to be registered for LET. Their registration can be phased in by the Department of Transport when their annual registration comes up for renewal. The Department of Transport should send a form to the registered owner confirming the details of the LET registration and issue the registered owner of the vehicle with the special number plate. If details such as the CO_2 emissions are not available for that motor vehicle, the Department of Transport should apply a standard statutory rate, or permit the registered owner to obtain certified data through appropriate inspection agents.

The Department of Transport would need to synchronise with the ATO the details of the motor vehicle that has been registered for LET, the details of the registered owner and the purchase LET payable. It is also proposed that the ATO issue the registered owner with at least two debit cards that the registered owner may use to pay the fuel LET. If a person other than the registered owner is using the motor vehicle, then the registered owner and the new user of the motor vehicle would need to complete a form notifying the Department of Transport and the ATO of the person responsible for the LET.

Since the LET only applies to passenger motor vehicles, it is proposed that certain passenger vehicles that are fitted to be used for specific businesses could apply for an exemption from the ATO. If an exemption for the LET has been obtained from the ATO, then this should be recognised in the special number plate issued by the Department of Transport.

Commercial motor vehicles are not liable for the payment of LET. However, motor vehicles that are not designed to carry passengers or carry less than nine passengers should also be required to register for LET and obtain a commercial LET classification. This is required to prevent policy gaming, ie using commercial vehicles as private passenger vehicles.

b. *The Special Number Plate Design*

The special number plate forms an important part of the LET administration. The number plate, issued by the state Department of Transport, should include the motor vehicle registration number, followed by the number of LET points that the vehicle attracts, ranging from 000 to 120 (a maximum of 30 LET points for each of the four categories). An example of a number plate could be: 1ABC 123 – 078. In this case, the vehicle registration number is '1ABC 123' and the '078' represents the total LET points. A passenger motor vehicle which is exempt from LET would show 000 as the LET points allocated for that vehicle. A commercial vehicle could have the prefix 'C' before '000' to indicate that it is a commercial vehicle.

The LET points are openly displayed on the number plate in order to educate the public about the LET points attracted by different makes and models of motor vehicles. The display of LET points on the number plate would also influence manufacturers and importers of motor vehicles to promote motor vehicles that attract the least amount of LET points.

The number plate with the display of the LET points also forms the basis for collecting the fuel tax as discussed below. Therefore, to prevent fraudulent activity such as transferring the number plate from one motor vehicle to another in order to reduce the fuel LET, it is important that once the number plate is affixed to the motor vehicle, it cannot be removed without special approval. To ensure that the number plate has not been tampered with, the number plate should display an intact Department of Transport seal. Number plate seals could be checked and certified when motor vehicles go for periodical roadworthiness checks. The unauthorised breaking of the seal should be an offence under the LET legislation. Accidental damage to the seal should be reported to the state Department of Transport or their authorised agents, and a replacement obtained for a fee.

c. *Application for Exemptions*

All passenger motor vehicles should be registered for LET within one year of the LET legislation being implemented. The intention of the legislation is to impose a

LET on all passenger motor vehicles as defined, whether those vehicles are used for personal or business use. Passenger motor vehicles that are designed and used for carrying goods for genuine business purposes could be eligible for a LET exemption. Exemptions from the LET should only be granted after the vehicle has been examined, as blanket exemptions can give rise to policy gaming ie large trucks being used as passenger motor vehicles. Such business vehicles should also be subject to criteria regarding size requirements, but this is not dealt with here as the focus of this thesis is on passenger motor vehicles. There is, however, a need to reform the taxation of passenger vehicles used for business and commercial motor vehicles in the future. It is recommended that LET registration be applicable for all commercial vehicles, but that these vehicles obtain a commercial classification and attract ‘000’ LET points.

Other exemptions or concessions could be made for specially designed vehicles required for pensioners, schools or disabled people. Alternatively, part of the LET revenues could be set aside to cushion the impact of the LET on the socially disadvantaged.

Exemptions should not be granted for passenger motor vehicles using alternative fuels or electricity, as reduced energy use should be encouraged even for these vehicles. An electric motor vehicle may accumulate LET points only on its weight and power. Since an electric vehicle would not require fuel from a petrol station, it would only attract the purchase LET, the annual registration LET and the disposal LET. Further work is required to design a LET for electric vehicles.

d. The Administration of the Purchase LET

It is recommended that the purchase LET be imposed on all passenger motor vehicles that are road registered in Australia for the first time after the implementation of the LET legislation, unless the registered owner of the vehicle has obtained an exemption from the ATO. The purchase LET would need to be paid by the registered owner of the passenger motor vehicle to the state Department of Transport or the ATO before the motor vehicle can be road registered and the number plate issued.

e. The Administration of the Fuel LET

It is proposed in this thesis that the fuel LET should be calculated and collected at the service station. In order to do this, service stations would need to be fitted with a special number plate recognition technology system, and install a LET debit card POS terminal at each fuel pump that is capable of collecting the LET.

The suggested procedure for collection of the fuel LET would commence when a motor vehicle drives into a service station for fuelling, and its number plate, including the LET points, is read by the special number plate recognition technology system. The motorist must have a LET debit card with a prepaid LET balance on it, and commences the fuelling by swiping the card at the pump's LET debit card POS terminal. The information on the number plate and the debit card must synchronise in order for the transaction to proceed. The LET rate is displayed, together with the balance on the card. This informs the motorist of the number of litres of fuel that can be pumped into the tank. The debit card is updated as the fuel is being pumped into the motor vehicle, and when there is no more LET credit left on the card, the pump stops supplying the fuel. The fuel pump LET debit card POS terminals have the facility for topping up the debit cards. Under this system, the LET collected goes directly to the ATO. A receipt of the LET paid could be printed on demand in a similar manner to a bank's ATM.

Once the fuelling is complete, the person pays for the fuel only at the service station POS. Under this system, the service station's employees have no involvement in the calculation and collection of the LET.

Companies that hire out motor cars or large organisations that have many drivers driving passenger motor vehicles should be able to issue temporary debit cards with the authority of the ATO.

The suggested fuel LET collection system relies on the special number plate recognition technology. Since every vehicle has a unique number plate, no expensive tags or transmitters need to be fitted in order for the system to recognise the vehicle. Number plate recognition technology can identify a vehicle by capturing an image of the number plate, and the imaging sensor can recognise a number plate the moment it enters its field of view. The sensor can take more than one image per vehicle. The image is processed, the number plate is extracted from the image and the digits are separated and recognised. The details can be stored and sent to third party systems, ie the LET debit card POS terminals.

Businesses could be invited to set up an approved number plate recognition system for use by service stations. There are a few Australian companies that already specialise in this area. For example, a company called 'Sensor Dynamics' specialises in automatic number plate recognition (ANPR) solutions. They already have a system called 'The Vyper Forecourt ANPR System' aimed at retail service station owners who want to deter customers from driving off without paying.[543] Such a system could be modified for the purpose of collecting the fuel LET.

There are also many global companies that specialise in ANPR solutions. The European Dacoll Group has the NDI Recognition Systems that provide global ANPR design, software, cameras and hardware. This company already provides the ANPR systems to the UK law enforcement community.[544] Another global company is INEX/ZAMIR that has been supplying ANPR technology for over 15 years.[545]

ANPR technology is already being used in Australia by the police and local councils, such as the City of Melbourne which commenced using it in July 2011 to capture parking offences. The system records vehicle registration details and locations and identifies those vehicles that have overstayed their parking limit. An alert is sent to the parking officer's hand-held device.[546]

Businesses could also be invited to set up the LET debit card POS terminals for LET collection at each service station pump. There are a few Australian companies that already specialise in this area. For example, Integrated Technology Services has the capacity to tailor a system to suit the specific needs of both the ATO and the taxpayers under the LET legislation. Other global corporations include Diebold,

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[543] Sensor Dynamics, *Forecourt Service Station ANPR Solutions* <www.sensordynamics.com.au>.
[544] NDI Recognition Systems UK, *Overview* (2012) <http://ndi-rs.com/ukrs/company_overview>.
[545] See INEX/ZAMIR (2010) <http://www.inexzamir.com/>.
[546] City of Melbourne, *Licence Plate Recognition* (28 April 2012) <http://www.melbourne.vic.gov.au/ParkingTransportandRoads/Parking/Pages/LicensePlateRecognition.aspx>.

Euronet Worldwide, Fujitsu Frontech Limited, Hitachi-Omron Terminal Solutions, NCR Corporation, Triton Systems, VeriFone Holdings, Wellington Technologies and Wincor Nixdorf, and global corporations that can provide multifunction ATMs for outdoor installations.[547]

f. The Administration of the Annual Registration LET

It is proposed in this thesis that the annual registration LET is calculated together with the state licence and third party insurance policy by the state Department of Transport, as discussed above. Since the annual registration LET charges belong to the federal government, the annual registration LET could be collected by the state Department of Transport and then periodically handed over to the ATO. Alternatively, the annual registration LET could be separately calculated by the LET Department of the ATO and invoiced to the registered owner, with one of the possible payment methods being the LET debit card.

g. The Administration of the Disposal Fee LET

A disposal fee could be calculated and collected from the registered owner either by the state Department of Transport or the ATO before the vehicle is deregistered.

h. The Setting Up and Operation of the LET Department

It is proposed that the LET legislation implements the LET system. The LET should be a Commonwealth tax and the government would need to set up a central LET Department in Canberra and sub-departments in each state and territory. The LET Department of the ATO should liaise closely with the state Departments of Transport, with free information exchange between the two bodies concerning the LET.

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[547] See ATM Marketplace (2012) <http://www.atmmarketplace.com/>.

The LET departments should be responsible for appointing authorised LET Agents to conduct tasks such as the annual or periodical road worthiness test and audits.

i. The Annual or Periodical Road Worthiness Test

It is proposed that passenger motor vehicles should be required under the LET legislation to be inspected annually or periodically. The checks should include:

- Whether the motor vehicle has gone through any modifications that affect its weight, engine capacity, engine power or CO_2 emissions;
- Whether the number plate seal is intact or broken; and
- The odometer reading to calculate the number of kilometres the motor vehicle has driven since the previous reading.

The inspection should be conducted by authorised LET agents at appropriate LET centres. Alternatively, the current motor vehicle inspection centres at the Department of Transport could be used by having a LET representative present at each of the centres.

j. LET Audits and Offences

In order to increase compliance levels, the LET legislation needs to be enforced, and the fear of a LET audit could deter non-compliance. LET audits could be of two types, general and specific. The general audit could include an overall mileage check to determine whether the fuel purchased for use in one vehicle is being siphoned off and used elsewhere. The debit card records should indicate the number of litres of fuel purchased for that vehicle, along with an indication of the range of kilometres that the motor vehicle could have driven, taking into consideration city and urban driving and the driving style. The general audit test should be able to match the information from the debit card with the mileage information obtained from the annual road worthiness test. If there is a large variance from the expected data, then the auditor should seek further tests and explanations from the registered owner.

Various specific audits should also be conducted on the operation of the service station to ensure that the fuel sales from that service station match the LET collected by the ATO. Specific audits should include a random examination of the ANPR videos to check that the make and model of motor vehicles correspond with the number plates.

The legislation should spell out offences and penalties under the LET legislation. Offences could include having incorrect information on the LET forms, tampering with number plates, and the siphoning of fuel. The aim of the system is not to be 100 per cent foolproof, but to ensure that the fear of committing an offence and the consequent severe penalties act as deterrents from committing offences under the Act.

k. The Responsibility of the Taxpayer

The responsibility of the taxpayer would involve the correct completion of the LET forms, the appropriate payment of LET under the LET legislation, and ensuring that appropriate annual checks and reporting requirements are complied with, such as when the motor vehicle is modified or the seal on the number plate is broken.

6.4.5 The Implementation of the LET System

The first step in the implementation process is a commitment from the Australian government that the motor vehicle tax policy needs a comprehensive review and that the way forward is through the implementation of the LET system. The Australian government bears the responsibility for this under the precautionary principle discussed in part 6.4.1 above. Once the government takes on the responsibility to bring about a change, the normal consultative and legislative process would need to be followed. This would include widespread consultation, awareness campaigns and various government-authorised pilot studies similar to the Oregon pilot study. A compliance and administration cost study would need to be undertaken as part of the implementation process.

a. Compliance and Administration Cost Study

LET compliance costs would be those expenses incurred by individuals and organisations in meeting the requirements of the LET legislation. LET administration costs are those costs that the taxation authorities incur in administering the taxation system.

Compliance costs in the taxation literature include: taxpayer's own labour, unpaid helper and internal staff costs; costs of external advisers; incidental or overhead costs; psychic costs associated with the worry of complying with taxation obligations and social welfare costs which distorts taxpayer behaviour as a consequence of the existence of the LET.[548]

Compliance costs can be divided into social and taxpayer compliance costs. Social compliance costs refer to the costs incurred by the entire economy, whereas taxpayer compliance costs are those incurred by the taxpayer. It is also necessary to consider the start-up costs of introducing the new LET, which can include design, drafting and enactment; administration and compliance.

The design, drafting and enactment costs normally refer to the costs incurred by society leading up to the enactment of the LET legislation. This would include costs incurred by all stakeholders in discussing, debating, promoting and opposing the tax, and these costs are difficult to quantify.[549]

The compliance cost of implementing the LET refers to the costs incurred by the economy in its preparation to comply with the LET legislation. For the LET, compliance costs affect all motor vehicle owners as well as various government departments and some businesses such as fuelling stations. The administration costs of implementing the LET refer to the start-up costs incurred by the ATO and other government bodies such as the Licensing offices of the state Departments of

[548] See Cedric Sandford, Michael Godwin and Peter Hardwick, *Administrative and Compliance Costs of Taxation* (Fiscal Publications, 1989).
[549] Binh Tran-Nam, 'The Implementation Costs of the GST in Australia: Concepts, Preliminary Estimates and Implications' (2000) 3 *Journal of Australian Taxation* 331.

Transport. The start-up compliance and administrative costs of the LET would include:

- Learning about the LET and the new procedures;
- Measuring and quantifying motor vehicles for LET compliance;
- Registering motor vehicles for LET;
- Purchasing and installing number plate recognition technology at service stations;
- Purchasing and installing the LET debit card POS terminals at each fuelling pump;
- Installation of special number plate design;
- Set-up and operation of the LET Department;
- Training LET agents for annual and periodical road worthiness testing;
- Training LET auditors;
- Setting up procedures and forms at the ATO and state Departments of Transport; and
- Training LET staff at the ATO and the state Departments of Transport.

Compliance costs can be minimised by getting things right the first time and this can be achieved by a comprehensive education and training program.[550] However, start-up compliance costs are difficult to quantify since the implementation and build-up period may be long and therefore not fully captured or accounted for. This is evident in the various forecasts of the business start-up compliance costs for the GST, ranging from AUD1.02 billion to AUD14.05 billion.[551]

Recurrent LET compliance costs would include the annual or periodical road worthiness test and the time taken to top up the debit card. The ATO would also incur recurrent LET collection costs in terms of staffing the LET Department and the state Departments of Transport, setting up tax collection systems within the departments, maintaining the LET debit card POS terminals and audit and legal costs of prosecution for non-compliance of the LET legislation. The Commissioner of

[550] Cedric Sandford, 'Minimising the Compliance Costs of a GST' in C Evans and A Greenbaum (eds), *Tax Administration – Facing the Challenges of the Future* (1998) 130.
[551] Binh, above n 549, 337–40.

Taxation Annual Report 2010–11[552] states that on average it costs AUD0.88 to collect AUD100 of revenue and this has been used to forecast the LET revenues in Chapter 7.[553]

The calculation of start-up and recurrent compliance costs for the LET requires a detailed exercise which is beyond the scope of this research. However it is recommended that a compliance cost study be undertaken as part of the LET implementation process. In addition, a Regulation Impact Statement (RIS) will also be required as soon as the administrative decision is made by the government that LET regulations are necessary and the regulations are likely to have an impact on the business or the non-profit sectors. Since the LET would have an impact on motor vehicle manufacturers and fuel stations, an RIS would need to be prepared by policy officers. The primary role of the RIS is to improve government decision-making processes and it is normally prepared after stakeholder consultation has been carried out. The Office of Best Practice Regulation (OBPR) is in charge of assessing and reporting on compliance with best practice regulation requirements. The OBPR is an independent arm of the Department of Finance and Deregulation.

The RIS for the LET would be required to set out: the problem or issues which gives rise to the need for action; the desired objectives; the options, both regulatory and non-regulatory that may constitute viable means of achieving the desired objectives; an assessment of the impact, being costs, benefits and risks to consumers, business, government and the community; a consultation statement; a recommended option and a strategy to implement and review the preferred option.[554]

b. Task Force and Pilot Study

It is recommended that the Australian government should first set up a Task Force similar to the Oregon Task Force to commence consultation with various government departments such as the Department of Infrastructure and Transport, the Treasury,

[552] Commissioner of Taxation, 'Annual Report 2010–11' (Australian Taxation Office, 30 September 2011) 9.
[553] See Appendix Table 7.2.
[554] Department of Finance and Deregulation, *Australian Government RIS* (25 June 2010) Commonwealth of Australia <http://www.finance.gov.au/obpr/ris/gov-ris.html>.

the Department of Environment and Resource Management and the Department of Sustainability, Environment, Water, Population and Communities. The Task Force should comprise representatives from each of the government departments, the transport industry, the motor vehicle industry, the oil industry, academics, banks and the business community. The Task Force should be given the primary responsibility for the detailed work involved in developing and recommending the LET system after carrying out detailed consultation with key stakeholders and the public. The Task Force should elicit views from interested parties on key issues that would need to be addressed in the development of the LET system by releasing discussion papers and holding conferences similar to the Ralph Review and the Henry Review, including on how the revenues from the LET would be dealt with under the federal/state relationship.

After the consultation process, the government should authorise pilot studies to be conducted, similar to the Oregon pilot study. The consultation process and the pilot study would form part of the public education process and this could take many years. The Oregon Road User Fee Task Force was set up in 2001 and the final report of Oregon's Mileage Fee Concept and Road User Fee Pilot Program was only released in November 2007. The timeline for the implementation of the LET system is dependent upon the commitment of resources and the political will. As stated in the Oregon Report, if a country can send a man to the moon with less than a decade of planning, then Australia should be able to find a way to implement the LET system in a much shorter period of time.[555]

6.5 CONCLUSION

The LET system described in this Chapter gives consumers the choice of purchasing and using a motor vehicle that either attracts no points, or attracts a large number of points. By undertaking to implement the LET system in Australia, the Australian government would be taking responsibility for persuading people to use passenger motor vehicles that consume less oil. This is similar to the government passing carbon tax legislation to control the carbon release into the environment.

[555] Whitty, above n 305, 68.

Under the recommended formulas for calculating and discounting the LET, each LET point in the first year would only attract a LET of AUD10 on the initial purchase, AUD2.50 every year on registration, 0.5 cents per litre excise on fuel and only AUD0.20 disposal fee. After five years of implementing the LET, each LET point would attract AUD50 on initial purchase, AUD12.50 every year on registration, 2.50 cents excise per litre on fuel and AUD1 disposal fee. In the tenth year after implementation of the LET, each LET point would attract AUD500 on initial purchase, AUD125 every year on annual registration, 25 cents excise per litre on fuel and AUD10 disposal fee. Thus the LET payable would be more if a person chooses to purchase and use a motor vehicle that attracts more LET points, as demonstrated in this chapter by the comparison between a Holden VE that attracts 63 LET points and a Smart Fortwo that attracts only 10 LET points. The maximum number of LET points that can be attracted under the system are 120.

An evaluation of the LET system is undertaken in Chapter 7 in terms of the revenues it can generate in Australia, the oil use it can save, tax collection, fee calculation, technology, cost of state-wide implementation, auditing, fee rate structure, the phase-in period, systemic precision, adaptability to congestion pricing, public acceptance, convenience, privacy and protection of personal details, the criteria of a good tax, and its potential to change motorist behaviour with regard to the choice and usage of passenger motor vehicles.

CHAPTER 7: EVALUATION OF THE LET SYSTEM

7.1 INTRODUCTION

The LET system described in Chapter 6 is evaluated in this chapter under five categories:

- The net revenue generation potential of the LET;
- The expected savings in oil usage as a result of implementing the LET;
- General matters relating to collection, fee calculation, technology, cost of state-wide implementation, auditing, fee rate structure, phase-in period, systemic precision, adaptability to congestion pricing, public acceptance, convenience and protection of privacy;
- The LET assessed under the known criteria of a good tax; and
- The LET's ability to change behaviour.

7.2 NET REVENUE GENERATION POTENTIAL

An exercise has been carried out as part of this thesis to measure the net revenue generation potential of the LET. The LET rates stated in Table 6.6 have been used to forecast the net revenue. They have not been indexed over the period of the forecast as it is proposed that the rates will not change for the first 10 years. The discount factor as stated in Table 6.8 has been taken into consideration over the 10 year period, ranging from 98 percent in year one to nil discount in year 10. This exercise demonstrates the ability of the LET to raise sufficient revenue to build the public transport infrastructure that would be required as a result of the change in travel behaviour that is anticipated after implementation of the LET.

In order to forecast the LET revenues, it was first necessary to categorise the current Australian motor vehicle fleet into the following categories: light cars, small cars, medium cars, large cars, SUVs, people movers (PM) and sports cars, so that the LET taxable value and the tax payable can be calculated for a vehicle falling within each of those categories. Part 7.2.1 describes how this exercise was carried out.

The next three parts 7.2.2 to 7.2.4 explain how the revenue forecasts are made under each category of the LET, ie the purchase LET, the annual registration LET and the fuel excise LET. The revenues from the disposal LET are likely to be small and are therefore ignored for the purpose of this exercise. The revenues have been forecasted by using year 2011 data as the starting point and years 2011 to 2015 as years before implementation of the LET. Years 2016 to 2025 are then treated as the first 10 years after implementation of the LET for which the revenues have been forecasted. These dates would change depending on the will of the government and acceptance of the LET system by the people. However, the data provides an insight into the revenue generation potential of the LET and how the revenues can be utilised in building an infrastructure for passenger transportation in Australia.

The total revenue forecast for the LET excluding the disposal LET for passenger motor vehicles from years 2016 to 2025 is expected to range from AUD2.21 billion in 2016 to AUD109.97 billion in year 2025 as shown in Appendix Table 7.5 in Appendix 7 at the end of the thesis. However, the forecast revenue could decrease to about AUD20 billion per annum by 2025 if an ideal LET car were to be increasingly adopted by the Australian population as shown in Figure 7.8 in Part 7.2.4.

7.2.1 LET Vehicles in Australia

The LET system as described in Chapter 6 operates by allocating LET points to each vehicle category on the basis of weight, engine size, engine capacity and CO_2 emissions. A rate is then applied at each taxing point to convert the LET points into LET payable. It is not possible to accurately forecast the LET points for every single motor vehicle in Australia. However a general revenue forecast has been achieved by examining the Australian motor vehicle fleet and extracting the LET points under the following six categories of motor vehicles: light cars, small cars, medium cars, large cars, SUVs, PMs and sports cars. Appendix 3 at the end of this thesis shows in detail the four step process by which the LET points were calculated and the information that was obtained and used in making those calculations. The motor vehicle categories are in line with the Commonwealth Government's Green Vehicle Guide and the motor vehicle specifications known as 'V Facts' obtained from the Federal Chamber of Automotive Industries. Appendix 3 also shows how the average characteristics, ie weight, engine capacity, engine power and CO_2 emissions, have been calculated for each category of motor vehicle, the calculation of the total LET points and the LET payable per vehicle under each of those categories.

For the purposes of this research, the specifications for typical Australian cars are summarised in Table 7.1.

TABLE 7.1: Specifications of Australian Vehicles

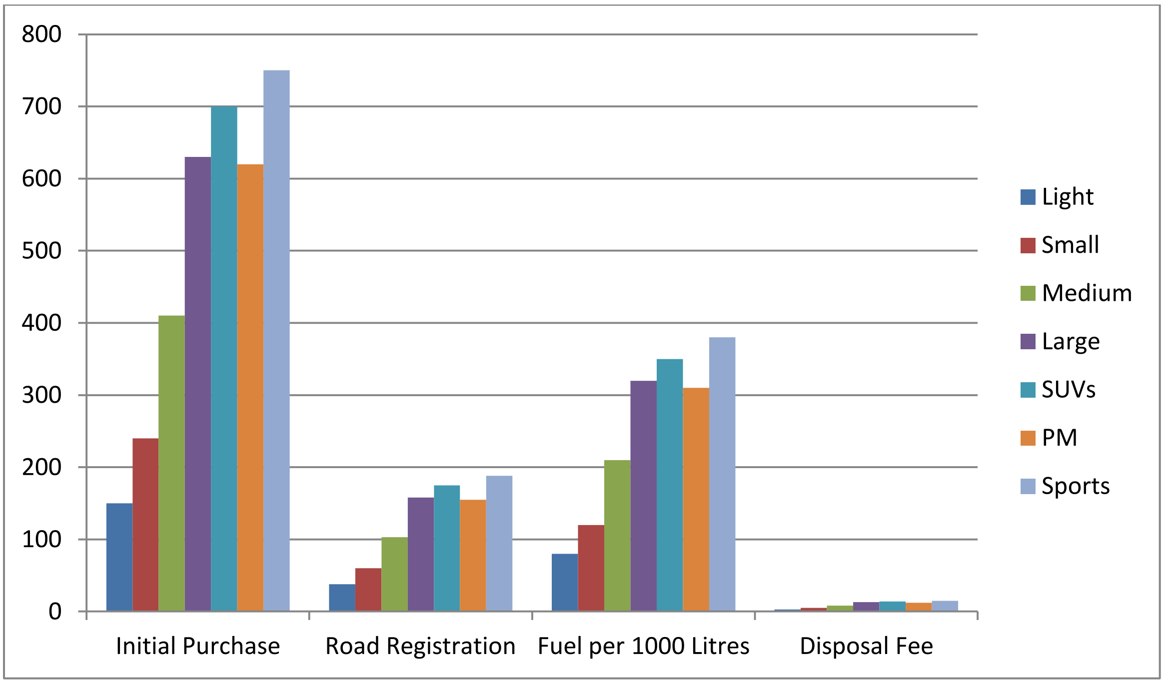
Category	**Weight (kg)**	**Engine Size (cc)**	**Engine Power (kW)**	**Emissions CO_2**
Light Car[556]	813	1147	59	128
Small Car[557]	1100	1469	79	146
Medium Car[558]	1387	2010	127	186
Large Car[559]	1659	3148	181	228
SUV[560]	1970	3252	174	258
People Mover[561]	1977	2775	135	242
Sports Car[562]	1605	3921	252	250

After carrying out the detailed exercise of extracting the typical characteristics of the motor vehicles under the seven categories as described in Appendix 3 and set out above, Appendix Table 3.10 in Appendix 3 shows the LET points allocated and Appendix Table 3.11 in Appendix 3 shows the LET payable by a single motor vehicle at each taxing point under each of the seven motor vehicle categories. Tables Appendix 3.12 to 3.18 apply the discount rate and show the LET attracted over a 10

[556] See Appendix Table 3.3 in Appendix 3.
[557] See Appendix Table 3.4 in Appendix 3.
[558] See Appendix Table 3.5 in Appendix 3.
[559] See Appendix Table 3.6 in Appendix 3.
[560] See Appendix Table 3.7 in Appendix 3.
[561] See Appendix Table 3.8 in Appendix 3.
[562] See Appendix Table 3.9 in Appendix 3.

year period at the four taxing points by each vehicle under the seven LET categories of motor vehicles as described above. The results in Appendix Table 3.10 confirm that light, small and medium cars have lower LET points compared with large cars, SUVs, people movers and sports cars. SUVs attract the most LET points, whereas sports cars are not as heavy, but score high points on engine size, engine power and CO_2 emissions. As a demonstration, the LET attracted by a single motor vehicle from each of the categories in the first year of implementation and discounted by 98 per cent is demonstrated in Figure 7.1.

FIGURE 7.1: LET Attracted in Year 1 at Four Taxing Points



Source: Appendix Tables 3.12 to 3.18 in Appendix 3.

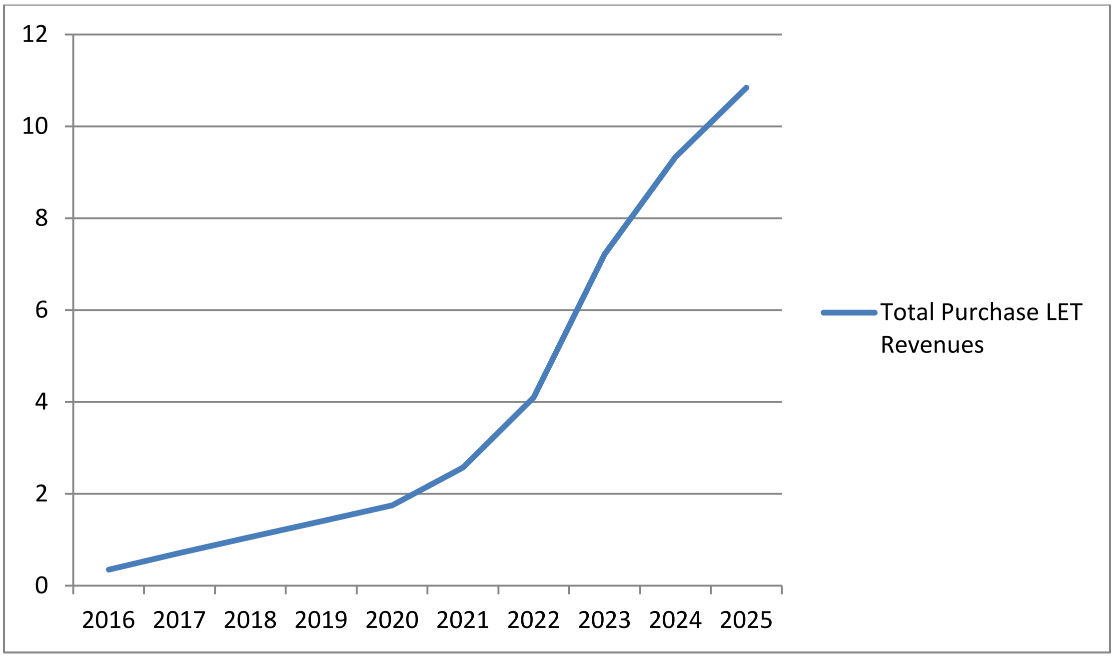
Figure 7.1 shows the LET payable by a single vehicle within each of the seven categories of motor vehicles on initial purchase, on annual road registration, the fuel LET payable per 1000 litres of fuel and the LET payable on disposal of a vehicle. In order to determine the total LET revenue that would be generated in the first 10 years of introducing LET, the exercises described in parts 7.2.2 to 7.2.4 and Appendices 4 to 6 were carried out.

The revenue forecast reveals that the timing of the change is important as public transport infrastructure has to be ready when the change is forecasted to occur. Thus the revenue raised can be controlled by changing the discount rate for years one to ten and in the process the timing of the change in travel behaviour can also be controlled, so as to bring about an orderly change in the personal transportation needs of the Australian people and avoid chaos.

7.2.2 Forecast of the Purchase LET Revenues

A six step process described in Appendix 4 at the end of this thesis was undertaken to forecast the purchase LET revenues for the years 2016 to 2025, on the assumption that the LET is implemented in year 2016. Based on the available data for 2011, the number and category of new motor vehicle sales that would naturally occur without the introduction of the LET were projected for years 2012 to 2025 based on logical assumptions. These projections were then adjusted by forecasted changes that would occur as a result of introducing the LET. These forecasted changes included an expected gradual decline in the number of new motor vehicle sales by 15 per cent over a period of 10 years to 2025 and a change in the types of passenger motor vehicles purchased from motor vehicles that attract a high LET to those that attract a lower LET in line with the discounted LET rates. The LET calculated in Appendix 3 for a single vehicle was then applied to the projected new motor vehicle sales to arrive at the projected income from the purchase LET. A summary of the total purchase LET revenues raised in each year from 2016 to 2025 is displayed in Figure 7.2.

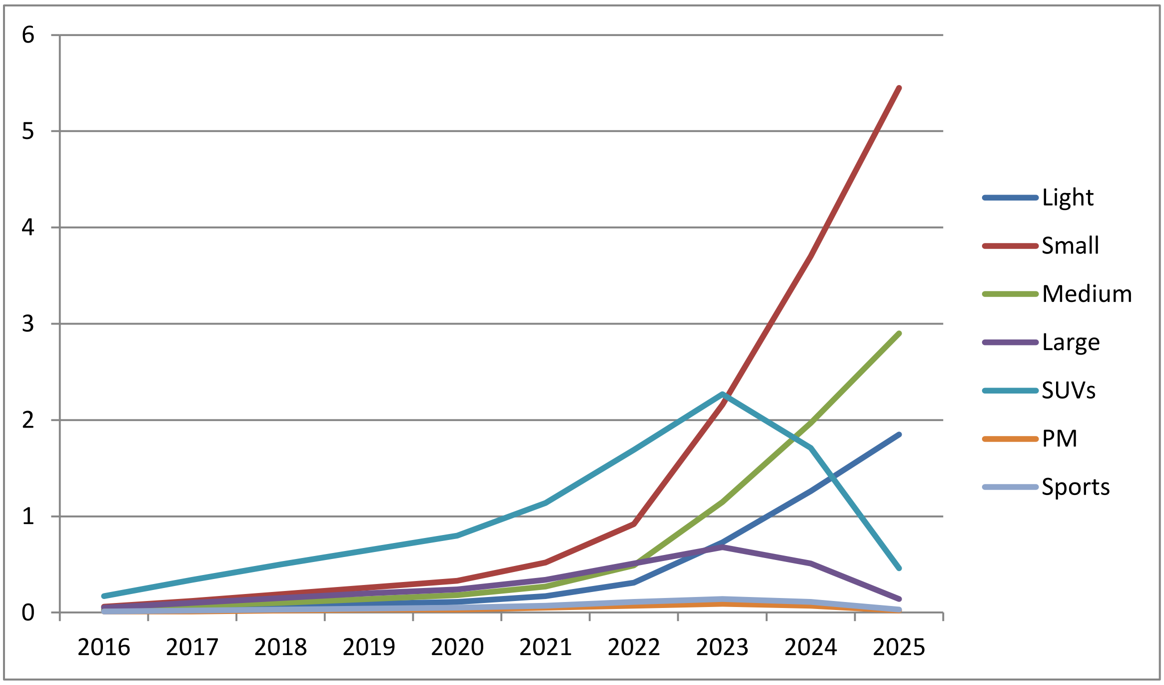
FIGURE 7.2: Total Purchase LET Revenues from Car Sales Data After Implementation of LET in AUD Billion



Source: Appendix Table 4.6 in Appendix 4.

The total LET revenues from the purchase LET are forecasted to range from AUD0.35 billion in 2016 to AUD10.84 billion in 2025. A further breakdown of the purchase LET revenues for each category of motor vehicle is shown in Figure 7.3.

FIGURE 7.3: Purchase LET Revenues for Each Motor Vehicle Category after Implementation of LET in AUD Billion



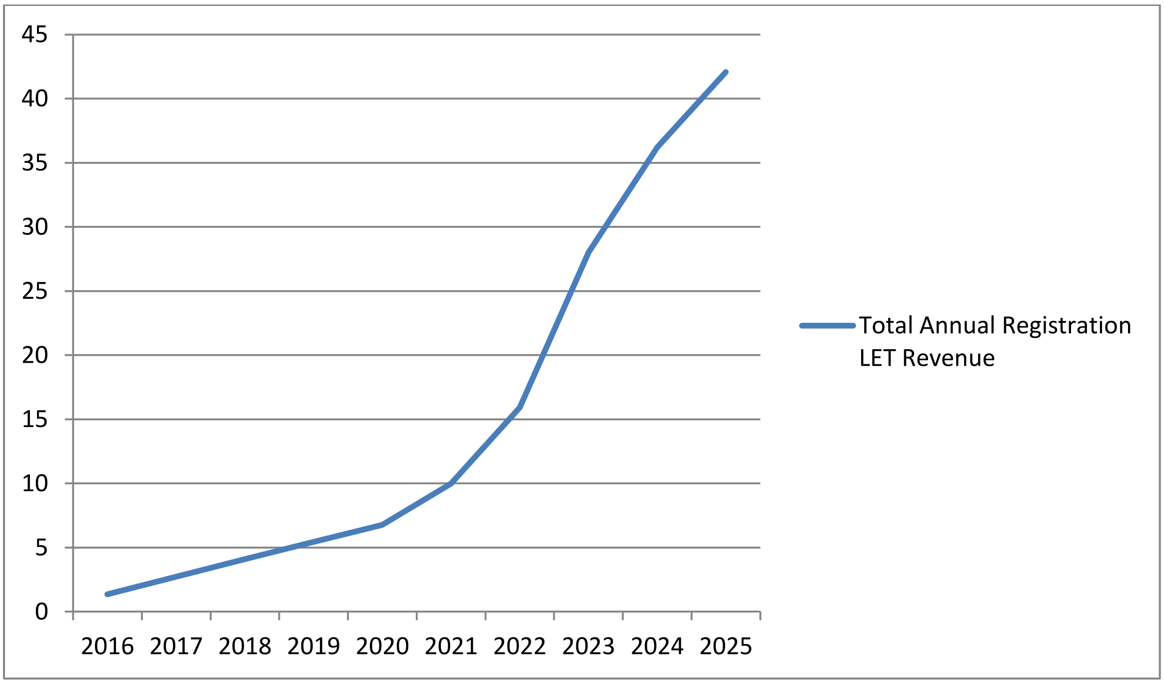
Source: Appendix Table 4.6 in Appendix 4.

It can be observed from Figure 7.3 that the revenues from large cars, SUVs, PMs and sports cars are expected to decline as the policy takes effect, whereas the revenues from light, small and medium cars are expected to increase.

7.2.3 Forecast of Annual Registration LET Revenues

A four step process described in Appendix 5 at the end of this thesis was undertaken to forecast the annual registration LET for the years 2016 to 2025. Based on the available data for 2011, the numbers and categories of the Australian passenger motor vehicle fleet for 2012 to 2025 were first projected based on logical assumptions. These projections were then adjusted to take into consideration the changes that may occur as a result of the introduction of the LET. For the purpose of the adjustments, it was assumed that there would be an expected gradual decline in the number of passenger motor vehicle stock of 15 per cent by 2025 as a result of the introduction of the LET. It was also assumed that the types of motor vehicles that made up the motor vehicle stock would change, with a gradual decline in passenger motor vehicles that attract a high LET and an increase in vehicles that attract a lower LET, in proportion to the LET discount rate. The LET calculated in Appendix 3 for a single vehicle was then applied to the projected motor vehicle stock to arrive at the projected income from the annual registration LET. A summary of the total annual registration LET revenues raised in each year is shown in Figure 7.4.

FIGURE 7.4: Total Forecasted Annual Registration LET Revenues after Implementation of LET in AUD Billion

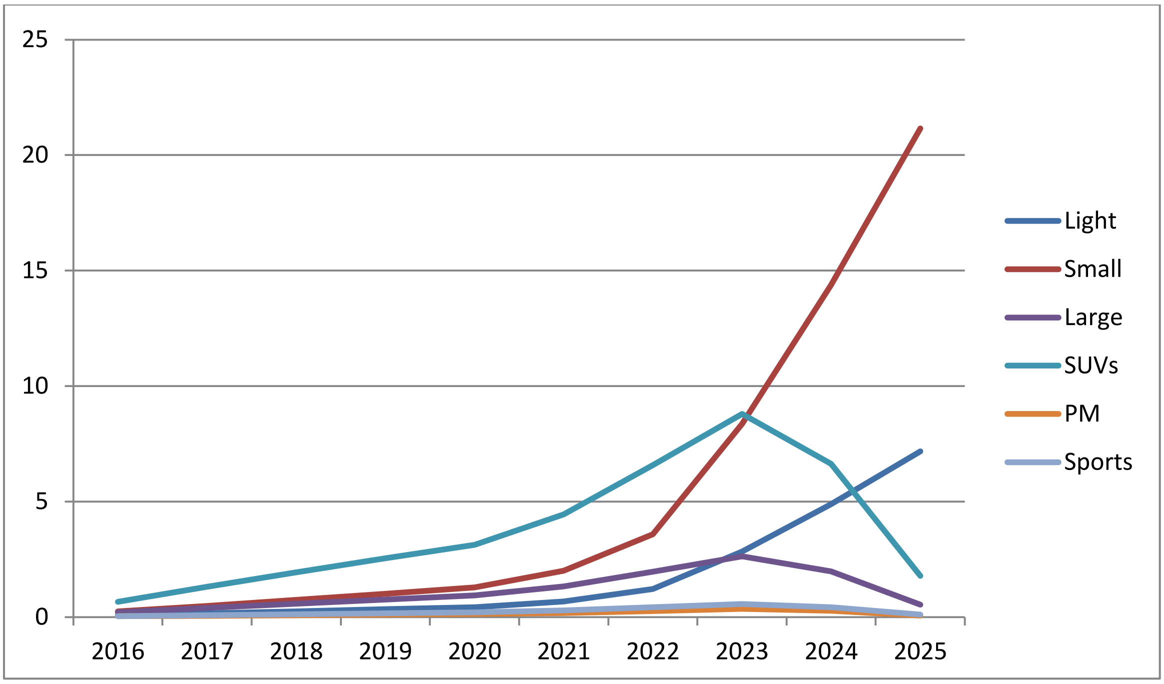


Source: Appendix Table 5.4 in Appendix 5.

The total LET revenues from the annual registration LET are forecasted to range from AUD1.37 billion in 2016 to AUD42.06 billion in 2025.

A further breakdown of the annual registration LET revenues for each category of motor vehicle is displayed in Figure 7.5 below. Most of the annual registration LET revenue is expected to be raised from SUVs until year 2023, and then overtaken by small vehicles.

FIGURE 7.5: Annual Registration LET Revenues for Each Motor Vehicle Category after Implementation of LET in AUD Billion

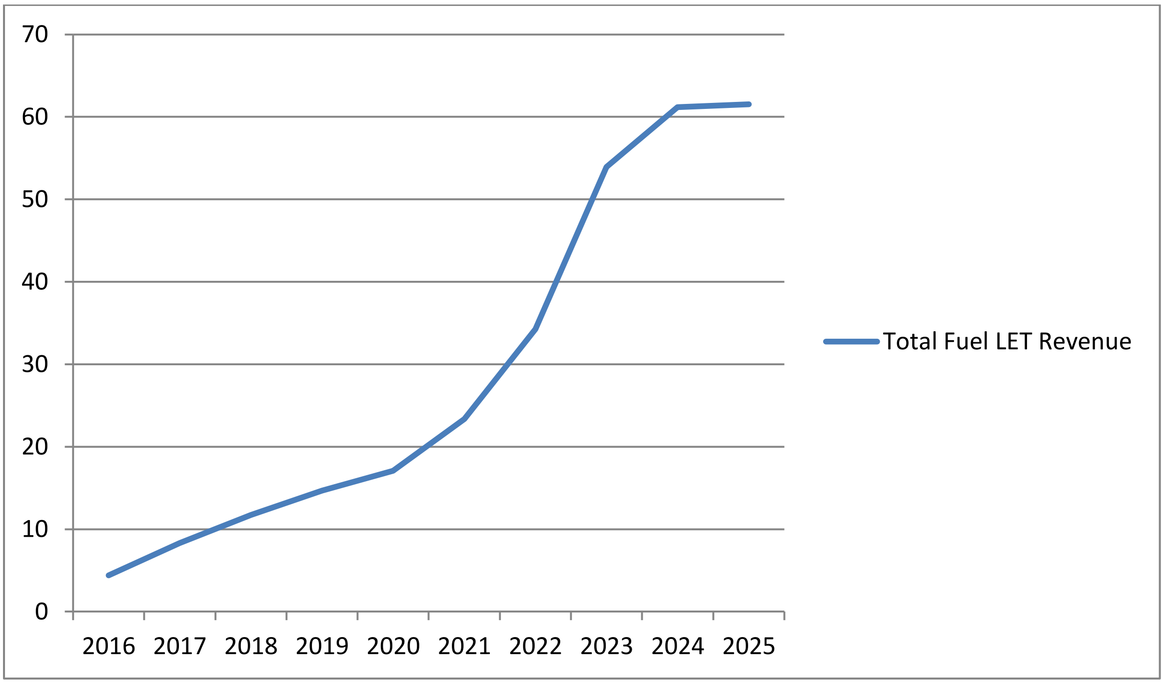


Source: Appendix Table 5.4 in Appendix 5.

7.2.3 Forecast of Fuel LET Revenues

A six step process described in Appendix 6 at the end of this thesis was undertaken to forecast the revenue from the fuel LET for the years 2016 to 2025. The average CO_2 emission data gathered for each category of Australian motor vehicle in Appendix 3 was used to determine the consumption of fuel per kilometre of travel. The ABS Survey of Motor Vehicle Use for the year 2011 revealed the average number of kilometres travelled by a passenger motor vehicle per annum and this data was used to determine the annual fuel use per category of vehicle. This result was then applied to the forecasted passenger motor vehicle fleet in Appendix 5 to calculate the total forecasted fuel use of the Australian vehicle fleet. The fuel LET per litre calculated in Appendix 3 for a single vehicle was then applied to the projected fleet fuel use to arrive at the projected income from the fuel LET. A summary of the total fuel LET revenues raised in each year is displayed in Figure 7.6 below.

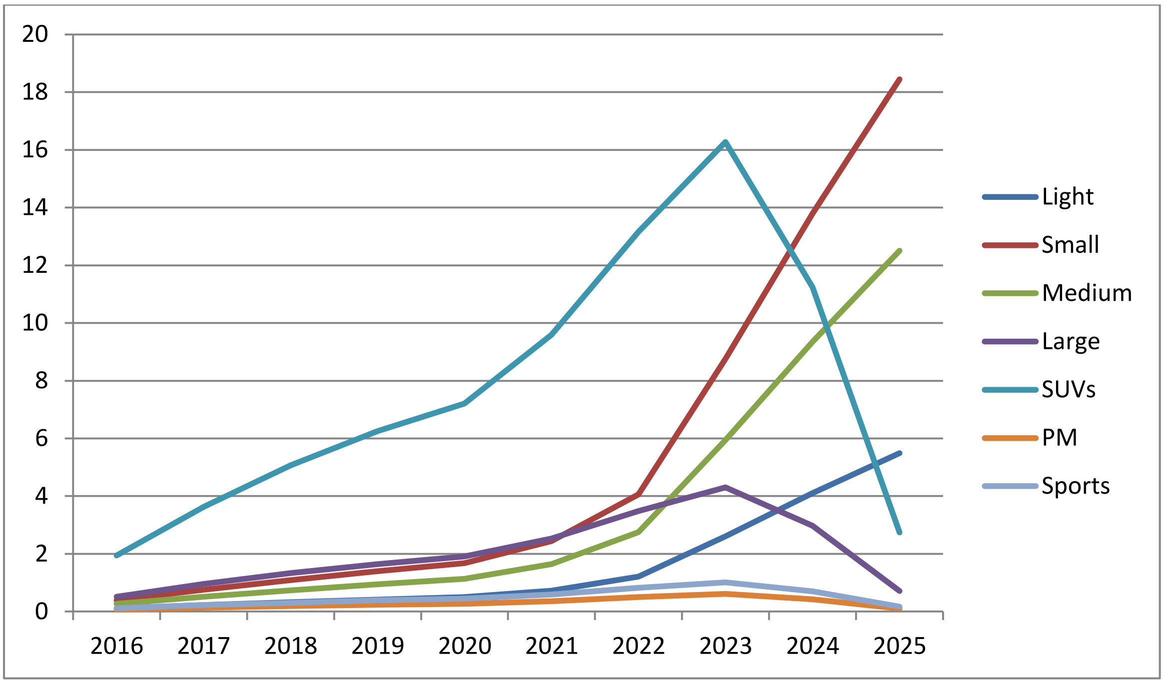
FIGURE 7.6: Total Forecasted Fuel LET Revenues after Implementation of LET in AUD Billion



Source: Appendix Table 6.6 in Appendix 6.

The total fuel LET revenues are predicted to range from AUD4.42 billion in 2016 to AUD61.52 billion in 2025. A further breakdown of the annual registration LET revenues for each category of motor vehicle is shown in Figure 7.7 below.

FIGURE 7.7: Fuel LET Revenues for Each Motor Vehicle Category after Implementation of LET in AUD Billion



Source: Appendix Table 6.6 in Appendix 6.

The data in Figure 7.7 demonstrates that the maximum fuel LET revenues are expected to be raised from SUVs until the year 2023. The fuel LET revenues from small motor vehicles are then forecast to increase steeply from 2021 to reach an expected maximum of AUD18.44 billion in 2025, whereas the fuel LET revenues from SUVs are expected to decrease from AUD16.27 billion in 2023 to AUD2.74 billion in 2025.

7.2.4 The Effect of Net Revenue Generation Potential

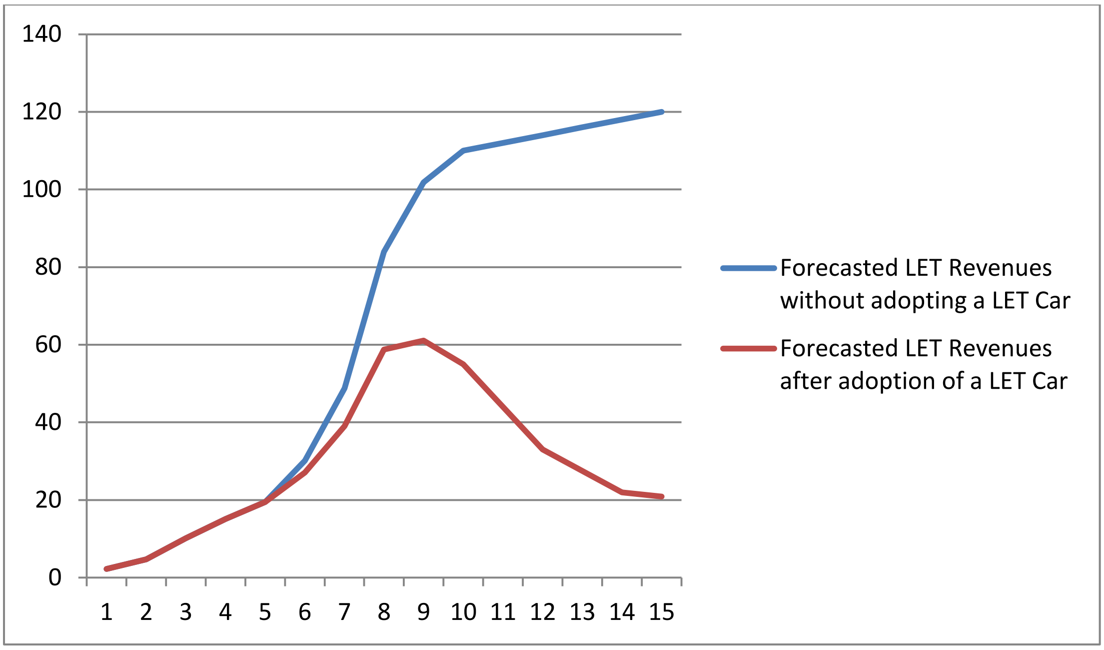
Appendix Table 7.1 in Appendix 7 at the end of this thesis shows the total forecast revenue from LET for the years 2016 to 2025, ranging from AUD6.15 billion to AUD114.42 billion. It is proposed in this thesis that when the LET is introduced by the Australian government, the LCT and the fuel excise for passenger motor vehicles should be abolished. Appendix Tables 7.3 and 7.4 in Appendix 7 show an estimate of the revenues that may be forgone from the LCT and the fuel excise. The cost of collecting the LET is forecasted in Appendix Table 7.2 in Appendix 7. The net revenue forecast after taking into consideration the forgone revenues from the LCT and fuel excise and the cost of collecting the LET is shown in Appendix Table 7.5 in Appendix 7 and ranges from AUD2.21 billion in 2016 to AUD109.7 billion in 2025.

To put it in perspective, the total revenue administered by the ATO on behalf of the government for the year ended 30 June 2011 was AUD280.89 billion, of which AUD204.73 billion was from income tax, AUD75.13 billion was from indirect tax and AUD1.02 billion was from other taxes. Of the income tax revenues, AUD136.55 billion was from individual income tax and AUD57.34 billion was from companies.[563] Thus the forecast LET revenues could be substantial. However it is possible that the revenues from the LET may not be generated as forecasted if a motor vehicle manufacturer in Australia designs and manufactures a new motor car that attracts no LET, and this car then dominates the Australian fleet. Moreover, the basis on which the forecasts are made may differ from the real changes that can occur in the number of motor vehicles in the motor vehicle fleet, the types of motor vehicles purchased and the number of vehicle kilometres travelled.

The purpose of the LET car is to use it for very short distance travel, especially within a suburb or to the nearest transport hub, and to encourage the use of public transport for medium to long-distance travel. Thus as the LET policy takes effect, the total forecasted LET revenues should substantially decrease, as LET cars that attract little or no LET are likely to be adopted by Australians, and passenger transportation is likely to shift from motor car to public transport. Figure 7.8 below shows an ideal shift in revenue position as the LET policy takes effect and the LET car is increasingly adopted by taxpayers. The reduction in LET revenues arising as a result of replacing the Australian vehicle fleet with LET vehicles is likely to be compensated by an increase in revenues from public transport usage, especially if public transport remains government-owned, rather than being privatised.

[563] Commissioner of Taxation, above n 552, 246 and 300.

FIGURE 7.8: Forecasted Reduction in LET Revenues With the Adoption of an Ideal LET Car

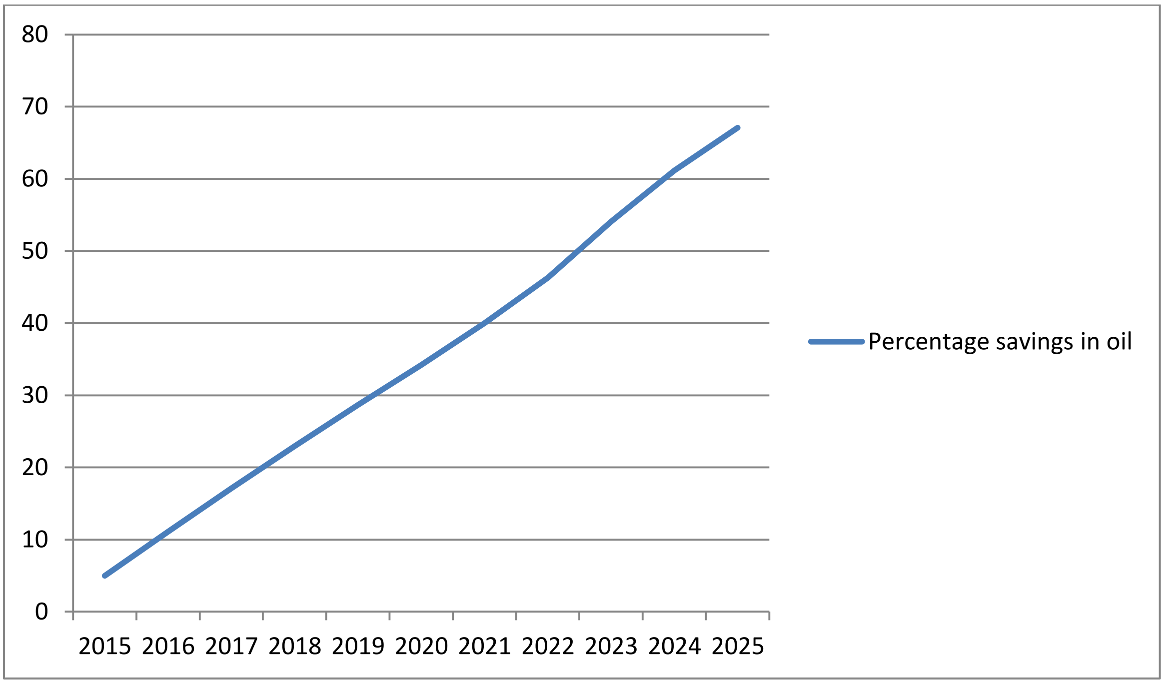


The purpose of the LET design is not to forecast the revenues it would generate with certainty, but to indicate its revenue generation potential, as the revenue generated should be used to bring about a change in personal transportation infrastructure in Australia that will last for 100 years. The level of LET imposed needs to be managed in order to bring about an orderly change. The raising of the forecast revenues should occur only in line with changes in infrastructure, in order to cope with the increased use in public transport. The LET would provide income to the government to build the public transport infrastructure that is required to bring about the desired changes. An orderly change is likely to be gradual. However, the government may run out of time if the public transport infrastructure has not been built before the conventional oil required for personal transportation becomes unaffordable by the general public. Thus the Australian government needs to act now and educate the population that a LET will enable Australia to decrease its reliance on foreign oil and provide an opportunity for the people to undertake personal transportation that is cheaper, faster and more energy efficient.

7.3 THE EXPECTED SAVING IN THE USAGE OF OIL

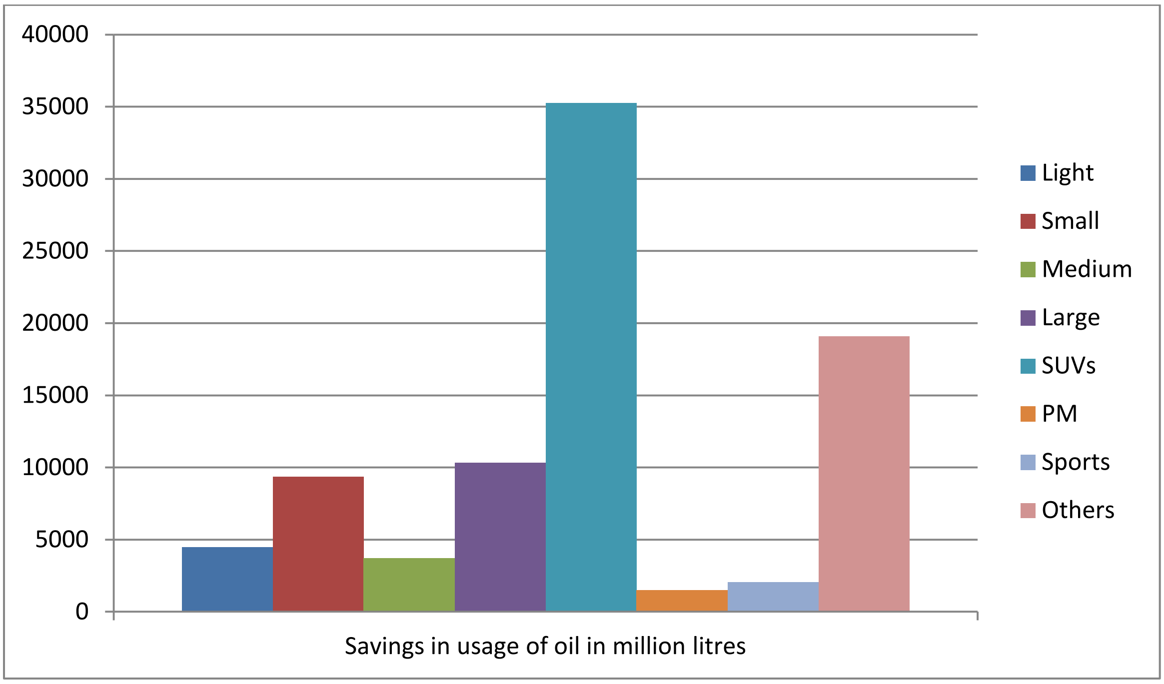
Based on the forecasts stated in part 7.2 above, the potential savings in oil as a result of introducing the LET are shown in Appendix Table 8.3 in Appendix 8 at the end of this thesis. The saving in oil ranges from 2.23 billion litres in 2016 to 15.66 billion litres in 2025. The total oil saved from 2015 to 2025 amounts to 85.71 billion litres. A comparison of the oil saved with the oil that would be consumed by passenger motor vehicles without the implementation of the LET shows savings ranging from five per cent in 2015 to 67 per cent in year 2025. The percentage saving in oil is shown in Figure 7.8 below.

FIGURE 7.9: The Expected Percentage Savings in Oil with the Introduction of the LET



The saving in oil for each motor vehicle category in million litres is shown in Figure 7.9.

FIGURE 7.10: Savings in Fuel by Vehicle Category from 2015 to 2025



Source: Appendix Table 8.3 in Appendix 8.

Figure 7.9 demonstrates that the greatest total savings in oil from 2015 to 2025 is from SUVs, representing 41 per cent of the total savings. The 'other' category in Figure 7.9 represents driving habits from all vehicle categories as discussed in Step 3 under Appendix 6.

The reduction in CO_2 resulting from the savings in oil can be estimated by using the conversion rate of one litre of oil emitting 2.36kg of CO_2 as stated in Step 1 of Appendix 6. Thus 85.71 billion litres of oil would save 202 million tonnes of CO_2 emissions from passenger motor vehicles to year 2025. This is a significant reduction in emissions.

7.4 GENERAL EVALUATION OF LET

A general evaluation of the LET is carried out in this part in terms of collection, fee calculation, technology, cost of state-wide implementation, auditing, fee rate structure, phase-in period, systemic precision, adaptability to congestion pricing, public acceptance, convenience and protection of privacy. This exercise is similar to the evaluation of the mileage fee under the Oregon study discussed in Chapter 5 of this thesis.

Based on the proposals made in Chapter 6, the purchase LET would be collected either directly by the ATO or indirectly via the state Departments of Transport. The fuel LET would be collected directly by the ATO through machines similar to ATMs set up at fuel pumps, with payment being made using prepaid debit cards. The annual registration LET would be collected by the state Departments of Transport along with state licensing fees. The disposal LET would also be collected by the state Departments of Transport. There will obviously be an initial compliance cost in setting up the collection systems as discussed in Part 6.4.5. However, the benefits derived from implementing the LET would far outweigh these costs, the benefits being not only the expected saving of oil and a decreased reliance on imported oil, but the preparedness of the public transport infrastructure to accommodate the increased demand when oil becomes expensive.

In terms of the fee calculation, the accumulation of LET points determines the amount of LET payable at each taxing point. The points are assigned at the time the motor vehicle is first registered for LET as discussed under part 6.4.4 above. Once the points are allocated, the amount of LET payable is only a mathematical formula.

The technology required for the LET system to operate is mainly the number plate recognition technology, the LET debit card POS terminals similar to 'Pay at the pump' systems, and the use of debit cards. These technologies are already advanced and are commercially available as demonstrated in Chapter 6 above. The adoption of this technology at each fuel pump at a service station would involve a cost. However, the cost is unlikely to outweigh the potential benefits to be derived from the LET system, as already discussed in this thesis.

The fee rate structure is based on the four characteristics of a motor vehicle that can affect the consumption of oil, ie vehicle weight, engine size, engine power and CO_2 emissions. The fee rate structure does not take into consideration a person's ability to pay the tax. However, these considerations can be addressed through the social security system and by providing tax rebates as discussed in part 7.5 below.

The phase-in period needs to be aligned with the time it would take to educate the public of the benefits of the LET system and setting up the administration of the system. A five year time frame has been estimated. Since the LET system is comprehensive and only requires the abolition of the LCT and fuel excises on passenger motor vehicles, the phase-in period of the full operation of the LET system could be relatively short. The annual registration LET would take at least a year to implement as its collection is proposed to be in line with licence fee renewals.

As regards systemic precision, the error rate is likely to be low as the LET calculation and collection would be precise. Any error in allocating the LET points is likely to be minimal under the vehicle certification process as discussed in part 6.4.4 above. The likelihood of error in the number plates issued by the Department of Transport is also likely to be low. Errors in using number plate recognition technology and the LET debit card POS terminals at the fuel pumps are also likely to be low. Thus it can be concluded that the LET system is likely to have a high systemic precision.

The audit of the LET system is discussed under 6.4.4 above where both general and specific audits are recommended. The fear of audits and the imposition of penalties would prevent abuse of the LET system. The aim of the system is not to be 100 per cent foolproof, but the system would deter LET avoidance.

The LET system can be adapted to congestion pricing by using the example of the Oregon mileage fee system as discussed in Chapter 5 above. Alternatively, a system similar to the Singapore congestion pricing system could be used whereby the number plate of the vehicle passing through the congested street is recognised and the congestion fee charged to the debit card already issued to the registered owner of the vehicle under the LET system. The congestion charges imposed could also be aligned to the LET points, thereby discouraging fuel guzzling passenger vehicles on congested roads.

Acceptance by the public would very much depend upon the education process. The public acceptance of the Norway toll system is high due to the public involvement in the organisational structure as discussed in part 5.2.2 above. The Norwegian study demonstrated that public confidence increases where there is a strong connection between user payments and perceived benefits. Thus the benefits of the LET system need to be demonstrated to the public in order for the system to be accepted by the public. The reasons for setting up the LET system were explored in Chapters 2, 3 and 4 of this thesis. The scarcity of oil and Australia's dependence on foreign oil together with passenger motor vehicles being the largest consumer of oil are the core catalysts that call for a change in the way passenger transportation is undertaken in Australia. The suggested LET would assist in bringing about this change, in terms of providing the necessary funds for the government to improve the public transport infrastructure and a change in the type of passenger motor vehicles that are purchased and used for personal transportation.

As regards convenience, the owners and users of passenger motor vehicles do not have to undertake tasks that are onerous. The LET collection at each taxing point would be fairly automated and therefore the LET can be said to be reasonably convenient.

The LET system is unlikely to invade the privacy of an individual. Unlike the kilometre/mileage system discussed in Chapter 5 for the Netherlands and Oregon, where the information about where the motor vehicle has been driven instigates privacy concerns as to how that information could be gathered and used by government organisations, the LET system only displays publicly the LET points attracted by the vehicle. This does not affect the privacy of the owner or user of the vehicle. In fact the display of the LET points act as an advertisement of the number of LET points attracted by that make and model and would amount to an educational exercise, rather than an infringement of privacy.

In conclusion, a general evaluation of the LET in terms of collection, fee calculation, technology, cost of state-wide implementation, auditing, fee rate structure, phase-in period, systemic precision, adaptability to congestion pricing, public acceptance, convenience and protection of privacy appears to be positive. In the next part, the LET is evaluated using Adam Smith's criteria of a good tax.

7.5 EVALUATION UNDER THE PRINCIPLES OF A GOOD TAX

The design of a good tax system should not only achieve its vision or purpose, but should also strive to achieve the criteria for an efficient tax. One way to assess the recommended LET is to assess it against a 'checklist' of desirable properties. The checklist of desirable properties can be drawn from the most famous canons of taxation set out by Adam Smith in *The Wealth of Nations* published in 1776.[564] Adam Smith's criteria of a good tax are:

> (i) The subjects of every state ought to contribute towards the support of the government, as nearly as possible, in proportion to their respective abilities ...
> (ii) The tax which the individual is bound to pay ought to be certain and not arbitrary ...
> (iii) Every tax ought to be levied at the time, or in the manner, in which it is most likely to be convenient for the contributor to pay it.
> (iv) Every tax ought to be so contrived as to take out of the pockets as little as possible, over and above that which it brings into the public treasury of the state.[565]

Mark Hinnells and Stephen Potter have built upon Adam Smith's criteria of a good tax and explored the principles of a good environmental tax, stating that taxes must not only be 'good taxes' in the conventional sense of the word but must be good taxes in a strictly environmental sense.[566]

The LET is evaluated below based upon a checklist of criteria drawn from Adam Smith's criteria of a good tax and Hinnells' and Potter's idea of a good environmental tax. Although the LET is evaluated using the commonly-used general principles, it has been noted by Clinton Alley and Duncan Bentley that the general principles should be interpreted within the perceived purpose or vision of the tax

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[564] Adam Smith, *An Inquiry into the Nature and Causes of the Wealth of Nations* (Oxford University Press, selected ed, 1993) 450, extracted from Clinton Alley and Duncan Bentley, 'A Remodelling of Adam Smith's Tax Design Principles' (2005) 20 Australian Tax Forum 579, 586.

[565] James Mirrlees et al, *Dimensions of Tax Design: The Mirrlees Review* (Oxford University Press, April 2010) 22.

[566] Mark Hinnells and Stephen Potter, 'Don't Tax More, Tax Different! A Tax Paradigm for Sustainability' (Paper No 20, Centre for Reform, 2001) 6.

system. Taxation, being the compulsory extraction of money by the government for which the taxpayer receives nothing directly in return, can have three purposes: to provide revenue for government expenditure; to act as an instrument to achieve economic aims set by the government; and to redistribute income on a socially acceptable basis.[567] The vision for the LET encompasses the three purposes stated: to provide revenues to the government for efficient public transport systems that will be required for passenger transportation when oil becomes expensive; to act as an instrument to change behaviour in the choice and usage of passenger motor vehicles; and to preserve the scarce oil resource so that it is available for use on a socially acceptable basis for current and future generations.

The LET is first evaluated under the four principles of an ideal tax system laid down by Adam Smith, being equity, certainty, convenience and economy.

7.5.1 Equity

Under the Adam Smith's criteria of equity, the subjects of every state ought to contribute towards the support of the government, as nearly as possible in proportion to their respective abilities. The question is whether equity is always measured in proportion to the revenue which the subjects respectively enjoy under the protection of the state. Equity or fairness is often classified as horizontal equity or vertical equity. Horizontal equity means people in the same situation should be equally treated. In other words, like taxpayers are taxed alike. Vertical equity means taxpayers in different situations are differently treated. The Asprey Report from the Taxation Review Committee in 1975 reflected on various interpretations of this principle. One way of viewing this principle is the 'benefit' approach, ie the tax payment should equate the benefits individuals are estimated to receive from government-provided goods and services. However, the Asprey Report stated that the benefit approach would be hard to apply as it is difficult to measure the benefits one derives from government-provided goods and services. Another approach is the 'ability to pay' approach where tax is viewed as a 'sacrifice' levied upon a private economic 'wellbeing' and the 'sacrifice' and the 'wellbeing' need to be measured in

[567] Alley and Bentley, above n 564, 582–83.

money terms. Thus an individual's wellbeing is often measured in terms of his or her income. However the Asprey Report identifies a number of problems including the meaning of 'income' and whether the unit of tax should be an individual or a family and whether income should be measured over one year or one's lifetime.[568] Further complications from the equity perspective occur in figuring out who actually pays the tax, in that the statutory or legal incidence shows who receives the tax bill, whereas economic incidence shows who bears the tax burden.

The literature in this field identifies a debate of the meaning of the phrase 'ability to pay' under Adam Smith's criteria. The question is whether the 'ability to pay' equates to the income or wealth of a person and consumption taxes are prone to breaching the 'ability to pay' principle because they are in proportion to consumption rather than the revenue they enjoy under the protection of the state.[569] Often a tax is accepted by the electorate if the benefits of the tax outweigh its regressive nature. An example of such a tax in Australia is the Goods and Services Tax (GST).[570] Taxes are labelled as regressive when they are a decreasing proportion of income as income rises.

Traditionally energy taxes have been labelled as strongly regressive, as early studies have ignored the indirect and long-term effects of environmental taxes. However later studies indicate that when the purpose of the environmental tax is to change behaviour over a long period, and the tax burden is measured over a longer period and includes both direct and indirect impacts that include the energy to produce energy and non-energy products, the regressivity is less.[571]

An environmental tax such as the LET may be considered regressive if measured in terms of a person's income as the tax is based on consumption criteria, ie the choice and use of a motor vehicle. However, a person has the choice to avoid the tax by choosing an appropriate LET vehicle or using public transport. It could be argued that a person has the ability to pay if they have the ability to consume more oil in their choice of a passenger motor vehicle. Under this interpretation, the LET would

[568] Asprey Committee, above n 41, 3.7–3.15.
[569] For good debate on the literature, see Alley and Bentley, above n 564.
[570] Ibid, 601.
[571] Jeff Hamond, Hardy Merriman and Gary Wolff, 'Equity and Distributional Issues in the Design of Environmental Tax Reform' (1999) *Redefining Progress* 1.

not be considered to be regressive. Moreover, the design of the LET can take into consideration certain special circumstances such as remote locations, disabilities, certain specific occupations and non-availability of public transport systems that may require dispensation to satisfy the criteria of equity. The design of the LET can in fact work in a progressive manner if the LET revenues are utilised in providing sufficient and frequent public transport facilities. Thus the LET collected from people with more ability to pay can be used to subsidise the public transport for people with less ability to pay.

In addition to equity in the traditional sense, the concept of intergenerational equity becomes relevant to the sustainability of the oil resource. The Brundtland Commission defined intergenerational equity in terms of sustainable development as: 'development that meets the needs of the present without compromising the ability of the future generations to meet their own needs.'[572] Sharon Beder argues that there are two ways of looking at how to ensure that future generations can supply their needs. One is a weak sustainability argument and the other is a strong sustainability argument. Under the weak sustainability argument, the view is that future generations will be adequately compensated for any loss of environmental amenity by having alternative sources of wealth creation. Under the preferred strong sustainability argument, the loss of environmental amenity cannot be replaced by human-made wealth and the future generation should not inherit a degraded environment.[573] Pearce et al argue that there are various reasons why the strong sustainability argument is preferred, being lack of substitutes, uncertainty as to whether substitutes can replace the degraded environmental asset, and that reversing the damage may be impossible or it may take centuries to repair.[574]

As regards oil, considering that it took millions of years for oil to be formed and that we are now accustomed to using oil in every aspect of our lives and there is uncertainty about finding a substitute for oil, the strong sustainability argument implies that oil should be considered a luxury and should be preserved for future generations and not wasted. Weiss argues that resource consumption can increase the

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[572] Brundtland, above n 495.

[573] Sharon Beder, 'Costing the Earth: Equity, Sustainable Development and Environmental Economics' (2000) 4 *New Zealand Journal of Environmental Law* 227, 228.

[574] David Pearce, Anil Markandya and Edward Barbier, *Blueprint for a Green Economy* (Earthscan, 1989), ch 2 in Beder, above n 573, 228.

real prices of those resources for future generations.[575] The imposition of a LET supports the intergenerational equity argument by reducing the consumption of oil in passenger motor vehicles so that the ability of future generations to meet their need for the oil resource is not compromised.

7.5.2 Certainty

Under Adam Smith's criteria, the requirement of certainty refers to the time of payment, the manner of payment and the quantity to be paid and these criteria ought to be clear and plain to the contributor and to every other person.[576] A tax that is certain will improve the taxpayer's understanding of his or her obligations and thereby increase the level of confidence a taxpayer will have in their compliance.[577] A simple tax is likely to be certain. A tax is called simple if the administration and compliance costs are less and these costs are likely to be less if the assessor and the assessed can establish with certainty what is due.[578] The Asprey Report mentions two aspects of simplicity. Firstly it states that a simple tax is one that requires the taxpayer to perform fewer operations for the administrators to make the assessment and the taxpayer to ascertain the liability. Secondly, a simple tax is one that has fewer collection points, ie 'the sheikdom that can raise all it requires (and maybe much more) from a single tax on a single oil company has what is unquestionably the simplest tax system of all.'[579]

The LET system as described in Chapter 6 satisfies the criteria of certainty as the rules clearly specify when the LET has to be paid, how it is to be paid and how the amount to be paid is to be determined. Moreover, the LET collection does not require complex tasks on the part of the taxpayer. Form-filling and using prepaid debit cards would not be classified as complex tasks. Since the LET is similar to the GST and is imposed on all registered owners of motor vehicles, it would not be classified as

[575] Edith Brown Weiss, 'In Fairness to Future Generations' (1990) 32(3) *Environment* 9, in Beder, above n 573, 229.
[576] See Alley and Bentley, above n 564, 608.
[577] American Institute of Certified Public Accountants, 'Guiding Principles of Good Tax Policy: A Framework for Evaluating Tax Proposals' (Tax Policy Concept Statement, March 2001) 7.
[578] Asprey Committee, above n 41, 3.7–3.20.
[579] Ibid 3.21–3.22.

simple under the second aspect of simplicity mentioned under the Asprey Report.[580] The imposition of the LET directly on registered motor vehicle owners should not be compromised for the sake of reducing collection points as it is necessary to impose the LET directly on the registered owner of the motor vehicles to bring about behavioural changes.

Certainty also refers to the degree of certainty with which the tax authority can accurately predict the incidence of tax and the certainty with which the revenue authorities can predict the revenue that will be raised in a particular year.[581] The revenue authorities can certainly identify the taxpayer under the LET as the taxpayer is the registered owner of the passenger motor vehicle. Although the LET behaviour change cannot be predicted with certainty, the revenues generated from the LET, if earmarked for public transport infrastructure, will not affect the government's general revenue. It should also be noted that the decline in LET revenues is likely to be compensated by an increase in revenues from the use of public transport. It should also be noted that if the LET is not introduced and the price of oil becomes unaffordable and people consequently demand public transport, this would not only bring about a drastic reduction in the collection of existing fuel excise, but could also result in chaos arising from an overburdened public transport system. By introducing the LET, there is a positive degree of certainty that the LET revenues are available to prepare for the increased demand on public transport systems when oil becomes unaffordable.

7.5.3 Convenience

Under the Adam Smith criteria on convenience, a tax should be due at a time or in a manner that is most convenient for the taxpayer. Convenience of payment assists in keeping compliance levels high. A convenient tax would be one that is assessed at the time of purchase when the person has a choice of purchasing the item or not.

[580] Ibid.
[581] Alley and Bentley, above n 564, 609.

Another example of a convenient tax payment is for the tax to be collected along with some other existing payment, thereby using an existing collection point.[582]

The LET would satisfy the criteria of convenience at the four collection points. The purchase LET is collected at the time of purchasing the vehicle, and the registered owner has a choice of whether or not to buy the vehicle and pay the purchase LET. The annual registration LET is also convenient as it is collected together with the existing state annual licence fees. The fuel LET is convenient as it is paid via prepaid debit card at the time of purchasing fuel. The disposal LET is convenient as it is paid at the time the number plate is returned to the Department of Transport.

The more difficult it is to pay a tax, more likely that it will not be paid. A system that has high compliance costs is likely to have reduced convenience. The compliance cost of the LET is discussed in part 6.4.5. As stated in that section, the start-up compliance costs of the LET includes learning about the LET procedures, including the use of the prepaid debit card and completing forms to register the motor vehicle for the LET. There could also be costs incurred if there is a dispute relating to the LET points allocated to a motor vehicle. The recurrent compliance costs for the LET would include the annual or periodical road worthiness test and the time it would take to top up the debit card. The proposed design of the LET does not provide for the taxpayer to keep transaction records or prepare a LET return. Therefore taxpayers are unlikely to incur the costs of an accountant or a tax preparer. However further compliance costs could arise if there is a difficulty in paying LET due to the failure of the prepaid debit card system. In this case, alternative procedures would need to be put in place, such as being able to extract temporary debit cards from convenient debit card outlets.

7.5.4 Economy

The economy criterion under the Adam Smith principle is that 'Every tax ought to be so contrived as to take out of pockets of the people as little as possible, over and

[582] Ibid 610; American Institute of Certified Public Accountants, above n 577, 8.

above that which brings into the public treasury of the State'.[583] This means that the cost of collection should be kept to a minimum. A tax that is administratively efficient would yield to the government the largest possible proportion of the money collected from the taxpayer. A tax that is complex increases the cost of administration and compliance.

The administration cost of the LET is discussed in part 6.4.5. The implementation of a new tax such as the LET would involve initial costs in setting up the LET Departments in each state, the tax collection systems and procedures within the LET Departments and the state Departments of Transport, all staff costs including training, designing forms and software, and purchasing and installing equipment such as the LET debit card POS terminals and the number plate recognition technology. The recurrent costs include accounting for the LET collections, auditing, maintenance of the LET debit card POS terminals and the automated number plate recognition systems, updating software to calculate the LET owed, accounting for revenues received, and identifying and prosecuting LET evaders. The fact that administrative costs are incurred does not obviate the need for implementing the LET for the purpose of changing motorist behaviour and reducing oil consumption in passenger motor vehicles.

In addition to administrative efficiency, economic efficiency is also desired of a good tax. This requires a tax to be neutral, in that considerations of tax liability do not influence the manner in which a person conducts his or her affairs. However, taxes are sometimes deliberately designed to change behaviour. Environmental taxes are often designed to tackle spillovers or externalities. The purpose of the LET is to change behaviour and therefore it will not satisfy the criteria of neutrality.

The LET is also explored under Mark Hinnells and Stephen Potter's criteria of a good environmental tax in the following section.

[583] Alley and Bentley, above n 564, 611.

7.5.5 Required Intervention

A 'good environmental tax' is one where the environmental intervention is justified. The intervention should be weighed against the costs to society of an environmental impact and this should be judged using the precautionary principle and not epidemiological evidence.[584] The precautionary principle for the LET was discussed under Chapter 6, part 6.4.1. The intervention through LET is justified on the basis that Australia imports around 80 per cent of the crude oil which is the primary energy source for the transport sector. The uncertainty of global oil supply justifies intervention through the LET by curbing the wastage of oil in fuel guzzling passenger vehicles.

7.5.6 Price Elasticity

Price elasticity of the commodity needs to be taken into consideration in setting the price of the product. A tax would only bring about a change if it is set high enough to be equal to or exceed the costs of change or the cost of damage. Hinnells and Potter state that price elasticity will depend upon the alternative technologies available and the ease of adoption of alternative modes of behaviour.[585] The LET is likely to bring about a change as it is not preventing the use of a passenger motor vehicle, but it is aimed at directing people to make appropriate choices based on the motor vehicle's oil consumption characteristics. The Australian government needs to ensure that the introduction of the LET and the LET rates are synchronised with the availability of alternative modes of public transport.

7.5.7 Built in Escalator

Hinnells and Potter state that it is better that an environmental tax is taxed earlier and lower to give a long term signal for change, since evolution is more manageable than revolution. Tax rates should be amended in light of the behavioural response to a

[584] Hinnells and Potter, above n 566, 6.
[585] Ibid.

price change.[586] The LET proposed in Chapter 6 has a built in escalator with a five year educational period before implementation of the LET and five years of a highly discounted rate, from 98 per cent discount in the first year to a 90 per cent discount in year five. The discount is then reduced to 85 per in the sixth year, 75 per cent in the seventh year, 50 per cent in the eighth year, 25 per cent in the ninth year and no discount in the tenth year. The proposed discounted rates for the LET should be adjusted in light of the behavioural response and the government's ability to provide alternative transport choices via the public transport network.

7.5.8 Use of Revenues Generated

The revenues collected from the environmental tax should be recycled into investments that reduce resource consumption.[587] It has been proposed in this thesis that the revenue from the LET should be used by the government in building or enhancing a public transport system that is time and energy efficient.

7.6 THE DESIRED ABILITY TO CHANGE BEHAVIOUR

There are a wide range of theories of behaviour change that can help to evaluate the LET's desired ability to change behaviour. According to research carried out by Lane and Potter in exploring consumer attitudes towards purchasing cleaner vehicles, both situational and psychological factors influence car purchasing behaviour. The situational factors include economic and regulatory environments, vehicle performance and existing fuel and road infrastructure. The psychological factors include attitudes, lifestyle, personality and self image.[588] Social and psychological models or theories can assist in pointing out the important issues that may need to be

[586] Ibid.
[587] Ibid.
[588] Ben Lane and Stephen Potter, 'The Adoption of Cleaner Vehicles in the UK: Exploring the Consumer Attitude — Action Gap' (2007) 15(11–12) *Journal of Cleaner Production* 1086.

dealt with in order to result in behaviour change.[589] Some of the recognised theories of behaviour change against which the LET is evaluated are:

- Individual level theories;
- Interpersonal behavioural theories; and
- Community theories of behaviour.

7.6.1 Individual Level Theories

Individual theories focus on the influences and processes involved in individual decision-making.

a. The Rational Choice Theory

The rational choice theory views people as rational economic actors who make decisions by assessing costs and benefits in order to maximise their welfare, and policy instruments such as the LET would lead individuals to modify their behaviour.[590] Anable, Lane and Kelay argue that the textbook rational choice theory tends to neglect the wider social, infrastructural and psychological factors such as peer pressure.[591] Applying the rational choice theory from a textbook perspective of individuals being rational economic actors, the LET is likely to influence individual behaviours by encouraging motorists to choose a motor vehicle that attracts less LET points, as the LET imposes extra costs on a consumer.

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[589] Elizabeth Ampt, David Engwicht and Sinclair Knight Merz 'A Personal Responsibility Perspective to Behaviour Change' (Paper presented at the 30th Australasian Transport Research Forum, Melbourne, Australia, 25–27 September 2007) 1.

[590] Jillian Anable, Ben Lane and Tanika Kelay, 'An Evidence Base Review of Public Attitudes to Climate Change and Transport Behaviour' (Working Paper No PPRO 004/006/006, UK Department for Transport, 2006) 66.

[591] Ibid 67.

b. Theory of Planned Behaviour (TPB)

Ajzen's TPB states that a particular behaviour is caused by a person's intention and the intention is influenced by the person's attitude, subjective and social norm and controlled beliefs. The central factor in the TPB is the individual's intention to carry out the particular behaviour.[592] Thus a person may have a wide range of motives or beliefs relating to their choice and usage of a motor vehicle for personal transportation.

Lane and Potter's research indicates that environmental issues play little part in the decision-making process to purchase a car. Their research points to a two stage decision-making process. Firstly the model decision is made on the capability and the purchase price of the vehicle. Then the consumer conducts a more sophisticated consideration of factors such as running costs, fuel economy, performance, safety, styling, image, brand and reliability.[593]

The beliefs central to the TPB are behavioural beliefs, normative beliefs and control beliefs. Behavioural beliefs relate to the consequences of certain actions. Normative beliefs relate to perceived expectations of others, and control beliefs refer to how feasible it is to perform a particular behaviour.[594]

Although general attitudes and specific behaviours are complex, the LET would form part of the perceived behavioural control in bringing about the desired change in behaviour. The LET would become part of a factor that would require consideration in the decision about the type of passenger motor vehicle to purchase and use. This is likely to occur due to the design of the LET, whereby the LET is imposed not only at the purchase level, but throughout the ownership of the passenger vehicle, ie at the registration level, the fuelling of the vehicle and the disposal of the vehicle.

[592] Ajzen, above n 40.
[593] Lane and Potter, above n 588, 1089.
[594] Ajzen, above n 40.

7.6.2 Interpersonal Behavioural Theories

Interpersonal behavioural theories state that people change not only because of personal characteristics, but also because of interactions with people around them.[595]

a. Triandis' Theory of Interpersonal Behaviour

According to Triandis, a person's behaviour is a function partly of what the person intends, partly out of the person's habitual responses and partly out of situational constraints and conditions under which the person operates. The person's intentions in turn are influenced by social, normative and affective factors as well as by rational deliberations.[596] The LET would become a situational constraint and condition under which a person would be required to operate and this constraint or condition is likely to influence a person's decision on the type of motor vehicle that they choose to purchase and use for personal transportation.

b. Social Learning Theory

Bandura's social learning theory states that in addition to using their own skills, competency and experience, people learn by observing peers and model their behaviour on what their peers are doing.[597] This theory focuses on the self-efficacy which increases people's confidence in their ability to take action. The design of the LET registration system displaying the LET points on the motor vehicle's number plate is likely to influence social learning, and social learning is a powerful tool to use in bringing about an effective change.

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[595] Ampt, Engwicht and Sinclair Knight Merz, above n 589, 2.
[596] Anable, Lane and Kelay, above n 590, 73.
[597] Ibid 74.

7.6.3 Community Theories of Behaviour

Community theories of behaviour are based on understanding how groups, organisations, social institutions and communities function.

a. Social Capital Theory

Social capital has been defined as the connections and relationships among and between individuals.[598] Halpern states that these relationships consist of networks, norms, relationships, values and informal sanctions that shape the quantity and cooperative quality of a society's social interaction.[599] Social capital can assist in explaining policy outcomes as it hinges on how people look around them for guidance on how to behave based on trust and participation.

The introduction of the LET is likely to demonstrate a demand for an ideal LET passenger vehicle that attracts the lowest number of LET points. When the demand for such a vehicle becomes apparent and a new motor vehicle design that is influenced by the LET emerges, the social capital theory would then work to increase the popularity of such a vehicle, especially if the new vehicle proves to be affordable, reliable and a fuel-efficient means of passenger transportation.

b. Diffusion of Innovation

The Diffusion of innovation theory states that new products, behaviours and ideas diffuse through a social network or through the media over time and spread within a society or from one society to another.[600] This theory may have an impact on the acceptance of the LET system as the LET number plates are advertised through the social networks and media over time. Lane and Potter's research on the adoption of cleaner vehicles in the UK indicates that private car buyers seek or collect

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[598] Robert D Putnam, 'Bowling Alone: America's Declining Social Capital' (1995) 6.1 *Journal of Democracy* 67.
[599] Anable, Lane and Kelay, above n 590, 76.
[600] Everett M Rogers, Arvind Singhal and Margaret M Quinlan, 'Diffusion of Innovation' in Don Stacks and Michael Salwen (eds) *An Integrated Approach to Communication Theory and Research* (Lawrence Erlbaum Associates, 1996) 409.

information from a wide range of sources. These include manufacturers' brochures, the internet, car magazines, sales staff, consumer guides, family and friends, television programs and radio and newspaper advertising.[601] These sources of information should be used in promoting the LET and desirable LET vehicles.

The diffusion of innovation theory may also have an effect on the innovative design of the new LET vehicle for passenger transportation. Five perceived characteristics of an innovation affect its rate of adoption. These are: relative advantage over existing products; compatibility with existing ideas and products; complexity to understand and use; whether the innovation can be tried out on a limited basis; and how visible adopting the innovation is to others.[602]

Lane and Potter suggested a series of 'hotspot' factors that influence the adoption of alternative innovations, being: the high purchase price resulting in a long payback period; products designed for easy and convenient use and not requiring users to adapt to technical requirements; a lack of systems integration between products and systems such as fuelling infrastructure and the life of an electric battery; and recognising that some people like to openly display their different choice, for example a highly observable eco-product sign.[603]

Thus the new LET vehicle would need to take into consideration these factors if it is to be readily accepted by people.

Although these suggested theories are well tested, it is a difficult task to predict behavioural change. Lane and Potter note that links between consumer values, knowledge, beliefs, attitudes, intentions and behaviour are not simple determinants.[604] There are many other theories that deal with human motivation, thought and action which are beyond the scope of this research. However, the imposition of a LET that is substantial enough and imposed at more than one taxing point is likely to affect behaviour around the choice and usage of motor vehicles for personal transportation, resulting in reduced oil usage.

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[601] Lane and Potter, above n 588, 1089.
[602] Ibid 1087.
[603] Ibid 1089–90.
[604] Ibid 1087.

7.7 CONCLUSION

This chapter explored the revenue generation capability of the LET system that was discussed in Chapter 6. The computations in Appendices 3 to 8 at the end of this thesis show that the LET has the potential to raise sufficient revenue to provide the Australian government with the funds to build the public transport infrastructure that will assist people to make changes relating to personal transportation that are likely to be triggered by the implementation of the LET. Based on various assumptions stated in Appendices 3 to 8, the LET has the potential to bring about a total saving of 85.71 billion litres of oil from 2015 to 2025 and this would result in reduction of 202 million tonnes of CO_2 emissions from passenger motor vehicles to year 2025.

An analysis of the evaluation of the LET carried out in this chapter shows that the LET has sound characteristics in terms of collection, fee calculation, technology, cost of state-wide implementation, auditing, fee rate structure, phase-in period, systemic precision, adaptability to congestion pricing, public acceptance, convenience and protection of privacy. The LET also conforms to the notion of a good tax under the principles discussed in this chapter and has the potential to be a good environmental tax with its desired ability to change motorist behaviour around the choice and usage of motor vehicles for personal transportation, and thus reduce oil consumption.

CHAPTER 8: CONCLUSION AND RECOMMENDATIONS FOR POSSIBLE FURTHER RESEARCH

8.1 INTRODUCTION

This chapter presents the conclusions on the key findings relating to the basic inquiry and research questions for this thesis as identified in Chapter 1, and the proposed policy recommendations. The basic inquiry of this thesis was whether the government of Australia bears responsibility for influencing Australian motorists' choice of motor vehicles in order to reduce oil consumption so as to preserve this scarce commodity, and whether this responsibility is being achieved within the current regulatory and tax environment. The core research questions identified in Chapter 1 were:

1. Is there a need to reform the design, choice and usage of passenger motor vehicles in Australia in order to sustain the limited oil resources?
2. What are the realistic tax measures that can be implemented and what criteria should the design of tax framework take into account to reform the choice and usage of motor vehicles for personal transportation in Australia in order to reduce the consumption of oil?

The following sections review the key findings and policy recommendations in relation to the research questions, and present the desired outcomes of the policy recommendations. This is followed by a discussion of the contributions made to research and methodology, the major limitations of the research, and some suggestions for future research, and finally, some concluding remarks.

8.2 REVIEW OF KEY FINDINGS AND POLICY RECOMMENDATIONS

To answer the research questions, it was first necessary to examine why and how the research problem has arisen. The problem was examined in Chapters Two and Three of this thesis and is briefly reiterated in the following part.

8.2.1 The First Research Question

The core underlying problem is the availability of oil and the dependence on foreign oil. The first reality is that the oil resource is finite and oil is a non-renewable source of energy. Once the energy from oil is used up, it cannot be recaptured. The facts stated in Chapter 2 of this thesis demonstrate that we will never know for certain when oil will completely run out and exactly how large the existing Australian and global oil reserves are. However, the Australian government's recent Draft White Paper released in December 2011 indicates that in 2010, Australia had only 10 years of economic demonstrated oil reserves[605] and that Australia is heavily dependent on imports of both refined petroleum products and crude oil to meet its liquid fuel demand.[606]

To determine whether Australia can rely on global oil reserves, it was necessary to carry out an assessment of the global oil position. Various government and independent agency reports were examined in Chapter 2 and these reports show concern about the global oil position and advocate that the governments of each country should take policy action to reduce the demand for oil.

The next question that was addressed in this thesis was why the availability of oil is important.[607] Lack of oil supply can lead to social and economic chaos and the ramifications of life without oil could include famine, disease and mass exodus. We as a society have become accustomed to using oil in every aspect of our lives, ranging from plastics to pharmaceuticals and all forms of transportation. Oil has

[605] Department of Resources, Energy and Tourism, above n 470, 14.
[606] Ibid, xxvi.
[607] See Chapter 2, part 2.3.

transformed our cities with the growth of the motor vehicle industry and has even influenced our land release policies and how our homes are designed. Homes with two or three car garages are now a norm rather than an exception.

The first step in resolving any problem is to recognise that there is a looming problem. In this thesis it was recognised that Australia imports about 80 per cent of the crude oil and the oil products it requires. It was also established that the transport sector accounts for about 70 percent of the total use of oil. A further examination of fuel consumption within the road transport sector revealed that passenger motor vehicles consumed the most, ie 60.9 per cent in 2007–08. Moreover, Australians are increasingly using private motor vehicles for personal transportation, and the use of public transportation system has been declining. Thus the problem recognised in this thesis was that Australians are heavily dependent on oil for their passenger motor vehicles. This led to the first inquiry for this thesis, to examine the motor vehicles that Australians drive in order to assess whether a change in government policy can influence the design, choice and usage of passenger motor vehicles in Australia in order to sustain the limited oil resources and reduce reliance on foreign oil.[608]

A review of passenger motor vehicles was undertaken in Chapter 3, where it was demonstrated that technological advances in motor vehicles have been eroded by model creep with increased power-to-weight ratios. This led to the question of whether we need two tonnes or more of metal in a passenger motor vehicle to carry a few hundred kilograms of passenger body weight, especially when Australian and global supplies of oil are uncertain. The logical conclusion was that passenger motor vehicle transportation needs to be examined by the Australian government and the growth and usage of these vehicles needs to be controlled by appropriate government policies.

Future motor vehicle designs and alternative biofuels were also examined in Chapter 3 and the conclusion drawn is that mass production and marketing of motor vehicles using new technologies is in its infancy and may take many years to have an impact. Therefore, Australian government policies need to focus on reducing the use of oil in existing vehicles with internal combustion engines that are available today, thereby answering the first research question of this thesis with the confirmation that there is

[608] See discussion in Chapter 2, part 2.4.

a need for the Australian government to reform the design, choice and usage of passenger motor vehicles in Australia in order to sustain the limited oil resources. The next question was to address the reform criteria by examining the regulatory and fiscal reforms undertaken in other countries. This is briefly reiterated in the next part.

8.2.2 The Second Research Question

In examining the regulatory reforms undertaken by other countries, it became apparent that some countries such as the US have recognised the problem of dependence on foreign oil in their motor vehicle use after the oil embargo was imposed in the 1970s by the Arab members of OPEC. The US government has tried to curb the oil consumption of its motor vehicle fleet by imposing mandatory fuel economy standards, ie the CAFE standards, since 1975. These standards have succeeded in increasing the fuel efficiency of the nation's fleet. However, the demand for large and powerful vehicles such as SUVs remains. The US government has therefore proposed more stringent standards to reduce fuel use and CO_2 emissions in its motor vehicle fleet for model years 2017 to 2025. Many problems with these standards have been identified in this thesis, such as the tendency for the standards to create tension between the government, the consumers and the motor vehicle industry, the inability to effect a reduction in the total number of motor vehicles on the road, the rebound effect, and an increase in policy gaming by manufacturers and importers to circumvent the standards imposed upon them. Thus it is proposed in this thesis that although the Australian government intends to implement mandatory CO_2 standards for passenger motor vehicles by 2015, the mandatory standards should be accompanied by a reform of Australia's motor vehicle taxes that influences end users in their passenger motor vehicle choices.[609]

This thesis then addressed the second research question regarding the realistic tax measures that can be implemented and the choice of criteria to design a tax framework that would be suitable to reform the choice and usage of motor vehicles for personal transportation in Australia in order to reduce oil consumption. To answer this research question, Chapter 4 examined the fiscal measures implemented

[609] See a discussion in Chapter 4, part 4.2.

by various countries around the world.[610] It was observed that many countries impose one-off and recurrent taxes directly or indirectly on registered owners of motor vehicles, and that these taxes, if they are set sufficiently high and use appropriate criteria, can play a role in affecting levels of motor vehicle ownership and the composition of the national fleet of vehicles.

It was also observed that many countries impose fuel taxes or fuel excise in order raise general revenues for the country or for road maintenance, however for political reasons, many countries have been unable to increase their fuel excise rates. This has created a road funding problem resulting in a desire to replace the declining fuel excise with kilometre-based user fee and congestion charges. Other travel demand management policies that can assist in improving social and market outcomes include road tolls, extra parking charges, pay-as-you-drive insurance policies, charges for the use of an express lane, leaving cars at home one day in a week and the banning of private cars in the city. Many countries provide income tax incentives or subsidies to encourage consumer demand for fuel-efficient or lower CO_2-emitting motor vehicles, especially for hybrid or plug-in electric vehicles. In spite of these incentives, the uptake of alternative fuel vehicles remains low. The reason for this is the excessive cost of these vehicles, insufficient battery range and lack of alternative fuel infrastructure.

This thesis also examined the current position of the Australian motor vehicle taxes.[611] Except for the LCT which provides for a higher threshold for motor vehicles whose fuel consumption does not exceed seven litres per 100km, the existing taxes and charges in Australia have little influence on the purchase and use of motor vehicles as the charges are not high enough or the basis on which they are imposed has no impact on the use of oil in motor vehicles. The Henry Tax Review suggested that fuel tax as a source of general government revenue should be phased out and transport-specific taxes should be imposed only where they improve social and market outcomes.

It was concluded in this thesis that the current taxation arrangements in Australia pertaining to passenger motor vehicles and fuel should be reformed from being just

[610] See the discussion on fiscal measures in Chapter 4, part 4.4.
[611] See Chapter 4, part 4.4 under *Lessons for Australia.*

revenue raisers to incorporating the principle of a reduction in oil use in passenger motor vehicles. A fitting method of addressing tax policy reform in Australia was to draw lessons from appropriate case studies. The three jurisdictions chosen for the case studies were Norway, the Netherlands and the state of Oregon in the US as these places have either enacted unique motor vehicle or fuel taxation regimes or have conducted parliamentary-approved studies that involve innovative ways of taxing their motor vehicles and road user charges.

Lessons were drawn from Norway's unique motor vehicle purchase tax system which is based on the vehicle's weight, engine capacity and CO_2 emissions.[612] The case study in the Netherlands reveals that the Dutch were prepared to make significant amendments to their motor vehicle taxation system to bring about a change in behaviour. The Oregon case study revealed a unique method of collecting the mileage fee, ie at the fuel station when the motor vehicle is being refuelled. Lessons were also drawn from the criteria set for the mileage fee concept in Oregon and how these criteria were tested and evaluated in a 12 month pilot program. The Oregon project has successfully triggered a national debate on the future of transportation funding in the 21st century.[613]

The lessons learnt from these case studies were then used to address the criteria for designing a tax framework to reform the choice and usage of motor vehicles for personal transportation in Australia in order to reduce the consumption of oil.

First a critical examination of the various policy options for Australia was conducted to resolve this identified problem.[614] The critical examination revealed that the best option for Australia is to conduct a comprehensive reform of the motor vehicle taxes and charges in Australia and introduce a LET system based on the precautionary principle and the polluter-pays principle.[615]

In order to design the LET criteria, it was necessary to examine the motor vehicle characteristics that cause extra oil use and emissions, and to ensure that these characteristics are taken into consideration in the design of the LET, by allocating

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612 See Chapter 5, part 5.2.3.
613 See a discussion of the Oregon study in Chapter 5, part 5.4.
614 See Chapter 6, part 6.3.
615 See Chapter 6, part 6.4.1.

progressive LET points on the vehicle weight, engine capacity, engine power and CO_2 emissions.[616] The accumulated LET points were then proposed to be taxed at four taxing points being: the purchase of the vehicle; annual registration; fuelling; and the disposal of the vehicle, by applying a set rate at each taxing point.

The administration, operation and implementation of the LET system are explained in detail in the thesis.[617] The LET is proposed to be a Commonwealth tax, but parts of the LET would be collected and administered by the states. It is also proposed that some existing Commonwealth taxes, such as the LCT and fuel excise for passenger motor vehicles, be abolished.

A detailed exercise was undertaken to evaluate the LET in terms of its revenue generation potential.[618] On the assumption that the LET is introduced in 2016, the net revenue forecast after taking into consideration the forgone revenues from the LCT and fuel excise and the cost of collecting the LET are forecasted to range from AUD2.21 billion in 2016 to AUD109.7 billion in 2025. The forecast saving in oil as a result of implementing the LET ranges from 2.23 billion litres in 2016 to 15.66 billion litres in 2025, resulting in a total saving in oil of 85.71 billion litres for the ten years from 2015 to 2025. The percentage oil savings from passenger motor vehicles is forecast to be five per cent in 2015 to 67 per cent in 2025.

The LET was then evaluated against set criteria, including the criteria of a good tax based on the most famous canons of a good tax set out by Adam Smith.[619] The LET has the potential not only to be a good tax, but also a good environmental tax with its goal of changing motorist behaviour regarding the choice and usage of motor vehicles for personal transportation, and reducing oil use, as discussed in this thesis.

In conclusion, this thesis has answered the basic inquiry and the core research questions set out in Chapter 1, confirming that the Australian government does bear a responsibility for influencing Australian motorists' choice of motor vehicles in order to reduce oil consumption so as to preserve this scarce commodity, and that this responsibility is not being achieved within the current regulatory and tax

[616] See Chapter 6, part 6.4.2.
[617] See Chapter 6, part 6.4.3.
[618] See Chapter 7, part 7.2.
[619] See Chapter 7, parts 7.4 and 7.5.

environment. This thesis explored the tax and regulatory measures that can be implemented in Australia and proposed a framework for the LET that is likely to achieve the desired aim of changing motorist behaviour in the choice and usage of passenger motor vehicles. The next part explains the likely desired outcome of policy recommendations arising from the LET.

8.3 DESIRED OUTCOME OF POLICY RECOMMENDATIONS

This thesis has highlighted the problem of how people have become accustomed to life with an available supply of oil to the point that they seem to believe it will be available forever, even though it may become a little more expensive. Oil as we know it today was only discovered in 1846 and 40 years later in 1886, Karl Benz invented the first gasoline motor vehicle. Since then, the global demand for oil has been continuously rising with the increase in the motor vehicle population, especially in countries such as India and China. Thus it is quite conceivable that the supply of affordable oil will diminish in the next 28 to 42 years. If this forecast is correct, then reforms such as the LET should be implemented sooner rather than later. If this forecast is incorrect and affordable oil does not diminish for the next 100 years, it is still worth considering reforms to preserve oil for necessities, as 100 years is not a long time when compared with the number of years that life on earth has been in existence and the number of years it has taken for oil to form.

The Australian population is particularly vulnerable to diminishing oil supplies as our cities are spread out and most people are accustomed to using motor vehicles for personal transportation. It is therefore necessary for the Australian government to take the lead and prepare the people to rely less on imported oil. The imposition of the LET could be the catalyst to bring about this change. It is likely to bring about a reaction, and if the LET is introduced with sufficient education and involvement of the people, the change can be controlled, rather than being volatile.

The LET is likely to force people to choose motor vehicle characteristics that attract less LET or no LET at all. These characteristics are the vehicle weight, engine capacity, engine power and CO_2 emissions. Since the LET points are expected to be demonstrated on the number plate, the demand for motor vehicles with less LET points will increase. It is hoped that the LET will inspire motor vehicle manufacturers to redesign passenger motor vehicles. The desire is for the LET to bring about a change in the Australian motor vehicle fleet to one which consumes less oil. However, the LET approach is to bring about this change directly through customer demand, rather than indirectly through regulations where customers are indirectly persuaded by motor vehicle manufacturers and importers.

An anticipated desired outcome of the LET is a newly-designed Australian micro-light motor vehicle that weighs 600kg, has a 600cc engine, 40kW of engine power and emits no more than 80g/km of CO_2. It should be possible for a motor vehicle manufacturer to design an affordable motor vehicle with these specifications. With appropriate light materials and aerodynamics, it is possible to produce a light and safe motor vehicle, and with mass production the cost can be kept affordable. Similar to an aeroplane, such a motor vehicle should be built to have a longer lifespan, allowing the cost of the vehicle to be spread out over more years. The motor vehicle design should take into consideration that as most families in Australia have more than one vehicle, the new generation vehicles should also offer two-seater cars that are not necessarily sports cars. The study of motor vehicle models in Chapter 7 indicates that most two-seater car models are sports cars with high engine power. The LET should highlight the design efficiency of the motor vehicle, and the notion that a motor vehicle is required as an efficient means of transportation, and not as a luxury item or a status symbol.

The current design of Australian cities and the suburbs within the cities is such that the need for passenger motor vehicles continues to exist. The LET does not take away the need to own a motor vehicle, but it encourages the purchase of a motor vehicle that consumes less oil. The ideal situation that may be achieved through the LET is for people to own a micro-light car that allows them to drive short distances including to the nearest transport hub. The use of public transport is encouraged for medium to long-distance travel and a micro-light car for local area travel.

In order to encourage the use of public transport, the income generated from the LET should be used by the Australian government to build sufficient and attractive public transport infrastructure and to cushion the impact of the tax on certain parts of the community, eg pensioners, disabled people and those who require special need vehicles. Many changes can be made to the public transport system to make it more attractive, such as extra car parking spaces near train stations. The income from the LET could be used to build multi-storeyed automated car parks, and as technology develops, these car parks could have robotic car lifts installed. Taking away the stress of parking would encourage the use of public transport. Prepaid reserved seats could be introduced in trains, which may help change the image of travelling in trains. In any case, more trains and buses and punctual service would enhance public transport use.

A desired outcome of the LET is to bring about a change in the perception of passenger motor vehicle transportation. The LET should not be used by the government to just raise revenue, ie as a cash cow, as this would crush society. The LET needs to be managed well, in that the imposition of the LET needs to coincide with the development of the public transport infrastructure, otherwise it is likely to cause anarchy. The design of the LET should take into consideration that dispensation may be required for people living in country areas with little or no public transport, large families, poor people and job and transport-specific vehicles. The government should implement the LET, but allow life to continue with minimal disruption.

The desired revenues forecast for the LET in Chapter 7 are just academic. The real objective of the LET is to monitor change taking place. The LET rate and timing of the discounted rate should take into consideration the manufacture of new micro-light cars, improvements to public transport infrastructure and social change taking place. It is emphasised in this thesis that for Australians to survive with expensive or no oil, change is important and the LET can assist in bringing about this change.

8.4 CONTRIBUTIONS TO RESEARCH

A vast quantity of research has been undertaken with regard to using fuel economy or CO_2 standards to bring about a behavioural change that will reduce fuel consumption in motor vehicles. Many countries are also focusing on demand management programs such as user-pay charges per kilometre driven and congestion charges. The present research has explored and gained a deeper understanding of how taxation can be used as a tool to change behaviour in the choice and usage of motor vehicles in order to reduce oil consumption. As a result, the current research findings and the developed LET framework provide new contributions to and implications for how the Australian government can bring about a change in the way passenger motor vehicle transportation is perceived in Australia.

The LET provides a new policy approach directed at resolving the global problem of how passenger motor vehicles are perceived and reducing the demand for large and powerful motor vehicles that consume and diminish the limited oil resources. Australia could become the pioneer in this area and may even benefit from a new motor vehicle industry for the manufacturing of new generation micro-light motor vehicles that could be exported to other countries. The LET would also generate the revenues required to build a better public transport infrastructure, and prepare the Australian cities for the next generation.

8.5 METHODOLOGICAL CONTRIBUTIONS

This thesis has been a pioneer in combining two methodologies, being interpretive description and legal methodology. Moreover, the interpretive description methodology has been used outside nursing science, for which it was first developed. The interpretive description methodology has permitted an examination of three different areas of investigation, being the position of oil resources, the position of passenger motor vehicles, and legal regulations and tax policy. The combination of these three areas has permitted a moral inquiry into whether the government of Australia bears a responsibility towards influencing Australian motorists' choice of motor vehicles in order to reduce oil consumption and preserve this scarce commodity, and whether this responsibility is being achieved within the current regulatory and tax environment. The legal methodology has permitted the investigation and formulation of tax policy proposals. The legal tax policy solution could not be suggested without probing into the problem. Therefore the combination of interpretive description and legal methodology has been an appropriate and ideal combination for this thesis.

8.6 MAJOR LIMITATIONS

A limitation of this research has been lack of experts in all of the three fields together, and therefore the research has not relied on expert interviews, but on a wide range of collateral documentary source material from each separate field that has contributed to the breadth of the inquiry. Documentary sources included government reports, refereed journal articles, industry reports, reports from representative world organisations, government legislation, research studies, books, media reports and general literature.

Another limitation has been that it has not been possible to test the policy recommendation made by this thesis, being the proposed LET. A pilot study similar to the one undertaken in Oregon could have been used to test the recommendations. However, such a study would have required a large amount of funding, the involvement of many organisations and a large time commitment. Moreover, a pilot study at this stage would have been considered to be too preliminary. It is hoped that this thesis ignites a debate in this area which persuades the government to take an active role in shaping the motor vehicle tax policy.

8.7 SUGGESTIONS FOR FUTURE RESEARCH

Within the Australian context, future recommendations for research would include gathering enough government and industry support and funding to conduct a pilot study of the operation of the LET. Future research also needs to be conducted in other areas where a policy change is required and recommended, ie commercial vehicles, recreational vehicles, alternative fuel vehicles including electric vehicles, zoning of land, house designs, public transport and city planning.

Within an international context, future research could include determining the willingness of nations to enter into an agreement of policy options to reduce the use of oil. This could be similar to the Kyoto agreement to reduce greenhouse gas emissions.

8.8 AUTHOR'S CONCLUDING COMMENTS

We as a society have a strong affinity to motor vehicles and we are increasingly dependent on oil. In this context, seeking behaviour change by the use of persuasive methods is unlikely to succeed in bringing about a lasting change, and therefore regulatory and fiscal reforms are required. However, without a strong political will, these regulatory and fiscal reforms would only end up as a window-dressing exercise. It is hoped that the Australian government does not wait for oil shortages to occur before taking the steps to bring about the recommended policy reform. If there is a constriction in the oil supply and Australia is not ready to embrace it, the government may face challenging problems pertaining to the personal transportation needs of the Australian people. Without preparedness, the government could be faced with the problem of transporting people to work and children to school, as well as delivering goods and services. The people of Australia will look to the government for answers when they cannot afford the oil for their passenger motor vehicles. Therefore the government needs to not only foresee these future problems, but to also have contemplated solutions to them.

The Australian government needs to see the big picture of over 100 years into the future in reforming its motor vehicle taxation system and realise that a future without change looks bleak and that life without oil would need substantial adjustments. However, these adjustments do not have to be all doom and gloom; they could bring about future opportunities for people, for businesses and for the country as a whole. The government need to set the scene by demonstrating to the people the full range of benefits arising from this reform, which could include the potential to create new jobs, create new markets, reduce imports and benefit the country as a whole.

An opportunity arising from the introduction of the LET could be the introduction to small micro-light motor vehicles. The LET could be used as a catalyst to inspire motor vehicle manufacturers to design and manufacture new generation micro-light motor vehicles that are suitable for driving short distances. This could be a tremendous opportunity for Australian car manufacturers with potential sales to replace some of the 16 million cars in Australia. The LET would set the manufacturing parameters for the types of cars that are going to be demanded by the consumers in Australia.

The introduction of the LET could also provide the opportunity to redesign and modernise the Australian public transport infrastructure. Many changes can be made, for example, if micro-light cars are encouraged for local area travel and public transport is encouraged for medium to long-distance travel, then car parking at the transport hubs will need to be changed.

Multi-storeyed or underground car parks may be required to cater for the increase in need for parking. Car parks could be automated or even robotised for convenience, including a provision for reserved and prepaid parking spots. Many countries in the world are introducing smart car parking stations with computer controlled parking levels, where the driver enters the car park and the car is automatically parked using automated conveyor belts and lifts. When the driver returns and requests the car via the parking meter, the car is automatically brought back to the driver. A very good example of such a car park is in Wolfburg, Germany, where a 10 level car park is fully automated with six entry and exit lanes.[620]

A rapid public transport system would enhance its usability. An increase in light trains may be necessary to join one suburb to another, and there could be an opportunity to install a limited number of high speed trains like the trains used in China, Japan and some European cities. The public transport system can be modernised with a range of different services instead of one type of service that fits all. There could be a provision where a person could pay extra to reserve a seat in a particular suburban train. In this way the person is assured of a seat, and the train service can be converted from cattle class to jet class.

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[620] See demonstration of an automated car park at http://www.youtube.com/watch?v=UrCmPWCgCRQ&feature=related.

With the increased use of train travel, another business opportunity could be a pre-booked micro-light car at the end of the journey to take the person from the train station to the place of work.

A new way of thinking could transform the public transport system into a luxury system that caters to the individual's desire to demonstrate a level of prestige, in much the same way that the need to drive a large and powerful motor vehicle is doing today. As well as saving oil, there are many other benefits to having a well organised and efficient transport system, such as reduced stress, and increased productivity, as work can be undertaken whilst travelling, including the conduct of meetings. This is possible especially in this day and age where computing and phone technology allow communication whilst travelling.

Other potential opportunities arising through the introduction of the LET include suburb redesign and centralised living. The message from this thesis is that a new way of thinking is required in passenger vehicle transportation, and this new way of thinking can bring about benefits and opportunities. The LET should not be seen as a bitter pill, but as a new opportunity arising from a necessity, that should be embraced. Just as we had to embrace the age of electronic commerce, and we are embracing the changes required to control CO_2 emissions in the carbon tax legislation, we can certainly embrace changes to reduce the consumption of oil in passenger motor vehicles by implementing the LET.

A direct result of implementing the LET would be the savings in oil and reduction in emissions, as forecast in Chapter 7 of this thesis. Reduced reliance on oil would mean reduced imports for Australia, resulting in a strengthened Australian economy. The benefits of reduced emissions are well known and would certainly be welcomed by the global community. In addition to the direct benefits, the LET could trigger some positive indirect benefits with foresight and planning.

The concluding thought is that a new way of thinking is required, as it takes millions of years for our planet to produce oil, but it takes only an instant to burn it, and once burnt, it is not recoverable. Therefore the Australian government should take the responsibility to implement appropriate taxation policies such as the proposed LET, in order to promote the efficient movement of people and goods with the least consumption of oil. If oil that has taken millions of years to form is used up within one to two centuries, what will happen to the needs of future generations in the centuries to come?

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APPENDIX 1: CO_2 OR FUEL EFFICIENCY-BASED TAX RATE DIFFERENTIATION IN MOTOR VEHICLE TAXES IN THE EU COUNTRIES

Country	CO_2/Fuel Consumption Taxes
Austria	A fuel consumption tax (Normverbrauchsabsage or NoVA) is levied upon the first registration of a passenger car. It is calculated as follows: - Petrol cars: 2% of the purchase price x (fuel consumption in litres – 3 litres); - Diesel cars: 2% of the purchase price x (fuel consumption in litres – 2 litres). Under a bonus-malus system, cars emitting less than 120g/km receive a maximum bonus of EUR300. Cars emitting more than 160g/km pay a penalty of EUR25 for each gram emitted in excess of 160g/km. Since 1 March 2011, there is an additional penalty of EUR25 for each gram emitted in excess of 180g/km and another penalty of EUR25 for each gram emitted in excess of 220g/km. These penalties are cumulative.
Belgium	Tax incentives are granted to private persons purchasing a car that emits less than 115g CO_2/km. The incentives consist of a reduction of the invoice price by the following amount: - Cars emitting less than 105g/km: 15% of the purchase price, with a maximum of EUR4640; - Cars emitting between 105 and 115g/km: 3% of the purchase price, with a maximum of EUR870.
Cyprus	1. The rates of the registration tax (based on engine capacity) are adjusted in accordance with the vehicle's CO_2 emissions. This adjustment ranges from a 30% reduction for cars emitting less than 120g/km to a 20% increase for cars emitting more than 250g/km. 2. The rates of the annual circulation tax (based on engine capacity) are reduced by 15% for cars emitting less than 150g/km.
Denmark	1. The annual circulation tax is based on fuel consumption. - Petrol cars: rates vary from DKK520 for cars driving at least 20km per litre of fuel to DKK18 460 for cars driving less than 4.5km per litre of fuel. - Diesel cars: rates vary from DKK160 for cars driving at least 32.1km per litre of fuel to DKK25 060 for cars driving less than 5.1km per litre of fuel. 2. Registration tax (based on price): An allowance of DKK4000 is granted for cars for every kilometre in excess of 16km (petrol) respectively 18km (diesel) they can run on one litre of fuel. A supplement of DKK1000 is payable for cars for every kilometre less than 16km (petrol) respectively 18km (diesel) they can run on one litre of fuel.
Finland	1. The registration tax is based on CO_2 emissions. Rates vary from 12.2% for cars emitting 60g/km or less to 48.8% for cars emitting 360g/km or more. The system is fully linear and technologically neutral. 2. The annual circulation tax is based on CO_2 emissions for cars registered since 1 January 2001 (total mass up to 2500kg) or 1 January 2002 (total mass

Country	CO_2/Fuel Consumption Taxes
	above 2500kg) respectively and for vans registered since 1 January 2008. Rates for cars vary from EUR20 to EUR600.
France	1. Under a bonus-malus system, a premium is granted for the purchase of a new car when its CO_2 emissions are 110g/km or less. The maximum premium is EUR5000 (below 60g/km). An additional bonus of EUR300 is granted when a car of at least 15 years old is scrapped and the new car purchased emits maximum 110g/km. A malus is payable for the purchase of a car when its CO_2 emissions exceed 150g/km. The maximum tax amounts to EUR2600 (above 240g/km). In addition to this one-off malus, cars emitting more than 245g/km pay a yearly tax of EUR160. 2. The regional tax on registration certificates ('carte grise') is based on fiscal horsepower, which includes a CO_2 emissions factor. Tax rates vary between EUR27 and EUR46 per horsepower according to the region.
Germany	The annual circulation tax for cars registered as from 1 July 2009 is based on CO_2 emissions. It consists of a base tax and a CO_2 tax. The rates of the base tax are EUR2 per 100cc (petrol) and EUR9.50 per 100cc (diesel) respectively. The CO_2 tax is linear at EUR2 per g/km. Cars with CO_2 emissions below 120g/km are exempt (110g/km in 2012–13, 95g/km subsequently).
Greece	The annual circulation tax for cars registered since 1 January 2011 is based on CO_2 emissions. Rates vary from EUR0.80 per gram of CO_2 emitted (101–120g/km) to EUR3.00 per gram (above 250g/km).
Ireland	1. The registration tax is based on CO_2 emissions. Rates vary from 14% for cars with CO_2 emissions of up to 120g/km to 36% for cars with CO_2 emissions above 225g/km. 2. The annual circulation tax for cars registered since 1 July 2008 is based on CO_2 emissions. Rates vary from EUR104 (up to 120g/km) to EUR2100 (above 225g/km).
Latvia	The registration tax is based on CO_2 emissions. Rates vary from LVL0.3 per g/km for cars emitting 120g/km or less to LVL5.0 per g/km for cars emitting more than 350g/km.
Luxembourg	1. The annual circulation tax for cars registered since 1 January 2001 is based on CO_2 emissions. Tax rates are calculated by multiplying the CO_2 emissions in g/km with 0.9 for diesel cars and 0.6 for cars using other fuels respectively and with an exponential factor (0.5 below 90g/km and increased by 0.1 for each additional 10g of CO_2/km). 2. Purchasers of new cars emitting maximum 110g/km (100g/km from 1 August 2011) receive an incentive of EUR750. The incentive is doubled to EUR1500 for cars emitting maximum 100g/km (90g/km as from 1 August). It increases to EUR3000 for cars emitting maximum 60g/km.
Malta	1. The registration tax is calculated through a formula that takes into account CO_2 emissions, the registration value and the length of the vehicle. 2. The annual circulation tax is based on CO_2 emissions and the age of the vehicle. During the first five years, the tax only depends on CO_2 emissions and varies from EUR100 for a car emitting up to 100g/km to EUR180 for a car emitting between 150 and 180g/km.
The Netherlands	1. The registration tax is based on price and CO_2 emissions. Cars emitting maximum 95g/km (diesel) and 110g/km (other fuels) respectively are exempt from this registration tax. 2. Cars emitting maximum 95g/km (diesel) and 110g/km (other fuels) respectively are also exempt from the annual circulation tax.

Country	CO_2/Fuel Consumption Taxes
Portugal	1. The registration tax is based on engine capacity and CO_2 emissions. The CO_2 component is calculated as follows: - Petrol cars emitting up to 115g pay [(EUR3.57 x g/km) – 335.58]. Diesel cars emitting up to 95g pay [(EUR17.18 x g/km) – 1364.61]. - The highest rates are for petrol cars emitting more than 195g [(EUR127.03 x g/km) – 20 661.74] and for diesel cars emitting more than 160g [(EUR166.53 x g/km) – 20 761.61]. 2.The annual circulation tax for cars registered since 1 July 2007 is based on cylinder capacity, CO_2 emissions and age.
Romania	The special pollution tax (registration tax) is based on CO_2 emissions, cylinder capacity and compliance with European emission standards.
Spain	The registration tax is based on CO_2 emissions. Rates vary from 4.75% (121–159g/km) to 14.75% (200g/km and more).
Slovenia	The registration tax is based on price and CO_2 emissions. Rates vary from 0.5% (petrol) and 1% (diesel) respectively for cars emitting up to 110g/km to 28% (petrol) and 31% (diesel) respectively for cars emitting more than 250g/km.
Sweden	1. The annual circulation tax for cars meeting at least Euro 4 exhaust emission standards (European pollutant emission standard for light-duty vehicles as defined by Directive 98/70/EC) is based on CO_2 emissions. The tax consists of a basic rate (SEK360) plus SEK 20 for each gram of CO_2 emitted above 120g/km. This sum is multiplied by 2.55 for diesel cars. Diesel cars registered for the first time in 2008 or later pay an additional SEK250 and those registered earlier an additional SEK500. For alternative fuel vehicles, the tax is SEK10 for every gram emitted above 120g/km. 2. A five-year exemption from annual circulation tax applies for 'environmentally-friendly cars': - Petrol/diesel/hybrid cars with CO_2 emissions up to 120g/km; - Alternative fuel/flexible fuel cars with a maximum consumption of 9.2l (petrol)/8.4l (diesel)/9.7cm/100km (CNG, biogas); - Electric cars with a maximum consumption of 37kWh/100km.
United Kingdom	1. The annual circulation tax is based on CO_2 emissions. Rates range from GBP20 (petrol, diesel)/GBP10 (alternative fuels) for cars emitting 101–110g/km to GBP435 (petrol, diesel)/GBP425 (alternative fuels) for cars emitting more than 255g/km. A special first year rate of registration has been applicable since 1 April 2010. Rates vary from GBP110 (131–140g/km) to GBP950 (more than 255g/km). 2. The private use of a company is taxed as a benefit in kind under personal income tax. Tax rates range from 5% of the car price for cars emitting up to 75g/km to 35% for cars emitting 235g/km or more. Diesel cars pay a 3% surcharge, up to the 35% top rate. Electric cars are exempt.

Source: European Automobile Manufacturers Association (ACEA), 'ACEA Tax Guide 2011 – More Governments Introduce Incentives' (19 November 2011) *ACEA* <http://www.acea.be/index.php/news/news_detail/tax_guide_2011_incentives_increase_further/>.

APPENDIX 2: OREGON PILOT PROGRAM SURVEYS AND SUMMARY OF THE RESULTS

As part of the pilot program, participants agreed to take part in three surveys. The owners and managers of the service stations agreed to be interviewed regarding their experience with the program.

Three surveys were conducted at the beginning, midpoint and end of the field test and they provide ODOT with an insight into the experience of the participant motorists.

Survey 1 was conducted on 20–29 June 2006 and the survey focus was:

- Reasons for participating;
- Understanding of the pilot program;
- Installation and early operational experience with on-vehicle device;
- Travel patterns and attitudes.

Survey 2 was conducted between 25 October and 8 November 2006, and the survey focus was:

- Experience with equipment;
- Experience with pilot program features;
- Travel patterns and attitudes.

Survey 3 was conducted between 15 March and 10 April 2007 and the survey focus was:

- Behaviour changes;
- Experience with equipment;
- Experience with pilot program features;
- Travel patterns and attitudes.

The results of the survey reported by ODOT are stated in the following four tables.

APPENDIX TABLE 2.1: Sample Size and Responses

	Households	Participants (motorists)	Vehicles
Registered participants	221	299	285
Survey 1 – Response Totals	194	288	274
Survey 2 – Response Totals	190	270	256
Survey 3 – Response Totals	183	264	251

APPENDIX TABLE 2.2: Initial Concerns — Survey 1

Concerns with the Program	Great Concern		Some Concern		No Concern		N/A	
Fear of burglary due to visible equipment	11	6%	81	42%	101	52%	1	1%
Having to purchase gas at Leathers	9	5%	62	32%	123	63%	0	
Whether payment will be worth effort	9	5%	55	28%	126	65%	4	2%
Accuracy of mileage readings	14	7%	44	23%	135	70%	1	1%
Impact of equipment on vehicle	9	5%	50	26%	135	70%	0	
Privacy associated with equipment	6	3%	29	15%	159	82%	0	
Ability to participate for full year	9	5%	21	11%	164	85%	0	
Getting full household participation	6	3%	8	4%	172	89%	8	4%
Going to reader station three times	2	1%	17	9%	174	90%	1	1%
Friends' and neighbours' opinions	2	1%	15	8%	175	90%	2	1%

APPENDIX TABLE 2.3: Satisfaction — Survey 2

Features of the Program	Satisfied		Neutral		Dissatisfied		N/A	
Getting information about the program	182	96%	6	3%	0	0%	2	1%
Having questions answered	175	92%	9	5%	3	2%	3	2%
Privacy associated with equipment	159	84%	23	12%	3	2%	5	3%
Having to purchase gas at participating stations	154	81%	9	5%	26	13%	1	1%
Out of pocket costs for fuel	152	80%	23	12%	8	5%	7	4%
Where the display was positioned in vehicle	145	76%	6	3%	39	20%	0	0%
Accuracy of mileage readings	142	75%	15	8%	5	3%	28	15%
The functioning of the equipment	143	75%	8	4%	37	20%	2	1%

APPENDIX TABLE 2.4: Satisfaction — Survey 3

Features of the Program	Satisfied		Neutral		Dissatisfied		N/A	
Getting information about the program	176	96%	3	2%	3	2%	1	1%
Having questions answered	171	94%	4	2%	5	3%	3	2%
The functioning of the equipment	126	69%	12	7%	45	25%	0	0%
Having to purchase gas at Leathers	131	71%	11	6%	41	22%	0	0%
Accuracy of mileage readings	128	70%	13	7%	14	7%	28	15%
Privacy associated with equipment	126	69%	23	13%	3	2%	31	17%
Out of pocket costs for fuel	131	71%	14	8%	13	7%	25	14%
Where the device was positioned in vehicle	132	72%	7	4%	44	24%	0	0%
Getting reimbursed for receipts	101	62%	8	5%	10	6%	44	25%

Based on the survey and interview results, ODOT reported the following analysis:

- With respect to the reasons for participating in the program, slightly over half the sample indicated that the monetary incentive was one of their reasons for participating. Thirty-eight per cent responded that they participated because the program seemed interesting or they were curious, and 18 per cent responded that they participated as they wanted to assist in finding an alternative to the gas tax.
- The three largest areas of dissatisfaction for the participants were the functioning of the on-vehicle device, the positioning of the display, and having to purchase gas at the participating stations. The amount of dissatisfaction with each of these issues increased slightly from levels recorded in the second survey.
- The percentage dissatisfied with purchasing gas at the participating stations rose from 13 per cent in the second survey to 22 per cent in the final survey. Participants cited numerous reasons for dissatisfaction. One reason related to difficulties with association of the fuel pump with a participant's particular vehicle to enable a gas tax credit against the fuel purchase price at the pump. When the system did not work, participants had to complete the extra step of sending in the receipts to ODOT for the gas tax refund. A second reason cited was the stations' inability to pump gas at various times.

A third reason cited by 14 people (seven per cent) was dissatisfaction with the accuracy of the mileage readings. Though this was an increase compared to the three per cent of dissatisfied respondents in the second survey this represents only half of those who thought there might be accuracy problems at the beginning of the pilot program.

- Behaviour changes in the rush hour group were expected, and some were observed. Twelve of the 84 households in the rush hour group reported that someone in the household began using alternative transportation modes to save money. Twenty-six also reported that someone in the household changed either the time or distance of travel to save money. Mostly this was by avoiding driving in the congestion zone during rush hour. This occurred in 23 households, although four households reported grouping errands or consolidating trips and one reported using a carpool.
- The price per mile for the VMT group was set to approximate the gas tax, so little change in behaviour was anticipated for this group. Surprisingly, however, 10 of the households in the VMT group reported that someone in the household started taking the train, took up biking, or began walking to save money through the program. This may be attributable to an increase in attentiveness owing to ready viewing of the display and simply participating in the pilot program itself.
- Ninety-one per cent of the participants agreed when they were asked, ‘If the program were changed so that participants could go to any local service station, would you have been willing to keep the equipment in your vehicle and stay with the same fee payment and refund of the gas tax?’ Taking into consideration that the pilot program did not perfectly mimic a real world implementation situation as the households did not actually have to pay the mileage fee this result indicates a strong willingness to accept the new system once people have become familiar with it.

APPENDIX 3: CHAPTER 7 METHODOLOGY TO CALCULATE THE LET FOR AUSTRALIAN MOTOR VEHICLE CATEGORIES

The following available information has been used in this exercise to calculate the LET for the following categories of Australian motor vehicles: Light cars; small cars; medium cars; large cars; SUVs; people movers and sports cars:

- Australian Bureau of Statistics, *Motor Vehicle Census, Australia, 31 January 2011* (Catalogue No 1304.3)
- Australian Bureau of Statistics, *Sales of New Motor Vehicles, Australia, January 2012* (Catalogue No 9314.0)
- Australian Bureau of Statistics, *Survey of Motor Vehicle Use, Australia, 12 Months Ended 31 October 2010* (Catalogue No 9208.0)
- Federal Chamber of Automotive Industries, *V Facts Car Sales Data for Year Ended 31 December 2011*
- The Australian government's *Green Vehicle Guide*, offering detailed criteria for small cars, medium cars, large cars, people movers, SUVs and sport cars.

The methodology below describes in detail the steps undertaken to calculate the LET for Australian motor vehicles, in order to be able to forecast government revenues.

STEP 1

The first step was to obtain the LET characteristics of the following categories of LET cars: Light car; small car; medium car; large car; people mover; SUV and sports car, and calculate the average LET for each LET characteristic. The following steps were undertaken for this exercise:

a) It was first necessary to extract the motor vehicle LET characteristics being: vehicle weight; engine capacity; engine power and CO_2 emissions of Australia's top 90 per cent of passenger motor vehicle makes on the motor vehicle register in 2011. The most popular motor vehicles makes comprising the registered passenger vehicles in Australia in 2011 were first extracted from the Australian Bureau of Statistics Motor Vehicle Census data and are listed in Appendix Table 3.1.

APPENDIX TABLE 3.1: Passenger Vehicles on Register in Australia in 2011

Make	Number	Percentage
Toyota	2 500 195	20.04
Holden	2 056 880	16.49
Ford	1 654 216	13.26
Mitsubishi	921 909	7.39
Mazda	751 968	6.03
Nissan	736 431	5.90
Hyundai	696 588	5.58
Honda	587 316	4.71
Subaru	472 251	3.79
BMW	249 035	2.00
Mercedes Benz	224 504	1.80
Volkswagen	218 971	1.76
Suzuki	208 677	1.67
Kia	190 806	1.53
Jeep	71 433	0.57
Land Rover	63 871	0.51
Chrysler	43 785	0.35
Others	825 208	6.62
TOTAL	**12 474 044**	**100.00**

Source: Australian Bureau of Statistics, *Motor Vehicle Census, Australia, 31 January 2011* (Catalogue No 9309.0, 28 July 2011).

b) For each of the above vehicle makes, it was then necessary to extract the list of available models for sale in 2011. This was obtained from the Commonwealth Government's *Green Vehicle Guide*.

c) The next step was to find out for each vehicle model the four criteria for calculating the LET, ie the vehicle kerb weight, engine capacity, engine power and CO_2 emissions. This data was found from the manufacturer's specifications for each make and model.

d) It was then necessary to categorise the list into the following vehicle classes: Light vehicles; small vehicles; medium vehicles; large vehicles; SUVs; people movers and sports vehicles, which was done by referring to the classification of vehicles in the Commonwealth Government's *Green Vehicle Guide*.

e) For each class of vehicle in 'd' above, it was then necessary to calculate the average vehicle weight, engine capacity, engine power and CO_2 emissions. A summary of the LET average for each vehicle class is summarised in Appendix Table 3.2. Further detail on each motor vehicle category is listed in Appendix Tables 3.3 to 3.9.

APPENDIX TABLE 3.2: Summary of LET Averages for Australian Vehicles

Motor Vehicle Category	Weight (kg)	Engine (cc)	Power (kW)	CO_2 Emissions
Light	813	1147	59	128
Small	1100	1469	79	146
Medium	1387	2010	127	186
Large	1659	3148	181	228
SUVs	1970	3252	174	258
People Movers	1977	2775	135	242
Sport	1605	3921	252	250

APPENDIX TABLE 3.3: LET Light Cars

Make	Marketing Model	Variant	Engine Displacement	Weight (kg)	Engine (cc)	Power (kW)	CO_2 Emissions
Fiat	500	0.9 Turbo Twin Air	0.9	930	875	63	92
Holden	Barina Spark	CDX	1.2	948	1200	59	127
Holden	Barina Spark	CD	1.2	962	1200	59	128
Nissan	Micra		1.2	675	1200	56	138
Nissan	Micra		1.2	675	1200	56	154
Nissan	Micra		1.5	675	1500	75	156
Smart	Fortwo	Cabrio 52kW MHD	2	750	1000	52	116
Suzuki	Alto	GL	1	885	1000	50	110
TOTAL				6500	9175	470	1021
LET Average				**813**	**1147**	**59**	**128**

APPENDIX TABLE 3.4: LET Small Cars

Make	Marketing Model	Variant	Engine Displacement	Weight (kg)	Engine (cc)	Power (kW)	CO_2 Emissions
Audi	A1	1.4 TFSI Ambition	1.4	1125	1390	90	124
Audi	A1	1.4 TFSI Attraction	1.4	1125	1390	90	124
Ford	Fiesta	Econetic	1.6	1088	1600	66	98
Ford	Fiesta	Low	1.6	1095	1600	89	146
Ford	Fiesta	Low	1.6	1129	1600	66	117
Holden	Barina	CD	1.6	1190	1600	76	162
Honda	Jazz	VTiS	1.5	1115	1500	88	151
Honda	Jazz	GLi	1.3	1110	1300	73	157
Hyundai	i20	Active	1.4	1110	1400	73.5	142
Hyundai	i20	Premium	1.6	1100	1600	91	144
Hyundai	Getz	1.4S 5-Door	1.4	1105	1400	70	165
Hyundai	Getz	1.6SX 5-Door	1.6	1107	1600	78	170
Hyundai	i20	Elite	1.6	1100	1600	91	155

Make	Marketing Model	Variant	Engine Displacement	Weight (kg)	Engine (cc)	Power (kW)	CO_2 Emissions
Kia	Rio	Si	1.4	1215	1400	70	162
Kia	Rio	Si	1.6	1203	1600	82	162
Mazda	2		1.5	1025	1500	76	162
Mazda	2		1.5	1052	1500	76	162
Nissan	Tiida		1.8	1110	1800	93	182
Suzuki	Jimny	VVT	1.3	1045	1300	60	174
Suzuki	Swift		1.4	1025	1400	70	132
Suzuki	Swift	Sport	1.6	1100	1600	92	179
Toyota	Yaris		1.3	1025	1299	63	134
Toyota	Yaris		1.5	1045	1497	80	137
Toyota	Yaris		1.5	1055	1497	80	147
Toyota	Yaris		1.3	1035	1299	63	147
Volkswagen	Polo	77TSI Comfortline	1.2	1088	1200	77	128
Volkswagen	Polo	Trendline	1.4	1068	1400	63	140
Volkswagen	Polo	GTI	1.4	1189	1400	132	142
Volkswagen	Polo	66TDI Comfortline	1.6	1140	1600	66	121
Volkswagen	Polo	66TDI Comfortline	1.2	1088	1200	77	128
TOTAL				33007	44072	2361.5	4394
LET Average				**1100**	**1469**	**79**	**146**

APPENDIX TABLE 3.5: LET Medium Cars

Make	Marketing Model	Variant	Engine Displacement	Weight (kg)	Engine (cc)	Power (kW)	CO_2 Emissions
BMW	1 Series	123d	2	1420	2000	150	138
BMW	1 Series	125i	3	1430	3000	160	190
BMW	1 Series	135i	3	1490	3000	225	198
BMW	1 Series	135i	3	1610	3000	225	200
BMW	1 Series	118d	2	1345	2000	105	144
BMW	1 Series	118i	2	1260	2000	115	182
BMW	1 Series	120i	2	1230	2000	100	182
Ford	Focus	LX	2	1343	2000	107	169

Make	Marketing Model	Variant	Engine Displacement	Weight (kg)	Engine (cc)	Power (kW)	CO_2 Emissions
Ford	Focus	TDCI	2	1458	2000	100	147
Ford	Focus	TDCI	2	1570	2000	120	157
Ford	Focus	XR5 Turbo	2.5	1581	2500	162	227
Ford	Focus	RS	2.5	1458	2500	224	246
Honda	Insight	VTi	1.3	1190	1300	76	109
Honda	Civic	VTiL	1.8	1240	1800	103	171
Honda	Civic	Hybrid	1.3	1265	1300	85	109
Honda	City	VTi, VTiL	1.5	1145	1500	88	156
Honda	Civic	Sport	2	1310	2000	114	200
Honda	Civic	Type R	2	1315	2000	148	219
Hyundai	i30	SX	1.6	1323	1600	89	166
Hyundai	i30cw	SLX	2	1390	2000	105	183
Hyundai	Elantra	Elite	2	1285	2000	105	175
Hyundai	ix35	2.0 Active	2	1485	2000	122	203
Hyundai	Elantra	Elite	2	1300	2000	105	186
Hyundai	i30	CRDi	1.6	1412	1600	85	159
Hyundai	ix35	2.0R-series Elite	2	1706	2000	135	198
Kia	Soul		1.6	1115	1600	91	167
Kia	Cerato Koup	2	2	1288	2000	115	186
Kia	Soul		1.6	1210	1600	94	137
Mazda	3		2	1305	2000	108	193
Mazda	3	Diesel	2.2	1456	2200	110	150
Mazda	3		2.5	1379	2500	122	204
Mazda	3	MPS	2.3	1456	2300	190	235
Mazda	RX-8		1.3	1318	1300	158	288
Mazda	RX-8		1.3	1299	1300	177	301
Mitsubishi	Lancer	ES	2	1335	2000	113	196
Mitsubishi	Lancer	Aspire	2.4	1339	2400	125	202
Nissan	Tiida		1.8	1128	1800	93	187
Subaru	Impreza	WRX STI	2.5	1505	2500	221	249
Subaru	Impreza	XV	2	1360	2000	110	208
Subaru	Impreza	XV	2	1360	2000	110	210

Make	Marketing Model	Variant	Engine Displacement	Weight (kg)	Engine (cc)	Power (kW)	CO_2 Emissions
Subaru	Impreza	WRX	2.5	1505	2500	221	249
Subaru	Impreza	AWD	2.5	1395	2500	195	252
Suzuki	Kizashi	XL	2.4	1450	2400	131	186
Suzuki	SX4		2	1235	2000	112	170
Toyota	Prius	Hybrid	1.8	1420	1798	100	89
Toyota	Corolla		1.8	1280	1798	100	171
Toyota	Corolla		1.8	1355	1798	100	173
Toyota	Corolla	Ultima	2	1360	1987	102	181
Toyota	Rukus		2.4	1390	2362	123	208
Volkswagen	Golf	118TSI Comfortl ine	1.4	1330	1400	118	150
Volkswagen	Golf	GTI	2	1380	2000	155	178
Volkswagen	Eos	155TSI	2	1571	2000	155	173
Volkswagen	Golf	GTD	2	1380	2000	125	145
Volkswagen	Golf	103TDI Comfortl ine	2	1380	2000	103	147
Volkswagen	Eos	103 TDI	2	1581	2000	103	160
Volkswagen	Golf	R	2	1496	2000	188	201
Volkswagen	Tiguan	132TSI	2	1611	2000	132	204
Volkswagen	Tiguan	155TSI	2	1515	2000	155	205
Volkswagen	Tiguan	103TDI	2	1610	2000	103	175
Volkswagen	Tiguan	125	2	1630	2000	125	205
Volkswagen	Tiguan	147	2	1660	2000	147	205
Volkswagen	New Beetle	Black Orange 75kW	1.6	1233	1600	75	185
Volkswagen	New Beetle	Black Orange TDI 77kW	1.9	1233	1900	77	149
Volkswagen	New Beetle Cabriolet	Black Orange 85kW	2	1352	2000	85	223
TOTAL				88 766	128 64 3	8120	11 911
LET Average				**1387**	**2010**	**127**	**186**

APPENDIX TABLE 3.6: LET Large Cars

Make	Marketing Model	Variant	Engine Displacement	Weight (kg)	Engine (cc)	Power (kW)	CO_2 Emissions
BMW	3 Series	320d	2	1430	2000	135	140
BMW	3 Series	320d	2	1430	2000	135	140
BMW	3 Series	320d Touring	2	1480	2000	135	142
BMW	3 Series	320d	2	1670	2000	135	149
BMW	3 Series	335i	3	1535	3000	225	202
BMW	3 Series	323i	2.5	1460	2500	140	203
BMW	3 Series	325i	2.5	1460	2500	160	212
BMW	3 Series	330d	3	1540	3000	180	164
BMW	3 Series	325i	2.5	1450	2500	160	222
BMW	3 Series	M3	3.9	1580	4000	309	290
BMW	3 Series	M3	3.9	1605	4000	309	295
BMW	3 Series	M3	3.9	1830	4000	309	297
BMW	5 Series	528i	3	1655	3000	190	187
BMW	5 Series	535i	3	1715	3000	225	197
BMW	5 Series	520d	2	1625	2000	135	137
BMW	5 Series	535d	3	1750	3000	220	162
BMW	5 Series	550i	4.4	1830	4400	300	243
BMW	5 Series Gran Turismo	530d GT	3	1960	3000	180	173
BMW	7 Series	730d	3	1865	3000	180	178
BMW	7 Series	740Li	3	1895	3000	240	235
BMW	7 Series	750Li	4.4	1980	4400	300	266
BMW	7 Series	760Li	6	2120	6000	400	303
BMW	X1	sDrive18i	2	1430	2000	110	191
BMW	X1	xDrive25i	3	1600	3000	160	217
BMW	X1	xDrive20d	2	1490	2000	130	164
BMW	X1	xDrive23d	2	1595	2000	115	167
Chrysler	300C		3.5	1782	3500	183	260
Chrysler	300C		3	1782	3000	160	216
Chrysler	300C		5.7	1873	5700	250	293
Chrysler	300C	SRT8	6.1	1888	6100	317	330
Ford	Mondeo	Titanium	2	1585	2000	130	165
Ford	Mondeo	LX	2.3	1527	2300	118	227
Ford	Falcon	XR6	4	1735	4000	195	243

Make	Marketing Model	Variant	Engine Displacement	Weight (kg)	Engine (cc)	Power (kW)	CO_2 Emissions
Ford	Falcon	G6E Turbo	4	1770	4000	270	278
Ford	Falcon	Ute	4	1580	4000	195	279
Ford	Falcon	GT	5	1844	5000	335	325
Ford	Falcon	F6	4	1778	4000	310	300
Ford	Ranger	Crew Cab XL	3	1610	3000	115	274
Ford		XR8	5.4	1825	5400	290	334
Holden	Cruze	CD	1.8	1402	1800	104	179
Holden	Sport Wagon	Omega	3	1622	3000	190	221
Holden	Commodore	SV6	3.6	1641	3000	190	210
Holden	Caprice		3.6	1873	3600	210	245
Holden	Cruze	CDX	2	1522	2000	110	210
Holden	Cruze	CD	2	1522	2000	110	210
Holden	Epica MY10.5	CDXi	2.5	1500	2500	115	219
Holden	Epica MY10.5	CDXi	2	1460	2000	110	199
Holden	Calais V Redline		6	1763	6000	270	343
Holden	Caprice V	AFM	6	1928	6000	270	210
Holden	HSV	GTS	6.2	1777	6200	325	329
Holden	HSV	Club Sport	6.2	1731	6200	217	357
Holden	Colorado	LX Crew Cab	3.6	1678	3600	157	313
Holden	Colorado	LX Space Cab	3.6	1602	3600	157	297
Holden	Colorado	LX Crew Cab	3	1932	3000	120	237
Holden	Utility	Omega	3	1636	3000	190	259
Holden	Utility	SS	6	1704	6000	270	307
Honda	Accord Euro		2.4	1555	2400	148	211
Honda	Accord	V6L	3.5	1650	3500	202	239
Honda	Accord	VTi	2.4	1515	2400	133	209
Honda	CR-V		2.4	1620	2400	125	237
Honda	Legend		3.7	1865	3700	226	269
Hyundai	i45	2.4 GDi	2.4	1529	2400	148	188

Make	Marketing Model	Variant	Engine Displacement	Weight (kg)	Engine (cc)	Power (kW)	CO_2 Emissions
		Active					
Hyundai	Grandeur	V6	3.8	1636	3800	194	255
Hyundai	Grandeur	2.2 CRDi	2.2	1725	2200	114	208
Kia	Cerato	2	2	1250	2000	115	187
Kia	Optima	2.4 auto	2.4	1475	2400	148	189
Kia	Sportage	2.0 A	2	1500	2000	122	210
Kia	Sportage	2.4 A	2.4	1588	2400	130	221
Kia	Sportage	2.0 DA	2	1705	2000	135	198
Land Rover	Defender	110 Wagon	2.4	2014	2400	90	291
Mazda	6	Diesel	2.2	1620	2200	132	154
Mazda	6		2.5	1470	2500	125	206
Mazda	CX-7	Classic	2.5	1589	2500	120	223
Mazda	BT-50	4x2	3.2	1735	3000	115	243
Mazda	BT-50	4x4	3.2	1876	3000	115	243
Mercedes-Benz	C Class	C300 Avantgarde	3	1555	3000	170	224
Mercedes-Benz	C Class	C250 Avantgarde	1.8	1585	1800	150	180
Mercedes-Benz	C Class	C350CDI Avantgarde	3	1700	3000	165	196
Mercedes-Benz	C Class	C63AMG	6.2	1795	6200	336	328
Mercedes-Benz	CL Class	CL500 BlueEfficiency	4.7	2040	4700	320	259
Mercedes-Benz	CL Class	CL600 B/T	5.5	2216	5500	380	259
Mercedes-Benz	E Class	E350 BlueEfficiency	3.5	1695	3500	200	222
Mercedes-Benz	E Class	E250 CDI	2.1	1695	2100	150	139
Mercedes-Benz	E Class	E220 CDI	2.1	1735	2100	125	157
Mercedes-Benz	E Class	E63 AMG	6.2	1840	6200	386	298
Mercedes-Benz	E Class	E500 BlueEfficiency	5.5	1695	5500	285	256

Make	Marketing Model	Variant	Engine Displacement	Weight (kg)	Engine (cc)	Power (kW)	CO_2 Emissions
Mercedes-Benz	S Class	S350 BlueEfficiency	3.5	1800	3500	200	234
Mercedes-Benz	S Class	S63 AMG	6.2	1880	6200	386	355
Mercedes-Benz	S Class	S500 BlueEfficiency	5.5	1880	5500	285	260
Mercedes-Benz	S Class	S600L	5.5	2180	5500	380	340
Mitsubishi	Lancer	Ralliart	2	1555	2000	177	243
Mitsubishi	Lancer	Evolution	2	1595	2000	217	245
Nissan	Dualis	2WD	2	1473	2000	102	195
Nissan	Dualis +2	2WD	2	1476	2000	102	199
Nissan	X-Trail		2	1426	2000	102	202
Nissan	Maxima		2.5	1516	2500	134	226
Nissan	Maxima		3.5	1535	3500	185	243
Nissan	Murano		3.5	1822	3500	191	261
Nissan	GT-R		3.8	1699	3800	357	298
Nissan	Navara	Dual Cab 2x4	4	1985	4000	198	339
Nissan	Navara	Dual Cab 4x4	3	1920	3000	170	246
Nissan	Navara	Dual Cab 4x4	2.5	1930	2500	128	264
Nissan	Navara	Dual Cab 4x4	2.5	1985	2500	140	283
Subaru	Liberty	2.5GT Premium	2.5	1432	2500	123	198
Subaru	Liberty	3.6R Premium	3.6	1536	3600	191	242
Toyota	Camry	Hybrid	2.4	1610	2362	140	142
Toyota	Aurion		3.5	1625	3456	200	233
Toyota	Camry	Atara	2.5	1505	2494	135	183
Toyota	RAV4	2WD	2.4	1545	2362	125	197
Toyota	RAV4	2WD	2.4	1585	2362	125	214
Toyota	Kluger	KXR	3.5	2630	3456	201	259
Volkswagen	Jetta	103 TDI	2	1540	2000	103	165
Volkswagen	Jetta	118TSI Comfortline	1.4	1405	1400	118	159

Make	Marketing Model	Variant	Engine Displacement	Weight (kg)	Engine (cc)	Power (kW)	CO_2 Emissions
Volkswagen	Golf	90TSI Trendline	1.4	1400	1400	90	156
Volkswagen	Jetta	147TSI Highline	2	1430	2000	147	185
Volkswagen	Passat	118TSI	1.8				168
Volkswagen	Passat	118TSI	1.8	1481	1800	118	180
Volkswagen	Golf	77TDI Trendline	1.6	1522	1600	77	127
Volkswagen	Jetta	125TDI Highline	2	1459	2000	125	159
Volkswagen	Passat	125TDI Highline	2	1526	2000	125	151
Volkswagen	Passat	125TDI Highline	2	1587	2000	125	175
Volkswagen	Passat	V6 220kW FSI Highline	3.2	1606	3200	184	240
Volkswagen	Passat CC	V6 FSI	3.6	1656	3600	220	254
TOTAL				204 057	387 192	22 320	28 064
LET Average				**1659**	**3148**	**181**	**228**

APPENDIX TABLE 3.7: LET SUVs

Make	Marketing Model	Variant	Engine Displacement	Weight (kg)	Engine (cc)	Power (kW)	CO_2 Emissions
BMW	X3	xDrive20i	3	1765	3000	200	248
BMW	X3	xDrive28i	3	1745	3000	190	210
BMW	X3	xDrive28i	2.5	1765	2500	160	243
BMW	X3	xDrive20d	2	1725	2000	135	147
BMW	X3	xDrive20d	2	1750	2000	125	185
BMW	X5	xDrive30d	3	2048	3000	225	233
BMW	X5	xDrive40d	3	2013	3000	180	231
BMW	X5	xDrive35i	3	2050	3000	225	279
BMW	X5	xDrive50i	4.4	2170	4400	300	292
BMW	X5	M	4.4	2305	4400	408	325
BMW	X6	xDrive35i	3	2070	3000	225	236
BMW	X6	xDrive40d	3	2110	3000	225	198

Make	Marketing Model	Variant	Engine Displacement	Weight (kg)	Engine (cc)	Power (kW)	CO_2 Emissions
BMW	X6	xDrive50i	4.4	2190	4400	300	292
BMW	X6	M	4.4	2305	4400	408	325
Ford	Territory	Ghia Turbo	4	2092	4000	245	337
Ford	Ranger	Regular Cab XL	2.5	1530	2500	105	219
Ford	Escape	XLT	2.3	1574	2300	109	250
Holden	Captiva	5	2.4	1833	2400	103	254
Holden	Captiva	7 CX	3.2	1764	3200	169	265
Holden	Captiva	7 SX	2	1764	2000	110	233
Hyundai	Santa Fe	SLX CRDi	2.2	1935	2200	145	176
Jeep	Patriot	Limited	2.4	1570	2400	125	230
Jeep	Patriot	Sport	2.4	1570	2400	125	206
Jeep	Wrangler	Sport	3.8	1855	3800	146	248
Jeep	Wrangler Unlimited	Sport	3.8	2050	3800	146	285
Jeep	Grand Cherokee	Overland	3	2142	3000	160	275
Jeep	Grand Cherokee	Limited	3.6	2191	3600	210	256
Jeep	Wrangler Unlimited	Sport	2.8	2105	2800	147	217
Jeep	Grand Cherokee	Overland	5.7	2307	5700	259	329
Jeep	Wrangler	Sport	2.8	1975	2800	130	227
Jeep	Grand Cherokee	Sport	6.1	2270	6100	313	380
Kia	Sorento	Si	2.2	1559	2200	145	194
Kia	Sorento	Si	2.3	1814	2300	128	219
Land Rover	Freelander 2	XS	3.2	1775	3200	171	255
Land Rover	Freelander 2	HSE	2.2	1770	2200	140	224
Land Rover	Freelander 2	SE	2.2	1805	2200	140	224
Land Rover	Discovery 4	V8	5	2548	5000	276	328
Land Rover	Range Rover Vogue	V8	5	2489	5000	276	326

Make	Marketing Model	Variant	Engine Displacement	Weight (kg)	Engine (cc)	Power (kW)	CO_2 Emissions
Land Rover	Range Rover Sport	TDV6	3	2535	3000	180	243
Land Rover	Discovery 4	SDV6 3.0 SE	3	2583	3000	180	244
Land Rover	Range Rover Vogue	TDV8	4.4	2710	4400	230	253
Land Rover	Range Rover Sport	Supercharged	5	2590	5000	375	327
Land Rover	Discovery 4	TDV6	2.7	2486	2700	140	275
Mazda	CX-7	Diesel	2.2	1928	2200	127	202
Mazda	CX-9		3.7	2041	3700	204	309
Mazda	CX-7	Sports	2.3	1761	2300	175	273
Mercedes-Benz	G Class	G55 AMG	5.4	2471	5400	373	372
Mercedes-Benz	G Class	G350 BlueTec	3	2458	3000	155	295
Mercedes-Benz	GL Class	GL500	5.5	2370	5500	285	322
Mercedes-Benz	GL Class	GL350CDI	3	2375	3000	165	254
Mercedes-Benz	M Class	ML350	3.5	2060	3500	200	279
Mercedes-Benz	M Class	ML500	5.5	2185	5500	285	306
Mercedes-Benz	M Class	ML300 CDI	3	2185	3000	140	254
Mercedes-Benz	M Class	ML350 CDI	3	2110	3000	165	254
Mercedes-Benz	M Class	ML63 AMG	6.2	2310	6200	375	392
Mitsubishi	Outlander	LS	2.4	1560	2400	125	227
Mitsubishi	Outlander	LS	2.4	1560	2400	125	222
Mitsubishi	Outlander	VR	3	1603	3000	169	247
Mitsubishi	Pajero	Exceed	3.2	2205	3200	147	243
Mitsubishi	Pajero	Exceed	3.8	2085	3800	184	322
Mitsubishi	Challenger	LS	2.5	2059	2500	113	259

Make	Marketing Model	Variant	Engine Displacement	Weight (kg)	Engine (cc)	Power (kW)	CO_2 Emissions
Nissan	Dualis	AWD	2	1525	2000	102	197
Nissan	X-Trail		2.5	1525	2500	125	223
Nissan	X-Trail		2	1675	2000	127	200
Nissan	X-Trail		2	1375	2000	110	216
Nissan	Pathfinder		2.5	2119	2500	140	224
Nissan	Pathfinder		4	2165	4000	198	327
Nissan	Pathfinder		3	2170	3000	170	246
Nissan	Patrol	DX	3	2360	3000	118	288
Nissan	Patrol	ST GU V11	4.8	2450	4800	180	408
Subaru	Outback	Diesel	2	1551	2000	110	160
Subaru	Forester	Diesel	2	1520	2000	108	168
Subaru	Liberty Exiga		2.5	1568	2500	123	202
Subaru	Outback	2.5i	2.5	1505	2500	123	198
Subaru	Forester	X	2.5	1480	2500	126	200
Subaru	Outback	3.6R	3.6	1569	3600	191	242
Subaru	Forester	XT	2.5	1545	2500	193	248
Subaru	Tribeca	3.6R	3.6	1942	3600	190	275
Suzuki	Grand Vitara		2.4	1567	2400	122	212
Suzuki	Grand Vitara		2.4	1567	2400	122	234
Suzuki	Grand Vitara		1.9	1630	1900	95	185
Suzuki	Grand Vitara		3.2	1677	3200	165	249
Toyota	RAV4 V6		3.5	1665	3456	201	246
Toyota	Kluger		3.5	2630	3456	201	259
Toyota	Kluger	Grande	3.5	2720	3456	201	259
Toyota	Hilux 4X2	Double Cab	2.7	1610	2694	116	262
Toyota	Hilux 4X2	Single Cab	2.7	1405	2694	116	266
Toyota	Hilux 4X2	Single Cab	2.7	1430	2694	116	271
Toyota	Hilux	Double	2.7	1625	2694	116	273

Make	Marketing Model	Variant	Engine Displacement	Weight (kg)	Engine (cc)	Power (kW)	CO_2 Emissions
	4X2	Cab					
Toyota	FJ Cruiser		4	2000	3956	200	267
Toyota	Prado		4	2345	3956	202	271
Toyota	Hilux 4X2	Single Cab	4	1555	3956	175	291
Toyota	Hilux 4X2	Single Cab	4	1535	3956	175	296
Toyota	Hilux 4X2	Single Cab	4	1550	3956	175	309
Toyota	Hilux 4X2	Single Cab	3	1495	2982	126	214
Toyota	Hilux 4X4	Single Cab	3	1675	2982	126	217
Toyota	Hilux 4X4	Double Cab	3	1945	2982	126	219
Toyota	Hilux 4X4	Extra Cab	3	1720	2982	126	219
Toyota	Prado		3	2330	2982	127	219
Toyota	Prado		4	2205	2982	127	306
Toyota	Hilux 4X4	Single Cab	4	1680	2982	126	308
Toyota	Hilux 4X4	Double Cab	4	1805	3956	175	311
Toyota	HiAce	Long	3	1830	2982	100	223
Toyota	Prado		3	2095	2982	127	225
Toyota	Prado		3	2205	2982	127	232
Toyota	Land Cruiser 200		4.7	2635	4664	202	341
Toyota	Land Cruiser 200		4.5	2640	4461	195	273
Toyota	Land Cruiser 200	Commercial	4.5	2720	4461	195	273
Toyota	Land Cruiser 70	Cab/Chassis	4.5	2055	4461	151	304
Toyota	Land Cruiser 70	4Dr Wagon	4.5	2230	4461	151	313
Volkswagen	Touareg	V6 TDI	3	2345	3000	176	283

Make	Marketing Model	Variant	Engine Displacement	Weight (kg)	Engine (cc)	Power (kW)	CO_2 Emissions
TOTAL				218 693	361 008	19 361	28 627
LET Average				**1970**	**3252**	**174**	**258**

APPENDIX TABLE 3.8: LET People Movers

Make	Marketing Model	Variant	Engine Displacement	Weight (kg)	Engine (cc)	Power (kW)	CO_2 Emissions
Chrysler	Grand Voyager	2.8L CRD	2.8	2100	2800	120	247
Chrysler	Grand Voyager	Limited	3.8	2025	3800	142	294
Ford	Territory	TS	4	2085	4000	182	299
Honda	Odyssey		2.4	1645	2400	132	212
Hyundai	iMax	Petrol 2.4	2.4	2128	2400	129	250
Hyundai	iMax	CRDi	2.5	2249	2500	125	259
Kia	Rondo 7	2.0 EX	2	1556	2000	106	201
Kia	Grand Carnival	SLi	3.5	1990	3500	202	259
Kia	Carnival	Si	2.7	2048	2700	139	268
Kia	Grand Carnival	SLi	2.9	2180	2900	136	224
Mercedes-Benz	R Class	R350 LWB	3.5	2116	3500	200	274
Mercedes-Benz	R Class	R350 CDI	3	2185	3000	165	253
Mercedes-Benz	R Class	R300 CDI	3	2185	3000	140	246
Mercedes-Benz	Viano	2.2CDI	3	2090	3000	110	231
Mercedes-Benz	Vito	113CDI Crew Cab	2.1	1750	2100	100	195
Mercedes-Benz	Vito	113CDI	2.1	1710	2100	100	216
Mercedes-Benz	Vito	122CDI Crew Cab	3	1920	3000	165	226
Toyota	HiAce	Commuter	2.7	2065	2694	111	294
Toyota	HiAce	Commuter	2.7	2070	2694	111	300
Toyota	Tarago		2.4	1725	2362	125	222
Toyota	Tarago	GLX v6	3.5	1930	3456	202	241

Make	Marketing Model	Variant	Engine Displaceme nt	Weight (kg)	Engine (cc)	Power (kW)	CO_2 Emissions
Toyota	Tarago	Ultima V6	3.5	1930	3456	202	243
Toyota	HiAce	Commuter	3	2160	2982	100	228
Toyota	HiAce	Commuter	3	2170	2982	100	243
Volkswagen	Caddy Life	MAXI TDI250	1.6	1403	1600	75	155
Volkswagen	Caravelle	TDI340	2	1968	2000	103	216
Volkswagen	Multivan	Comfortline TDI400	2	2000	2000	132	232
TOTAL				53 383	74 926	3654	6528
LET Average				**1977**	**2775**	**135**	**242**

APPENDIX TABLE 3.9: LET Sports Cars

Make	Marketing Model	Variant	Engine Displacement	Weight (kg)	Engine (cc)	Power (kW)	CO_2 Emissions
BMW	Z4	sDrive23i	2.5	1430	2500	150	192
BMW	Z4	sDrive30i	3	1430	3000	190	195
BMW	Z4	sDrive35i	3	1525	3000	225	210
BMW	Z4	sDrive35is	3	1545	3000	250	210
Mazda	MX-5		2	1123	2000	118	192
Mercedes-Benz	SLK Class	200 Kompressor	2	1455	1796	135	196
Mercedes-Benz	SLS	AMG	6.2	1736	6200	420	311
Mercedes-Benz	SL Class	SL350	3.5	1825	3500	200	236
Mercedes-Benz	SL Class	SL63 AMG	6.2	1929	6200	386	330
Mercedes-Benz	SL Class	SL500	5.5	1810	5500	285	291
Mercedes-Benz	SL Class	SL600	5.5	2045	5500	380	340
Mercedes-Benz	SLK Class	SLK200 BlueEfficien cy	1.8	1455	1800	135	196
Mercedes-Benz	SLK Class	SLK350 BlueEfficien cy	3.5	1495	3500	224	227

Make	Marketing Model	Variant	Engine Displacement	Weight (kg)	Engine (cc)	Power (kW)	CO_2 Emissions
Mercedes-Benz	SLK Class	SLK55 AMG	5.4	1530	5400	265	288
Mercedes-Benz	SLK Class	SLK200 BlueEfficiency	1.8	1455	1800	135	190
Mercedes-Benz	SLS Class	SLS AMG	6.2	1736	6200	420	311
Mercedes-Benz	SL Class	SL63 AMG	6.2	1929	6200	386	330
Nissan	370Z		3.7	1485	3700	245	247
Nissan	370Z	Roadster	3.7	1565	3700	245	257
TOTAL				30 503	74 496	4794	4749
LET Average				**1605**	**3921**	**252**	**250**

STEP 2

The second step required the calculation of the LET points based on the recommendations in Chapter 6. Appendix Table 3.10 shows the LET points calculated for each LET motor vehicle category.

APPENDIX TABLE 3.10: LET Points

Motor Vehicle Category	Weight (kg)	Engine (cc)	Power (kW)	CO_2 Emissions	Total LET Points
Light	3	4	2	6	15
Small	6	5	4	9	24
Medium	10	8	9	14	41
Large	14	15	15	19	63
SUVs	18	15	14	23	70
People Movers	18	13	10	21	62
Sport	13	19	21	22	75

STEP 3

The third step required the calculation of the LET payable by using the rates demonstrated in Table 6.6 in Chapter 6. Appendix Table 3.11 shows the LET payable for a single vehicle in each LET motor vehicle category.

APPENDIX TABLE 3.11: LET Payable

Motor Vehicle Category	Total LET Points	Initial Purchase	Road Registration	Fuel Consumption	Disposal Fee
Light	15	7500	1875	3.75	150
Small	24	12 000	3000	6	240
Medium	41	20 500	5125	10.25	410
Large	63	31 500	7875	15.75	630
SUVs	70	35 000	8750	17.50	700
People Movers	62	31 000	7750	15.5	620
Sport	75	37 500	9375	18.75	750

STEP 4

The fourth step required the application of the recommended discount over a 10 year period to the calculation of LET that would be attracted by a single motor vehicle under each motor vehicle category described in Appendix Table 3.11. The LET attracted by a single motor vehicle under each of the motor vehicle categories is calculated in Appendix Tables 3.12 to 3.18.

APPENDIX TABLE 3.12: LET Attracted by Light Motor Vehicle

Year	Discounted Tax Rate AUD	Light Motor Vehicle			
		Initial Purchase LET AUD	Road Registration LET AUD	Fuel Per litre LET AUD	Disposal Fee LET AUD
1	2%	150	38	0.08	3
2	4%	300	75	0.15	6
3	6%	450	113	0.23	9
4	8%	600	150	0.30	12
5	10%	750	188	0.38	15
6	15%	1125	281	0.56	23
7	25%	1875	469	0.94	38
8	50%	3750	938	1.88	75
9	75%	5625	1406	2.81	113
10	100%	7500	1875	3.75	150

APPENDIX TABLE 3.13: LET Attracted by Small Motor Vehicle

Year	Discounted Tax Rate AUD	Small Motor Vehicle			
		Initial Purchase LET AUD	Road Registration LET AUD	Fuel Per litre LET AUD	Disposal Fee LET AUD
1	2%	240	60	0.12	5
2	4%	480	120	0.24	10
3	6%	720	180	0.36	14
4	8%	960	240	0.48	19
5	10%	1200	300	0.60	24
6	15%	1800	450	0.90	36
7	25%	3000	750	1.50	60
8	50%	6000	1500	3.00	120
9	75%	9000	2250	4.50	180
10	100%	12 000	3000	6.00	240

APPENDIX TABLE 3.14: LET Attracted by Medium Motor Vehicle

Year	Discounted Tax Rate AUD	Medium Motor Vehicle			
		Initial Purchase LET AUD	Road Registration LET AUD	Fuel Per litre LET AUD	Disposal Fee LET AUD
1	2%	410	103	0.21	8
2	4%	820	205	0.41	16
3	6%	1230	308	0.62	25
4	8%	1640	410	0.82	33
5	10%	2050	513	1.03	41
6	15%	3075	769	1.54	62
7	25%	5125	1281	2.56	103
8	50%	10 250	2563	5.13	205
9	75%	15 375	3844	7.69	308
10	1	20 500	5125	10.25	410

APPENDIX TABLE 3.15: LET Attracted by Large Motor Vehicle

Year	Discounted Tax Rate AUD	Large Motor Vehicle			
		Initial Purchase LET AUD	Road Registration LET AUD	Fuel Per litre LET AUD	Disposal Fee LET AUD
1	2%	630	158	0.32	13
2	4%	1260	315	0.63	25
3	6%	1890	473	0.95	38
4	8%	2520	630	1.26	50
5	10%	3150	788	1.58	63
6	15%	4725	1181	2.36	95
7	25%	7875	1969	3.94	158
8	50%	15 750	3938	7.88	315
9	75%	23 625	5906	11.81	473
10	100%	31 500	7875	15.75	630

APPENDIX TABLE 3.16: LET Attracted by SUVs

Year	Discounted Tax Rate AUD	SUVs			
		Initial Purchase LET AUD	Road Registration LET AUD	Fuel Per litre LET AUD	Disposal Fee LET AUD
1	2%	700	175	0.35	14
2	4%	1400	350	0.70	28
3	6%	2100	525	1.05	42
4	8%	2800	700	1.40	56
5	10%	3500	875	1.75	70
6	15%	5250	1313	2.63	105
7	25%	8750	2188	4.38	175
8	50%	17 500	4375	8.75	350
9	75%	26 250	6563	13.13	525
10	100%	35 000	8750	17.50	700

APPENDIX TABLE 3.17: LET Attracted by People Movers

Year	Discounted Tax Rate AUD	People Movers			
		Initial Purchase LET AUD	Road Registration LET AUD	Fuel Per litre LET AUD	Disposal Fee LET AUD
1	2%	620	155	0.31	12
2	4%	1240	310	0.62	25
3	6%	1860	465	0.93	37
4	8%	2480	620	1.24	50
5	10%	3100	775	1.55	62
6	15%	4650	1163	2.33	93
7	25%	7750	1938	3.88	155
8	50%	15 500	3875	7.75	310
9	75%	23 250	5813	11.63	465
10	100%	31 000	7750	15.50	620

APPENDIX TABLE 3.18: LET Attracted by Sports Motor Vehicles

Year	Discounted Tax Rate AUD	Sports Motor Vehicle			
		Initial Purchase LET AUD	Road Registration LET AUD	Fuel Per litre LET AUD	Disposal Fee LET AUD
1	2%	750	188	0.38	15
2	4%	1500	375	0.75	30
3	6%	2250	563	1.13	45
4	8%	3000	750	1.50	60
5	10%	3750	938	1.88	75
6	15%	5625	1406	2.81	113
7	25%	9375	2344	4.69	188
8	50%	18 750	4688	9.38	375
9	75%	28 125	7031	14.06	563
10	100%	37 500	9375	18.75	750

APPENDIX 4: CHAPTER 7 METHODOLOGY TO FORECAST REVENUES FROM PURCHASE LET ON PASSENGER MOTOR VEHICLES

The following available information has been used in this exercise to forecast the purchase LET revenues for the following categories of Australian motor vehicles: Light cars; small cars; medium cars; large cars; SUVs; people movers and sports cars for 10 years from 2016 to 2025:

- Australian Bureau of Statistics, *Population Projections, Australia*,(Catalogue No 3222.0, 4 September 2008)
- Australian Bureau of Statistics, *Motor Vehicle Census, Australia, 31 January 2011* (Catalogue No 9309.0, 28 July 2011)
- Australian Bureau of Statistics, *Sales of New Motor Vehicles, Australia, January 2012* (Catalogue No 9314.0, 15 February 2012)
- Australian Bureau of Statistics, *Survey of Motor Vehicle Use, Australia, 12 Months Ended 31 October 2010* (Catalogue No 9208.0, 23 August 2011)
- Federal Chamber of Automotive Industries, *V Facts Car Sales Data for Year Ended 31 December 2011*

The methodology below describes in detail the steps undertaken to calculate the purchase LET for Australian motor vehicles for 10 years after the introduction of the LET.

STEP 1

The first step was to obtain the number of new vehicles purchased by Australians in any one year. The information on the number of new motor vehicles sold in Australia was obtained from the ABS publication 9314. The data from that publication for the year ended 31 December 2011 is displayed in Appendix Table 4.1.

APPENDIX TABLE 4.1: Australian Motor Vehicle Sales for Year Ended 31 December 2011

Month	Number of Passenger Vehicles	Number of SUVs	Total
January 2011	43 539	17 032	60 571
February 2011	45 455	18 916	64 371
March 2011	50 228	23 066	73 294
April 2011	41 565	17 054	58 619
May 2011	42 577	17 121	59 698
June 2011	54 322	21 518	75 840
July 2011	45 701	19 383	65 084
August 2011	48 423	22 111	70 534
September 2011	47 700	20 778	68 478
October 2011	47 536	20 400	67 936
November 2011	46 712	24 182	70 894
December 2011	45 764	22 367	68 131
Total	**559 522**	**243 928**	**803 450**

Source: Australian Bureau of Statistics, *Sales of New Motor Vehicles, Australia, January 2012* (Catalogue No 9314.0, 15 February 2012).

STEP 2

The next step was to obtain a breakdown of the new motor vehicle sales into the following categories: Light cars; small cars; medium cars; large cars; SUVs; people movers and sports cars. The ABS data does not provide a breakdown of the categories of passenger vehicles. However the Federal Chamber of Automotive Industries releases V Facts car sales data for each month with a breakdown into the motor vehicle categories. Upon request, the Federal Chamber of Automotive Industries provided the data shown in Appendix Table 4.2.

APPENDIX TABLE 4.2: Car Sales Data for Year Ended 31 December 2011

Category of Motor Vehicle	**New Car Sales Data**
Light	132 442
Small	244 090
Medium	75 984
Large and Upper Large	81 119
People Movers	11 109
Sports	14 570
SUVs	244 136
Total	**803 450**

Source: Federal Chamber of Automotive Industries, *V Facts Car Sales Data for Year Ended 31 December 2011*.

STEP 3

The third step required a forecast of the new motor vehicle sales data for years 2011 to 2025. Since there are no readily available projections of new motor sales data, for the purpose of this thesis, the Australian population growth forecast for 15 years to 2025 was used, which had a growth rate of 1.70 per cent per annum from 2011 to 2016 and 1.64 per cent from 2017 to 2025.[621] The introduction of LET was aimed at bringing about an expected reduction in new motor vehicle sales from 5 per cent to 15 per cent, increasing by one per cent each year from 2015 to 2025. The 5 per cent change takes into consideration that people may refrain from purchasing a motor vehicle in anticipation of the LET being introduced in 2016. Thereafter only a one per cent per annum reduction in the vehicle fleet is forecast. These are just assumptions for the purposes of this thesis.

[621] Cp7-7, p39.

APPENDIX TABLE 4.3: New Motor Vehicle Sales Forecast from 2011 to 2025

Year	% Change in Population	Projected New Motor Vehicle Sales Without LET	% Reduction Due to LET	Projected Motor Vehicle Sales Due to LET
2011	1.70%	803 450		803 450
2012	1.70%	817 109		817 109
2013	1.70%	831 000		831 000
2014	1.70%	845 127		845 127
2015	1.70%	859 494	5%	816 519
2016	1.70%	874 105	6%	821 659
2017	1.64%	888 965	7%	826 737
2018	1.64%	903 544	8%	831 261
2019	1.64%	918 362	9%	835 710
2020	1.64%	933 423	10%	840 081
2021	1.64%	948 731	11%	844 371
2022	1.64%	964 290	12%	848 575
2023	1.64%	980 104	13%	852 691
2024	1.64%	996 178	14%	856 713
2025	1.64%	1 012 515	15%	860 638

STEP 4

The fourth step required the new motor vehicle sales projected in Appendix Table 4.3 to be split into the various categories of motor vehicles. For the purpose of this thesis, the split has been carried out using the same proportions as the new car sales for 2011 as shown in Appendix Table 4.2 above. The result is shown in Appendix Table 4.4.

APPENDIX TABLE 4.4: Projected New Motor Vehicle Sales into Categories

	Light Cars	**Small Cars**	**Medium Cars**	**Large Cars**	**SUVs**	**People Movers**	**Sports**	**Total**
2011	132 442	244 090	75 984	81 119	244 136	11 109	14 570	803 450
2012	134 694	248 240	77 276	82 498	248 286	11 298	14 818	817 109
2013	136 983	252 460	78 589	83 901	252 507	11 490	15 070	831 000
2014	139 312	256 752	79 925	85 327	256 800	11 685	15 326	845 127
2015	134 596	248 061	77 220	82 439	248 107	11 290	14 807	816 519
2016	135 444	249 622	77 706	82 957	249 669	11 361	14 900	821 659
2017	136 281	251 165	78 186	83 470	251 212	11 431	14 992	826 737
2018	137 026	252 539	78 614	83 927	252 586	11 494	15 074	831 261
2019	137 760	253 891	79 035	84 376	253 938	11 555	15 155	835 710
2020	138 480	255 219	79 448	84 817	255 267	11 615	15 234	840 081
2021	139 187	256 522	79 854	85 250	256 570	11 675	15 312	844 371
2022	139 881	257 799	80 252	85 675	257 848	11 733	15 388	848 575
2023	140 559	259 049	80 641	86 091	259 098	11 790	15 463	852 691
2024	141 222	260 271	81 021	86 497	260 320	11 845	15 536	856 713
2025	141 869	261 464	81 392	86 893	261 513	11 900	15 607	860 638

STEP 5

The fifth step is to forecast a change in purchasing behaviour, from choosing motor vehicles that attract a high LET to those that attract lower LET. For the purpose of this thesis, it is assumed that the new car sales data shown in Appendix Table 4.4 are adjusted with a reduction each year from two per cent to 95 per cent between years 2016 to 2025 for large cars, SUVs, people movers and sports cars, with these decreases in sales being reflected by an increase in sales for light, small and medium cars. These assumptions are made in line with the tax discount rate increases and the expectation that five per cent of the population may never change its behaviour despite the high LET rates. It is assumed that the LET will influence people to purchase light, small and medium vehicles instead of the large cars, SUVs, people movers and sports cars that attract more LET. However, these are only assumptions for this thesis and an economic study would need to be conducted to determine the real perceived change in people’s habits, which is beyond the scope of this thesis. The adjusted new motor vehicle sales data is shown in Appendix Table 4.5.

APPENDIX TABLE 4.5: Projected New Motor Vehicle Sales after Introduction of LET

	Light Cars	Small Cars	Medium Cars	Large Cars	SUVs	People Movers	Sports	Total
2011	132 442	244 090	75 984	81 119	244 136	11 109	14 570	803 450
2012	134 694	248 240	77 276	82 498	248 286	11 298	14 818	817 109
2013	136 983	252 460	78 589	83 901	252 507	11 490	15 070	831 000
2014	139 312	256 752	79 925	85 327	256 800	11 685	15 326	845 127
2015	134 596	248 061	77 220	82 439	248 107	11 290	14 807	816 519
2016	137 544	253 494	78 911	81 298	244 676	11 134	14 602	821 659
2017	140 508	258 956	80 612	80 131	241 164	10 974	14 393	826 737
2018	143 402	264 290	82 272	78 891	237 431	10 804	14 170	831 261
2019	146 307	269 642	83 938	77 626	233 623	10 631	13 943	835 710
2020	149 220	275 011	85 610	76 336	229 740	10 454	13 711	840 081
2021	155 379	286 362	89 143	72 463	218 085	9924	13 015	844 371
2022	167 000	307 781	95 811	64 256	193 386	8800	11 541	848 575
2023	195 062	359 498	111 910	43 045	129 549	5895	7731	852 691
2024	223 362	411 655	128 146	21 624	65 080	2961	3884	856 713
2025	246 390	454 095	141 358	4345	13 076	595	780	860 638

STEP 6

The sixth step is to forecast the total revenues from the purchase LET for the ten years from 2016 to 2025. The purchase LET revenues are calculated by multiplying the new car sales data from Appendix Table 4.5 with the LET payable for a single car. Appendix Table 3.11 in Appendix 3 showed the purchase LET payable for a single car as follows: Light cars – 7500; small cars – 12 000; medium cars – 20 500; large cars – 31 500; SUVs – 35 000; people movers – 31 000 and sports vehicle – 37 500. Appendix Tables 3.12 to 3.18 in Appendix 3 showed the purchase LET attracted by a single vehicle under the various motor vehicle categories for 10 years from the date of introduction of the LET. Appendix Table 4.6 shows a forecast for the total purchase LET revenues in AUD billion for 10 years from 2016 to 2025 for each category of motor vehicle.

APPENDIX TABLE 4.6: Purchase LET Revenues from Car Sales Data after Implementation of LET in AUD Billion

	Light Cars	Small Cars	Medium Cars	Large Cars	SUVs	People Movers	Sports	Total
	AUD billion	AUD billion	AUD billion	AUD billion	AUD billion	AUD billion	AUD billion	AUD billion
2016	0.02	0.06	0.03	0.05	0.17	0.01	0.01	0.35
2017	0.04	0.12	0.07	0.10	0.34	0.01	0.02	0.71
2018	0.06	0.19	0.10	0.15	0.50	0.02	0.03	1.06
2019	0.09	0.26	0.14	0.20	0.65	0.03	0.04	1.40
2020	0.11	0.33	0.18	0.24	0.80	0.03	0.05	1.75
2021	0.17	0.52	0.27	0.34	1.14	0.05	0.07	2.57
2022	0.31	0.92	0.49	0.51	1.69	0.07	0.11	4.10
2023	0.73	2.16	1.15	0.68	2.27	0.09	0.14	7.22
2024	1.26	3.70	1.97	0.51	1.71	0.07	0.11	9.33
2025	1.85	5.45	2.90	0.14	0.46	0.02	0.03	10.84
Total	4.65	13.71	7.29	2.91	9.74	0.39	0.62	39.32

APPENDIX 5: CHAPTER 7 METHODOLOGY TO FORECAST REVENUES FROM ANNUAL REGISTRATION LET ON PASSENGER MOTOR VEHICLES

The following available information has been used in this exercise to forecast the annual registration LET revenues for the following categories of Australian motor vehicles: Light cars; small cars; medium cars; large cars; SUVs; people movers and sports cars for 10 years from 2016 to 2025:

- Australian Bureau of Statistics, *Population Projections, Australia* (Catalogue No 3222.0, 4 September 2008)
- Australian Bureau of Statistics, *Motor Vehicle Census, Australia, 31 January 2011* (Catalogue No 9309.0, 28 July 2011)
- Australian Bureau of Statistics, *Sales of New Motor Vehicles, Australia, January 2012* (Catalogue No 9314.0, 15 February 2012)
- Australian Bureau of Statistics, *Survey of Motor Vehicle Use, Australia, 12 Months Ended 31 October 2010* (Catalogue No 9208.0, 23 August 2011)
- Federal Chamber of Automotive Industries, *V Facts Car Sales Data for Year Ended 31 December 2011.*

The methodology below describes in detail the steps undertaken to calculate the annual LET for Australian motor vehicles for 10 years after the introduction of the LET.

STEP 1

The first step was to forecast the total motor vehicle population for each year from 2011 to 2025. The total passenger motor vehicle population in 2011 is stated in Appendix Table 3.1 of Appendix 3, numbering 12 474 044. The motor vehicle population growth was forecast using the same percentage increases as the projected

Australian population growth for the 15 years to 2025.[622] The results were compared with the projections from BITRE in June 2003 which had predicted an increase of 1.75 per cent per annum growth in vehicle population from 14.7 million cars in year 2006/07 to 18.1 million cars in year 2019/20.[623] BITRE predicted that passenger cars would number just under 14 billion in 2020. The population growth rate was considered a better forecasting tool than the BITRE 2003 forecast.

The introduction of the LET is aimed at bringing about an expected reduction in the motor vehicle fleet from 5 per cent to 15 per cent increasing by one per cent each year from 2015 to 2025. These are just assumptions for the purpose of this thesis. The 5 per cent change takes into consideration that people who own two motor vehicles may get rid of one vehicle in anticipation of the LET. Thereafter only a one per cent per annum reduction in the vehicle fleet is forecast.

The Australian population and the projected motor vehicle stock data for the years 2011 to 2025 are shown in Appendix Table 5.1.

APPENDIX TABLE 5.1: Motor Vehicle Fleet Projections for Years 2011 to 2025

Year	% Change in Population	Australian Population in Millions	Projected Motor Vehicle Stock without LET	% Reduction Due to LET	Projected Motor Vehicle Stock with LET
2011	1.70%	22 447	12 474 044		12 474 044
2012	1.70%	22 829	12 686 103		12 686 103
2013	1.70%	23 217	12 901 767		12 901 767
2014	1.70%	23 612	13 121 097		13 121 097
2015	1.70%	24 013	13 344 156	5%	12 676 948
2016	1.70%	24 422	13 571 007	6%	12 756 746
2017	1.64%	24 823	13 801 714	7%	12 835 594
2018	1.64%	25 230	14 028 062	8%	12 905 817

[622] Australian Bureau of Statistics, *Population Projections, Australia* (Catalogue No 3222.0, 4 September 2008) 39.

[623] Department of Sustainability, Environment, Water, Population and Communities, 'Indicator: A-35 Projections of Motor Vehicle Travel and Pollutant Emissions' (22 November 2010) *State of the Environment 2006*<http://www.environment.gov.au/soe/2006/publications/drs/indicator/376/index.html>.

Year	% Change in Population	Australian Population in Millions	Projected Motor Vehicle Stock without LET	% Reduction Due to LET	Projected Motor Vehicle Stock with LET
2019	1.64%	25 644	14 258 122	9%	12 974 891
2020	1.64%	26 065	14 491 955	10%	13 042 760
2021	1.64%	26 492	14 729 623	11%	13 109 365
2022	1.64%	26 926	14 971 189	12%	13 174 646
2023	1.64%	27 368	15 216 716	13%	13 238 543
2024	1.64%	27 817	15 466 270	14%	13 300 992
2025	1.64%	28 273	15 719 917	15%	13 361 929

STEP 2

The second step required a breakdown of the total motor vehicle population into the motor vehicle categories of light cars, small cars, medium cars, large cars, SUVs, people movers and sports cars. For the purpose of this thesis, a breakdown of the passenger motor vehicle population is based on the available breakdown of the car sales data for year ended 31 December 2011 as shown in Appendix Table 4.2 above. The breakdown of the total passenger car population into its various categories from years 2011 to 2025 is shown in Appendix Table 5.2.

APPENDIX TABLE 5.2: Motor Vehicle Projections with LET in Categories

	Light Cars	Small Cars	Medium Cars	Large Cars	SUVs	People Movers	Sports	Total
2011	2 056 242	3 789 644	1 179 697	1 259 421	3 790 358	172 474	226 208	12 474 044
2012	2 091 198	3 854 068	1 199 752	1 280 831	3 854 794	175 406	230 054	12 686 103
2013	2 126 748	3 919 587	1 220 148	1 302 606	3 920 326	178 388	233 964	12 901 767
2014	2 162 903	3 986 220	1 240 890	1 324 750	3 986 971	181 420	237 942	13 121 097
2015	2 089 689	3 851 287	1 198 886	1 279 907	3 852 012	175 279	229 888	12 676 948
2016	2 102 843	3 875 530	1 206 433	1 287 964	3 876 260	176 383	231 335	12 756 746
2017	2 115 840	3 899 484	1 213 890	1 295 925	3 900 219	177 473	232 764	12 835 594
2018	2 127 416	3 920 818	1 220 531	1 303 014	3 921 557	178 444	234 038	12 905 817
2019	2 138 802	3 941 802	1 227 063	1 309 988	3 942 545	179 399	235 291	12 974 891
2020	2 149 990	3 962 421	1 233 482	1 316 841	3 963 168	180 337	236 521	13 042 760
2021	2 160 969	3 982 656	1 239 781	1 323 565	3 983 406	181 258	237 729	13 109 365

	Light Cars	Small Cars	Medium Cars	Large Cars	SUVs	People Movers	Sports	Total
2022	2 171 730	4 002 488	1 245 955	1 330 156	4 003 243	182 161	238 913	13 174 646
2023	2 182 263	4 021 901	1 251 998	1 336 608	4 022 659	183 044	240 072	13 238 543
2024	2 192 557	4 040 873	1 257 904	1 342 913	4 041 634	183 908	241 204	13 300 992
2025	2 202 602	4 059 386	1 263 666	1 349 065	4 060 151	184 750	242 309	13 361 929

STEP 3

The third step is to forecast a change in motor vehicle population due to the shifting of categories from high LET categories to lower LET categories. For the purpose of this thesis, it is assumed that the car population data shown in Appendix Table 5.2 decreases each year from two per cent to 95 per cent between years 2016 to 2025 for large cars, SUVs, people movers and sports cars, with this decrease in sales being reflected by an increase in sales for light, small and medium cars. These assumptions are made in line with the tax rate increases and the prediction that five per cent of the population may never change their behaviour despite the high LET rates. It is assumed that the LET will influence people to purchase light, small and medium vehicles instead of large cars, SUVs people movers and sports cars that attract a higher LET. However, these are only assumptions for this thesis and an economic study would need to be conducted to make a real prediction for the change in people's habits, which is beyond the scope of this PhD. The adjusted motor vehicle population data is shown in Appendix Table 5.3 below.

APPENDIX TABLE 5.3: Motor Vehicle Projections with LET in Categories

	Light Cars	Small Cars	Medium Cars	Large Cars	SUVs	People Movers	Sports	Total
2011	2,056,242	3,789,644	1,179,697	1,259,421	3,790,358	172,474	226,208	12,474,044
2012	2,091,198	3,854,068	1,199,752	1,280,831	3,854,794	175,406	230,054	12,686,103
2013	2,126,748	3,919,587	1,220,148	1,302,606	3,920,326	178,388	233,964	12,901,767
2014	2,162,903	3,986,220	1,240,890	1,324,750	3,986,971	181,420	237,942	13,121,097
2015	2,089,689	3,851,287	1,198,886	1,279,907	3,852,012	175,279	229,888	12,676,948
2016	2,135,459	3,935,640	1,225,145	1,262,205	3,798,735	172,855	226,708	12,756,746
2017	2,181,475	4,020,448	1,251,546	1,244,088	3,744,210	170,374	223,454	12,835,594
2018	2,226,407	4,103,257	1,277,324	1,224,834	3,686,263	167,737	219,996	12,905,817

	Light Cars	Small Cars	Medium Cars	Large Cars	SUVs	People Movers	Sports	Total
2019	2,271,496	4,186,357	1,303,192	1,205,189	3,627,142	165,047	216,467	12,974,891
2020	2,316,725	4,269,714	1,329,141	1,185,157	3,566,851	162,304	212,869	13,042,760
2021	2,412,349	4,445,949	1,384,002	1,125,031	3,385,895	154,070	202,070	13,109,365
2022	2,592,784	4,778,488	1,487,520	997,617	3,002,432	136,621	179,185	13,174,646
2023	3,028,454	5,581,427	1,737,471	668,304	2,011,329	91,522	120,036	13,238,543
2024	3,467,832	6,391,198	1,989,548	335,728	1,010,409	45,977	60,301	13,300,992
2025	3,825,350	7,050,103	2,194,662	67,453	203,008	9,238	12,115	13,361,929

STEP 4

Based on the forecast passenger motor vehicle population in Appendix Table 5.3 and the registration LET payable for a single vehicle shown in Appendix Tables 3.12 to 3.18 in Appendix 3, it is now possible to forecast the total revenues from the annual registration LET. Appendix Table 5.4 below shows the predicted total annual registration LET revenues in AUD billion from 2016 to 2025 for each category of motor vehicle

APPENDIX TABLE 5.4: Revenue Forecast for Annual Registration LET for Passenger motor vehicles in AUD Billion

	Light Cars	Small Cars	Medium Cars	Large Cars	SUVs	People Movers	Sports	Total
	AUD billion	AUD billion	AUD billion	AUD billion	AUD billion	AUD billion	AUD billion	AUD billion
2016	0.08	0.24	0.13	0.20	0.66	0.03	0.04	1.37
2017	0.16	0.48	0.26	0.39	1.31	0.05	0.08	2.74
2018	0.25	0.74	0.39	0.58	1.94	0.08	0.12	4.10
2019	0.34	1.00	0.53	0.76	2.54	0.10	0.16	5.44
2020	0.43	1.28	0.68	0.93	3.12	0.13	0.20	6.78
2021	0.68	2.00	1.06	1.33	4.44	0.18	0.28	9.98
2022	1.22	3.58	1.91	1.96	6.57	0.26	0.42	15.92
2023	2.84	8.37	4.45	2.63	8.80	0.35	0.56	28.01
2024	4.88	14.38	7.65	1.98	6.63	0.27	0.42	36.21
2025	7.17	21.15	11.25	0.53	1.78	0.07	0.11	42.06
	18.05	53.23	28.31	11.30	37.79	1.52	2.42	152.62

APPENDIX 6: CHAPTER 7 METHODOLOGY TO FORECAST REVENUES FROM FUEL LET ON PASSENGER MOTOR VEHICLES

Information from the following sources has been used in this exercise to forecast the fuel LET revenues for the following categories of Australian motor vehicles: Light cars; small cars; medium cars; large cars; SUVs; people movers and sports cars for the 10 years from 2016 to 2025:

- Department of Sustainability, Environment, Water, Population and Community, *Emissions from Different Fuels*;
- Australian Bureau of Statistics, *Survey of Motor Vehicle Use, Australia, 12 Months Ended 31 October 2010* (Catalogue No 9208.0, 23 August 2011).

The methodology below describes in detail the steps undertaken to calculate the fuel LET for Australian motor vehicles for 10 years after the introduction of the LET.

STEP 1

The first step required a forecast of annual fuel use per LET vehicle category. The CO_2 emission data gathered under each category in Appendix Tables 3.2 to 3.9 in Appendix 3 has been used to calculate the number of litres of fuel used per 100 kilometres by those vehicles. The Department of Sustainability, Environment, Water, Population and Community data shows that the use of one litre of petrol emits 2.3kg of CO_2 and one litre of diesel emits 2.7kg of CO_2.[624] The *Survey of Motor Vehicle Use* states that 84.1 per cent of passenger motor vehicles use petrol.[625] It is assumed that the remaining 15.9 per cent of the vehicles use diesel, and the small percentage

[624] Department of Sustainability, Environment, Water, Population and Communities, *Emissions From Different Fuels* (24 October 2008) Commonwealth of Australia <http://www.environment.gov.au/settlements/transport/fuelguide/environment.html>.
[625] Australian Bureau of Statistics, *Survey of Motor Vehicle Use, Australia, 12 Months Ended 31 October 2010* (Catalogue No 9208.0, 23 August 2011).

of vehicles that use auto gas or other alternative fuel has been ignored for the purpose of this exercise. Thus the average figure of 2.36kg of CO_2 (combined petrol and diesel) has been used to convert the CO_2 emissions of the various car categories into litres of fuel consumed per 100 kilometres as shown in Appendix Table 6.1 below.

APPENDIX TABLE 6.1: Conversion of CO_2 Emission Data into Fuel Use by Various LET Motor Vehicle Categories

Motor Vehicle Category	CO_2 Emissions g/km	Conversion into kg per 100km	Conversion into litres per 100km
Light	128	12.8	5.42
Small	146	14.6	6.19
Medium	186	18.6	7.88
Large	228	22.8	9.66
People Movers	242	24.2	10.25
SUVs	258	25.8	10.93
Sport	250	25	10.59

STEP 2

The second step required a forecast of the number of kilometres travelled by each category of motor vehicle per year, using the ABS statistics entitled *Survey of Motor Vehicle Use*. For the 12 months ended 31 October 2010, motor vehicles registered in Australia travelled an average of 14 100 kilometres per vehicle.[626] On the basis of this average, the number of litres of fuel consumed by a single vehicle under each motor vehicle category is forecasted in Appendix Table 6.2 below.

[626] Ibid 4.

APPENDIX TABLE 6.2: Forecast Annual Fuel Consumption in Litres by Single Motor Vehicle

Motor Vehicle Category	Average Annual Kilometres Travelled	Conversion into Litres per 100km	Annual Fuel Use per Vehicle in Litres
Light	14 100	5.42	765
Small	14 100	6.19	872
Medium	14 100	7.88	1111
Large	14 100	9.66	1362
People Movers	14 100	10.25	1446
SUVs	14 100	10.93	1541
Sport	14 100	10.59	1494

STEP 3

Step 3 required a forecast of the annual fuel consumption of the motor vehicle fleet. This could be obtained by multiplying the annual fuel use per vehicle in Appendix Table 6.2 by the number of motor vehicles forecast in Appendix Table 5.3 in Appendix 5. However an adjustment is required as the CO_2 data used in Appendix Table 6.1 is historical to year 2011. It does not take into consideration possible changes in the CO_2 data arising from the proposed implementation of CO_2 legislation in 2015. Also, the CO_2 emission data is based on new motor vehicles, whereas CO_2 emissions by older models of motor vehicles are likely to be higher. Due to this, and also taking into account different driving environments and habits, an 'other' column has been inserted in the data for the total fuel used by the vehicle fleet. The 'other' column in year 2011 shows the difference required to bring the total fleet fuel consumption to 18 431 litres, being the actual fuel consumption of passenger motor vehicles in 2010 as stated in the ABS *Survey of Motor Vehicle Use*.[627] The annual fleet fuel consumption in million litres with the 'other' column is shown in Appendix Table 6.3 below.

[627] Ibid 7.

APPENDIX TABLE 6.3: Total Annual Fleet Fuel Consumption in Million Litres

	Light Cars	**Small Cars**	**Medium Cars**	**Large Cars**	**SUVs**	**People Movers**	**Sports**	**Other**	**Total**
Annual fuel use	765	872	1111	1362	1541	1446	1494		
2011	1573	3305	1311	1715	5841	249	338	4099	18 431
2012	1600	3361	1333	1744	5940	254	344	4169	18 744
2013	1627	3418	1356	1774	6041	258	350	4240	19 063
2014	1655	3476	1379	1804	6144	262	355	4312	19 387
2015	1599	3358	1332	1743	5936	253	343	4166	18 731
2016	1634	3432	1361	1719	5854	250	339	4172	18 761
2017	1669	3506	1390	1694	5770	246	334	4178	18 788
2018	1703	3578	1419	1668	5681	243	329	4182	18 802
2019	1738	3651	1448	1641	5589	239	323	4184	18 813
2020	1772	3723	1477	1614	5497	235	318	4186	18 821
2021	1845	3877	1538	1532	5218	223	302	4157	18 692
2022	1983	4167	1653	1359	4627	198	268	4077	18 330
2023	2317	4867	1930	910	3099	132	179	3843	17 278
2024	2653	5573	2210	457	1557	66	90	3606	16 213
2025	2926	6148	2438	92	313	13	18	3417	15 366

STEP 4

The fourth step required an adjustment to the annual fuel use data as a 50 per cent reduction in the number of kilometres driven is desirable by year 2025. The decrease in mileage would be gradual, commencing at 5 per cent in 2016 and increasing by five per cent until 2025 as shown in Appendix Table 6.4.

APPENDIX TABLE 6.4: Adjustment to Annual Fuel Use Due to Forecast Reduction in Mileage

	Light Cars	Small Cars	Medium Cars	Large Cars	SUVs	People Movers	Sports
2011–2015	765	872	1111	1362	1541	1446	1494
2016	727	828	1055	1294	1464	1374	1419
2017	689	785	1000	1226	1387	1301	1345
2018	650	741	944	1158	1310	1229	1270
2019	612	698	889	1090	1233	1157	1195
2020	574	654	833	1022	1156	1085	1121
2021	536	610	778	953	1079	1012	1046
2022	497	567	722	885	1002	940	971
2023	459	523	667	817	925	868	896
2024	421	480	611	749	848	795	822
2025	383	436	556	681	771	723	747

STEP 5

Step 5 required a forecast of the adjusted annual fleet consumption taking into consideration the reduced mileage and fuel use forecast in Appendix Table 6.4. Appendix Table 6.5 shows the adjusted annual fleet fuel consumption in million litres.

APPENDIX TABLE 6.5: Total Annual Fleet Fuel Consumption in Million Litres with Forecast 50 Per Cent Mileage Reduction

	Light Cars	Small Cars	Medium Cars	Large Cars	SUVs	People Movers	Sports	Other	Total
2011	1573	3305	1311	1715	5841	249	338	4099	18 431
2012	1600	3361	1333	1744	5940	254	344	4169	18 744
2013	1627	3418	1356	1774	6041	258	350	4240	19 063

	Light Cars	Small Cars	Medium Cars	Large Cars	SUVs	People Movers	Sports	Other	Total
2014	1655	3476	1379	1804	6144	262	355	4312	19 387
2015	1599	3358	1332	1743	5936	253	343	4166	18 731
2016	1552	3260	1293	1633	5561	237	322	3964	17 823
2017	1502	3155	1251	1525	5193	222	300	3761	16 909
2018	1448	3041	1206	1418	4828	206	279	3554	15 982
2019	1390	2920	1158	1313	4472	191	259	3347	15 050
2020	1329	2792	1108	1211	4122	176	239	3139	14 116
2021	1292	2714	1076	1073	3652	156	211	2910	13 084
2022	1289	2708	1074	883	3007	128	174	2650	11 915
2023	1390	2920	1158	546	1860	79	108	2306	10 367
2024	1459	3065	1216	251	856	37	50	1983	8917
2025	1463	3074	1219	46	156	7	9	1709	7683

STEP 6

In this step, the fuel LET revenue is forecast by multiplying the forecast fuel consumption in Appendix Table 6.5 by the fuel LET shown in Appendix Tables 3.12 to 3.18 in Appendix 3. The ‘other’ category in Appendix Table 6.5 has been allocated an average AUD12.50 taxable value, being the average taxable values of all the motor vehicle categories. The forecast fuel LET revenue in AUD billion is shown in Appendix Table 6.6.

APPENDIX TABLE 6.6: Revenue Forecast for Fuel LET For Passenger Motor Vehicles in AUD Billion

	Light Cars	Small Cars	Medium Cars	Large Cars	SUVs	People Movers	Sports	Other	Total
	AUD billion	AUD billion	AUD billion	AUD billion	AUD billion	AUD billion	AUD billion	AUD billion	AUD billion
2016	0.12	0.39	0.27	0.51	1.95	0.07	0.12	0.99	4.42
2017	0.23	0.76	0.51	0.96	3.63	0.14	0.23	1.88	8.33

	Light Cars	Small Cars	Medium Cars	Large Cars	SUVs	People Movers	Sports	Other	Total
	AUD billion	**AUD billion**	**AUD billion**	**AUD billion**	**AUD billion**	**AUD billion**	**AUD billion**	**AUD billion**	**AUD billion**
2018	0.33	1.09	0.74	1.34	5.07	0.19	0.31	2.67	11.74
2019	0.42	1.40	0.95	1.65	6.26	0.24	0.39	3.35	14.66
2020	0.50	1.68	1.14	1.91	7.21	0.27	0.45	3.92	17.07
2021	0.73	2.44	1.65	2.53	9.59	0.36	0.59	5.46	23.36
2022	1.21	4.06	2.75	3.48	13.16	0.50	0.82	8.28	34.25
2023	2.61	8.76	5.94	4.30	16.27	0.62	1.01	14.41	53.91
2024	4.10	13.79	9.35	2.97	11.24	0.43	0.70	18.59	61.17
2025	5.49	18.44	12.50	0.72	2.74	0.10	0.17	21.36	61.52

APPENDIX 7: METHODOLOGY TO FORECAST NET REVENUES FROM LET

The following information has been used to forecast the net revenue generation potential of the LET for the 10 years from 2016 to 2025:

- Data gathered in Appendices 4 to 6;
- Commissioner of Taxation, *Annual Report 2010–11* (Australian Taxation Office, 30 September 2011).

The methodology below describes in detail the steps undertaken to calculate the forecast net revenue for 10 years after the introduction of the LET.

STEP 1

The first step was to obtain the total gross revenues forecast from the purchase LET, annual registration LET and fuel LET from Appendix Tables 4.6, 5.4 and 6.6 in the foregoing Appendices. A summary of the total gross revenue from the LET is shown in Appendix Table 7.1.

APPENDIX TABLE 7.1: Total Gross Revenue Forecast for LET (Excluding Disposal LET) for Passenger Motor Vehicles in AUD Billion

	Light Cars	Small Cars	Mediu m Cars	Large Cars	SUVs	People Movers	Sports	Other	Total
	AUD billion	AUD billion	AUD billion	AUD billion	AUD billion	AUD billion	AUD billion	AUD billion	AUD billion
2016	0.22	0.69	0.42	0.76	2.78	0.11	0.17	0.99	6.15
2017	0.43	1.36	0.84	1.45	5.28	0.20	0.33	1.88	11.78
2018	0.64	2.02	1.24	2.07	7.50	0.29	0.47	2.67	16.90
2019	0.85	2.67	1.62	2.61	9.45	0.37	0.59	3.35	21.50
2020	1.04	3.29	1.99	3.08	11.14	0.43	0.70	3.92	25.60
2021	1.58	4.96	2.99	4.21	15.18	0.59	0.95	5.46	35.91

	Light Cars	Small Cars	Mediu m Cars	Large Cars	SUVs	People Movers	Sports	Other	Total
	AUD billion	AUD billion	AUD billion	AUD billion	AUD billion	AUD billion	AUD billion	AUD billion	AUD billion
2022	2.74	8.57	5.15	5.95	21.42	0.83	1.34	8.28	54.28
2023	6.18	19.29	11.54	7.61	27.34	1.06	1.72	14.41	89.14
2024	10.24	31.88	18.96	5.46	19.58	0.76	1.23	18.59	106.71
2025	14.51	45.04	26.64	1.39	4.97	0.19	0.31	21.36	114.42
Total	38.42	119.77	71.39	34.60	124.64	4.83	7.82	80.91	482.37

STEP 2

The second step was to estimate the cost of collecting the LET. The Commissioner of Taxation's *Annual Report 2010–11* states that on average it costs AUD0.88 to collect AUD100 of revenue.[628] Based on this data, Appendix Table 7.2 below shows the predicted cost of collecting the LET.

APPENDIX TABLE 7.2: Estimate of Cost of Collecting LET

	Total Gross LET	Cost of Collection
	AUD billion	AUD million
2016	6.15	54.10
2017	11.78	103.69
2018	16.90	148.70
2019	21.50	189.20
2020	25.60	225.25
2021	35.91	316.00
2022	54.28	477.63
2023	89.14	784.42
2024	106.71	939.01
2025	114.42	1006.89

[628] Commissioner of Taxation, above n 552, 9.

STEP 3

It has been proposed in this thesis that the government would abolish the Luxury Car Tax (LCT) when the LET is introduced. Therefore it was necessary to forecast the revenues from LCT that would be forgone for the 10 years from 2016 to 2024.

The Commissioner of Taxation's *Annual Report 2010–11* states that the LCT collected in 2010–11 was AUD489 million.[629] Based on the forecast motor vehicle population from Appendix Table 5.2 in Appendix 5 above, the potential LCT revenue for years 2011 to 2025 was calculated, and is shown in Appendix Table 7.3.

APPENDIX TABLE 7.3: Estimate of Luxury Car Tax for Years 2011 to 2025

	Total Forecast Car Population from Appendix Table 5.2	**Estimated Luxury Car Tax**
		AUD million
2011	12 474 044	489
2012	12 686 103	497
2013	12 901 767	506
2014	13 121 097	514
2015	12 676 948	497
2016	12 756 746	500
2017	12 835 594	503
2018	12 905 817	506
2019	12 974 891	509
2020	13 042 760	511
2021	13 109 365	514
2022	13 174 646	516
2023	13 238 543	519
2024	13 300 992	521
2025	13 361 929	524

[629] Ibid 300.

STEP 4

It has been proposed in this thesis that the government would abolish the excise of AUD0.38 that is currently collected on fuel when the LET is introduced. Therefore it was necessary to forecast the revenues from excise that would be forgone for the 10 years from 2016 to 2024.

The fuel consumption forecast in Appendix Table 6.5 in Appendix 6 has been used to estimate the excise revenue that would be forgone in the years 2016 to 2025, and is shown in Appendix Table 7.4.

APPENDIX TABLE 7.4: Estimate of Excise Revenue

	Fleet Fuel Consumption	**Excise Forgone @ AUD0.38 per Litre**
	Million Litres	**AUD million**
2016	17 823	6773
2017	16 909	6426
2018	15 982	6073
2019	15 050	5719
2020	14 116	5364
2021	13 084	4972
2022	11 915	4528
2023	10 367	3939
2024	8917	3389
2025	7683	2920

The excise revenue forgone for 2016 needs adjusting due to the phasing-in period for existing cars, which would only become LET-registered gradually as their state annual registration became due. Thus for the purpose of this thesis, the excise revenue forgone for 2016 has been estimated to be reduced by 50 per cent, totalling AUD3386.50 million.

STEP 5

Appendix Table 7.5 below shows the net revenue forecast of the LET for the years 2016 to 2025 by subtracting from the gross revenue the cost of collecting the LET, the forgone LCT and the forgone excise duty on fuel.

APPENDIX TABLE 7.5: Net Revenue Forecast for LET

Year	Gross LET	Collection Cost	LCT	Excise	Total Deductions	Net LET
	AUD billion	AUD million	AUD million	AUD million	AUD billion	AUD billion
2016	6.15	54.10	500.08	3386.50	3.94	2.21
2017	11.78	103.69	503.17	6425.51	7.03	4.75
2018	16.90	148.70	505.93	6072.99	6.73	10.17
2019	21.50	189.20	508.63	5719.15	6.42	15.08
2020	25.60	225.25	511.29	5364.11	6.10	19.50
2021	35.91	316.00	513.91	4971.95	5.80	30.11
2022	54.28	477.63	516.46	4527.60	5.52	48.75
2023	89.14	784.42	518.97	3939.40	5.24	83.90
2024	106.71	939.01	521.42	3388.52	4.85	101.86
2025	114.42	1006.89	523.81	2919.51	4.45	109.97

APPENDIX 8: METHODOLOGY TO FORECAST SAVINGS IN USE OF OIL WITH THE INTRODUCTION OF LET FOR PASSENGER MOTOR VEHICLES

The following steps were undertaken to calculate the savings in the use of oil with the introduction of LET in passenger motor vehicles.

STEP 1

The first step was to obtain a breakdown of the projected motor vehicle stock without LET as stated in Appendix Table 5.1, into the motor vehicle categories of light car, small car, medium car, large car, SUVs, people movers and sports car. For the purpose of this thesis, a breakdown of the passenger motor vehicle population is based on the available breakdown of the car sales data for year ended 31 December 2011 as shown in Appendix Table 4.2 above. The breakdown of the total passenger car population into its various categories from years 2011 to 2025 is shown in Appendix Table 8.1.

APPENDIX TABLE 8.1: Motor Vehicle Projections Without LET in Categories

	Light Cars	Small Cars	Medium Cars	Large Cars	SUVs	People Movers	Sports	Total
2011	2 056 242	3 789 644	1 179 697	1 259 421	3 790 358	172 474	226 208	12 474 044
2012	2 091 198	3 854 068	1 199 752	1 280 831	3 854 794	175 406	230 054	12 686 103
2013	2 126 748	3 919 587	1 220 148	1 302 606	3 920 326	178 388	233 964	12 901 767
2014	2 162 903	3 986 220	1 240 890	1 324 750	3 986 971	181 420	237 942	13 121 097
2015	2 199 672	4 053 986	1 261 986	1 347 271	4 054 750	184 505	241 987	13 344 156
2016	2 237 067	4 122 904	1 283 439	1 370 174	4 123 681	187 641	246 101	13 571 007
2017	2 275 097	4 192 993	1 305 258	1 393 467	4 193 783	190 831	250 284	13 801 714
2018	2 313 774	4 264 274	1 327 447	1 417 156	4 265 078	194 075	254 539	14 036 343
2019	2 353 108	4 336 767	1 350 014	1 441 248	4 337 584	197 374	258 866	14 274 961
2020	2 393 110	4 410 492	1 372 964	1 465 749	4 411 323	200 730	263 267	14 517 635

	Light Cars	Small Cars	Medium Cars	Large Cars	SUVs	People Movers	Sports	Total
2021	2 433 793	4 485 470	1 396 304	1 490 667	4 486 315	204 142	267 743	14 764 435
2022	2 475 168	4 561 723	1 420 042	1 516 008	4 562 583	207 613	272 294	15 015 430
2023	2 517 246	4 639 272	1 444 182	1 541 780	4 640 146	211 142	276 923	15 270 692
2024	2 560 039	4 718 140	1 468 733	1 567 990	4 719 029	214 732	281 631	15 530 294
2025	2 603 559	4 798 348	1 493 702	1 594 646	4 799 253	218 382	286 419	15 794 309

STEP 2

Based on the assumptions made in Steps 1 and 2 in Appendix 6 and using the annual fuel use per vehicle in litres stated in Appendix Table 6.2, Appendix Table 8.2 below shows the annual fleet fuel consumption in million litres by the motor vehicle population without LET adjustment.

APPENDIX TABLE 8.2: Total Annual Fleet Oil Consumption in Million Litres by the Motor Vehicle Population Without LET Adjustment

	Light Cars	Small Cars	Medium Cars	Large Cars	SUVs	People Movers	Sports	Other	Total
2011	1573	3305	1311	1715	5841	249	338	4099	18 431
2012	1600	3361	1333	1744	5940	254	344	4169	18 744
2013	1627	3418	1356	1774	6041	258	350	4240	19 063
2014	1655	3476	1379	1804	6144	262	355	4312	19 387
2015	1683	3535	1402	1835	6248	267	362	4385	19 716
2016	1711	3595	1426	1866	6355	271	368	4459	20 052
2017	1740	3656	1450	1898	6463	276	374	4535	20 393
2018	1770	3718	1475	1930	6572	281	380	4612	20 739
2019	1800	3782	1500	1963	6684	285	387	4691	21 092
2020	1831	3846	1525	1996	6798	290	393	4771	21 450
2021	1862	3911	1551	2030	6913	295	400	4852	21 815
2022	1894	3978	1578	2065	7031	300	407	4934	22 186
2023	1926	4045	1604	2100	7150	305	414	5018	22 563
2024	1958	4114	1632	2136	7272	311	421	5103	22 947
2025	1992	4184	1660	2172	7396	316	428	5190	23 337

STEP 3

The expected savings in the use of oil as a result of the introducing the LET was calculated by deducting the data in Appendix Table 8.2 above from the data in Appendix Table 6.5 in Appendix 6. The expected saving in the usage of oil in million litres as a result of introducing the LET is shown in Appendix Table 8.3.

APPENDIX TABLE 8.3: Saving in Usage of Oil in Million Litres as a Result of Introducing the LET

	Light Cars	Small Cars	Medium Cars	Large Cars	SUVs	People Movers	Sports	Other	Total
2011	0	0	0	0	0	0	0	0	0
2012	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0
2015	84	177	70	92	312	14	19	219	986
2016	159	335	133	233	794	34	46	495	2228
2017	238	501	199	373	1270	54	74	774	3483
2018	322	677	269	512	1744	75	101	1058	4756
2019	410	862	342	650	2212	94	128	1344	6042
2020	502	1054	417	785	2676	114	154	1632	7334
2021	570	1197	475	957	3261	139	189	1942	8730
2022	605	1270	504	1182	4024	172	233	2284	10 272
2023	536	1125	446	1554	5290	226	306	2712	12 195
2024	499	1049	416	1885	6416	274	371	3120	14 030
2025	529	1110	441	2126	7240	309	419	3481	15 655
Total	4455	9355	3712	10 347	35 237	1504	2040	19 063	85 714