

# **Carbon Emissions Trading and Australia's Urban Transport**

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## Acronyms and symbols

ABARE	Australian Bureau of Agricultural and Resource Economics
ABS	Australian Bureau of Statistics
AGT	Automated guided transit
AUD\$	Australian dollars
BAU	Business-as-usual
bbf	Barrel
bpk	Billion passenger kilometres
b/v/km	Billion vehicle kilometres
BRT	Bus rapid transit
BTRE	Bureau of Transport and Regional Economics
CAF	Council for the Australian Federation
CBD	Central business district
CH <sub>4</sub>	Methane
CNG	Compressed natural gas
COAG	Council of Australian Governments
CO <sub>2</sub>	Carbon dioxide
CO <sub>2</sub> -e	Carbon dioxide equivalent
COP	Conference of the Parties
CPRS	Carbon Pollution Reduction Scheme
CSIRO	Commonwealth Scientific and Industrial Research Organisation
EFM	Environmentally friendly modes
EIA	Energy Information Administration
EITE	Emissions intensive-trade exposed
ETS	Emissions Trading Scheme
EU	European Union
EU-ETS	European Union Emissions Trading Scheme
FCCC	(United Nations) Framework Convention on Climate Change
GAMUT	Australasian Centre for Governance and Management of Urban Transport
g CO <sub>2</sub> e/p/km	Grams of CO <sub>2</sub> -e per passenger kilometre
GCCR	Garnaut Climate Change Review
GDP	Gross domestic product
GFC	Global financial crisis
GHG	Greenhouse Gas(es)
Gg	Gigagrams (10 <sup>9</sup> grams)
GL	Gigalitre (10 <sup>9</sup> litres)
ha	Hectare
ICE	Internal combustion engine
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
IPP	Import parity pricing
Kg	Kilogram
km/h	Kilometres per hour
km(s)	Kilometre(s)
l	Litre
l/100km	Litres per 100 kilometres
LCA	Lifecycle analysis
LCV	Light commercial vehicle
LGA	Local government area
LNG	Liquefied natural gas
LPG	Liquefied petroleum gas
LRRT	Light rail rapid transit
LRT	Light rail transit
LULUCF	Land use, land use change, and forestry
mbd	Million barrels a day
mmtce	Million metric tons of carbon equivalent
mmtco <sub>2</sub> e	Million metric tons of carbon dioxide equivalent
Mt	Million tonnes
MtCO <sub>2</sub> -e	Million tonnes carbon dioxide equivalent

N <sub>2</sub> O	Nitrous oxide
NACE	National Average Carbon Emission
NAFC	National Average Fuel Consumption
NESA	National Energy Security Assessment
NETS	National Emissions Trading Scheme
NTTF	National Emissions Trading Taskforce
MRT	Mass rapid transit
OECD	Organization for Economic Co-operation and Development
OPEC	Organization of the Petroleum Exporting Countries
PJ	Petajoule (10 <sup>15</sup> joules)
p/km/c	Passenger kilometres per capita
ppbv	Parts per billion by volume
pph	Persons per hectare
ppmv	Parts per million by volume
PULP	Premium unleaded petroleum
QLD	Queensland
SA	South Australia
SSD	Statistical sub-division
sq km	Square kilometre
tCO <sub>2</sub> -e/MWh	Tonnes carbon dioxide equivalent per megawatt hour
UN	United Nations
UN FCCC	United Nations Framework Convention on Climate Change
US\$	United States dollar
VKT	Vehicle kilometres travelled

## 1 Introduction

To date, Australia has failed to curtail its emissions of greenhouse gases (GHG) from energy sources, despite a series of national policies and strategies – beginning with 1992's *National Greenhouse Response Strategy*, some 17 years ago. A reliance on voluntary measures and 'soft' policy approaches by state, territory and federal governments has been ineffectual; a new phase of policy response is soon to begin. Australia is attempting to develop a market-based set of policies to mitigate GHG emissions with preparations well advanced for a national GHG emissions trading scheme. This scheme will apply across the national economy and employ economic signals to change personal and institutional behaviours and preferences. GHG emissions from the transport sector are a major emissions source and have proved difficult, if not impossible, to control under normal economic circumstances. This gives rise to a very simple question: Will emissions trading reduce GHG emissions from transport? This Working Paper seeks to address this question.

Urban transport is the focus of our interest and road transport by motor vehicles in particular, given that this is the location and source of the majority of transport emissions. Nationally, around 80 per cent of passenger vehicle use occurs in the capital cities and other urban areas (ABS, 2007: 14). Particular aspects of urban freight transport are also examined, but not in any detail. International transport is not examined – although, nationally, Australians have a relatively high rate of international air and sea travel, with the result that some households and firms emit high levels of GHG from these sources; domestic air travel (i.e., within Australia) is similarly excluded.

Section 2 provides background on the key policy-related issues facing the transport sector's response to climate change and impinging on the proposed national GHG emissions trading scheme. While a number of these issues are common to all industrialized nations, it is their application to Australia that is examined here. Section 3 deals with carbon trading and describes the forthcoming national system, together with an overview of recent political developments. Section 4 describes key limits on emissions trading in the sector. Section 5 assesses the likely success of GHG emissions trading for the transport sector, based on an appraisal of the characteristics of the sector in which the market for carbon emissions would function. Section 6 describes the set of market failures that will afflict the proposed CPRs and Section 7 does likewise for the barriers to an effective market; in practice, the division between these failures and barriers is likely to be blurred. A brief conclusion is offered to close the study.

## 2 Key climate change – urban transport issues

### 2.1 *Transport's GHG emissions*

According to the most recent national inventory of GHG emissions (2006), total (net) emissions were 576 MtCO<sub>2</sub>-e, with some 79.1 MtCO<sub>2</sub>-e from the transport sector (13.7 per cent) (AGO, 2008: Table 1). Road transport is the major emissions source for the sector (87 per cent), unsurprisingly, since it provides the majority of passenger and freight movement; domestic aviation, railways, and shipping are comparatively minor emission sources (see Table 1). Carbon dioxide is the overwhelmingly dominant GHG produced by the sector (see Table 1).

As the national economy and population have continued to grow, emissions from transport have followed suit. Transport emissions have continued to grow almost one-third over recent decades, increasing from 62 MtCO<sub>2</sub>-e in 1990 to 81 MtCO<sub>2</sub>-e in 2005 – although emissions fell slightly in 2006, as described above (DCC, 2008a). Broken down into modes and vehicle categories, it is clear that not only is motorized road transport the major emissions source, but that passenger cars are the dominant mode, accounting for around 55 per cent of national transport emissions (DCC, 2008a) (see Table 2). Forecasts by the federal Department of Climate Change describe continued emissions growth, with both passenger and freight emissions rising, with proportionally very considerable increases in freight emissions from light commercial vehicles, rigid trucks, and articulated trucks (see Table 2). Earlier forecasts showed similar emissions growth trends; see, e.g., *Greenhouse Gas Emissions from Australian Transport: Base Case Projections to 2020* (BTRE, 2005a) and *Tracking to the Kyoto Target* (AGO, 2005), based on models that have a strong coupling between future transport emissions and growth in population and GDP.

**Table 1 National energy sector emissions, 2006, gigagrams of CO<sub>2</sub>-e**

	CO <sub>2</sub> (Gg)	CH <sub>4</sub> (Gg)	N <sub>2</sub> O (Gg)	Total (Gg)	Share of total national emissions (%)
<b>Transport</b>	<b>76.8</b>	<b>0.6</b>	<b>1.7</b>	<b>79.1</b>	<b>13.7</b>
Civil aviation	6.0	0.001	0.06	6.1	1.1
Road transportation	66.7	0.5	1.6	68.9	12.0
Railways	1.9	0.002	0.02	1.9	0.3
Navigation (domestic)	2.1	0.1	0.01	2.2	0.4
Other	0.04	0.0004	0.0002	0.0	0.0

Source: Australian Greenhouse Office (2008) *Australian Greenhouse Gas Inventory 2006*. Canberra: Department of Environment and Water Resources: Appendix II: Table 1.

**Table 2 National transport GHG emissions: historical and forecast, million tonnes of CO<sub>2</sub>-e**

	Emissions (MtCO <sub>2</sub> -e)				Increase above 1990 level (%)	
	1990	2005	Kyoto period average 2008–2012	2020	Kyoto period average 2008–2012	2020
Passenger cars	35.2	44.0	45.7	49.3	30	40
Motorcycles	0.2	0.2	0.2	0.3	16	47
Buses	1.2	1.3	1.4	1.6	21	40
Light commercial vehicles	7.5	11.1	12.8	17.9	69	137
Rigid trucks	4.1	5.6	6.2	6.9	50	67
Articulated trucks	6.1	8.8	10.2	12.8	68	111
Aviation	2.9	5.1	6.5	8.7	122	198
Rail	1.7	2.1	2.6	3.3	47	89
Shipping	3.0	2.4	2.5	2.8	-17	-9
<b>TOTAL</b>	<b>62.1</b>	<b>80.8</b>	<b>88.1</b>	<b>103.7</b>	<b>42</b>	<b>67</b>

Source: Department of Climate Change (2008a) *Transport Sector Greenhouse Gas Emissions Projections 2007*. Canberra: Table 2.3.

A great many factors influence transport emissions, both directly and indirectly, indeed, this fact is central to the argument presented in this GAMUT Working Paper. Direct influences on total transport emissions are:

- GHG emissions from different energy (as fuel) sources
- Fuel type and consumption levels
- Vehicle – and vehicle fleet – fuel economy per mode
- Vehicle use (e.g., km per annum)
- Vehicle loading (i.e., passenger numbers), and
- Vehicle type and number.

There are many methodologies available for estimating transport emissions, drawing on different datasets and built on varying assumptions, giving rise to a range of estimates and findings. Such information provides an insight into the differences in emissions between modes, which serves as the basis for policy decisions promoting modal switch as a strategy for emissions reduction (see, e.g., BTRE, 2002). Evidence from comparative studies has shown a lower GHG emissions profile from transport systems with higher levels of active and public transport (see, e.g., Scheurer et al, 2005). An example of these differences is data produced for Melbourne, as shown in Table 3. Active transport (i.e., walking and cycling) involves no fossil fuel combustion and is the most attractive form of mobility from an emissions perspective. It is interesting to note the relatively high emissions from trains and trams; this is attributable to the brown coal fuel source for the bulk of the electricity supplied to Melbourne, subsequently used by these public transport modes. However, as the data in Table 2

indicate, mode-switching from driver-only cars to trains or trams during peak hour produces significant emissions savings.

**Table 3 Melbourne: greenhouse gas emissions by mode, grams of CO<sub>2</sub>-e per passenger kilometre**

Car Average occupancy (g CO <sub>2</sub> e/p/km)	Car Driver only (g CO <sub>2</sub> e/p/km)	Motorcycle (g CO <sub>2</sub> e/p/km)	Bus (g CO <sub>2</sub> e/p/km)	Train (g CO <sub>2</sub> e/p/km)	Tram (g CO <sub>2</sub> e/p/km)
213 (Peak: 250– Off-peak: 189)	302 (Peak: 313– Off-peak: 297)	112	159 (Peak: 101– Off-peak: 197)	145 (Peak: 96– Off-peak: 198)	158 (Peak: 122– Off-peak: 178)

Source: Commissioner for Environmental Sustainability (2008) *Public Transport's Role in Reducing Greenhouse Emissions*. Melbourne: Commissioner for Environmental Sustainability.

Given that the private motorcar is the major emissions source in the sector, its fuel types, fuel efficiency, distance driven, and passenger loadings are of particular interest. For example, there has been considerable attention given to the problem of vehicle fuel efficiency. Average passenger car fuel efficiency is around 11 litres per 100 kilometres (ABS, 2007), (see Table 4). Despite a relatively high level of awareness of the potential gains to individual consumers, firms, and the national economy from greater vehicle fuel efficiency, there has been little progress. Overall, there has been little change to vehicle fuel efficiency for many decades; today's average rate of fuel consumption is around that of the 1960s. Although engine fuel efficiency improved over this time, increases in vehicle weight, additional equipment, and greater performance eroded these potential improvements (Moriarty and Honnery, 2008b).

According to the Federal Government's Green Vehicle Guide, the top five best-performing vehicles available in Australia, based on a metric that combines low GHG emissions and a low air pollution rating, are: 1) Toyota Prius, 2) Fiat 500, 3) Fiat Punto, 4) Toyota Yaris, and 5) Citroen C3. Toyota's Prius, for example, has a combined urban/rural fuel consumption of 4.4 l/100km and a 106 gCO<sub>2</sub>/km; for comparison, the popular Holden Commodore (3.6 l/ 6-cylinder engine) gets 10.8 l/100km for 256 gCO<sub>2</sub>/km and the Ford Falcon (4.0 l/ 6 cylinder engine) gets 10.2 l/100km for 243 gCO<sub>2</sub>/km.<sup>1</sup> Based on the weighted average of the CO<sub>2</sub> emissions of the 20 best-selling new car models in Australia in 2007, the average emissions performance was 226 gCO<sub>2</sub>/km (ATC & EPHC VEFWG, 2008: 20).

Australia does not have vehicle fuel efficiency standards. Between 2003 and 2005 there was a voluntary agreement between the Commonwealth and the automotive industry – the National Average Fuel Consumption (NAFC) target – that established voluntary targets for fuel economy: 6.8 l/100km for petrol passenger cars by 2010. In 2005, the fuel economy target was replaced with a voluntary GHG emissions target, the National Average Carbon Emissions (NACE). This NACE was set at an average 222 gCO<sub>2</sub>/km from new light vehicles (i.e., under 3.5 tonnes) by 2010. This covers all fuel types and a variety of vehicle types, including cars, four-wheel drives, vans, and light trucks. According to the Federal Chamber of Automotive Industries (FAI), the NACE for all new light vehicles was 226.1 gCO<sub>2</sub>/km in 2007 (FAI, n.d.). In 2002, the NACE was 252 gCO<sub>2</sub>/km, leading the industry to believe that the target for 2010 will be achieved (FAI, n.d.). This has been achieved by 'changes in market segmentation; advances in engine technology and vehicle design; and a growth in alternative vehicle types (particularly diesel)' (FAI, n.d.). Australian Design Rules for motor vehicles have sought the reduction of pollutant emissions, but these do not cover GHG.

<sup>1</sup> Available online at: [www.greenvehicleguide.gov.au](http://www.greenvehicleguide.gov.au).

**Table 4 Motor vehicle fuel use: average rate of fuel consumption, 2002–2006, litres per 100 kilometres**

	2002 (l/100km)	2003 (l/100km)	2004 (l/100km)	2005 (l/100km)	2006 (l/100km)
Passenger vehicles	11.3	11.4	11.5	11.6	11.4
Motor cycles	6.0	6.0	6.3	5.8	6.4
Light commercial vehicles	13.2	13.1	13.1	13.3	13.0
Rigid trucks	28.8	28.1	27.8	29.1	29.6
Articulated trucks	53.9	54.2	55.0	54.7	55.6
Non-freight carrying trucks	26.6	25.7	24.0	22.7	26.4
Buses	28.0	27.6	26.6	27.3	26.8
TOTAL	13.6	13.7	13.8	14.0	13.8

Source: Australian Bureau of Statistics (2007) *Survey of Motor Vehicle Use: 12 Months Ended 31 October 2006*. Publication No. 9208.0: Table 1.

Data presented here on GHG emissions from the transport sector is a measure of fossil fuel energy consumption for powering vehicles (i.e., ‘direct emissions’) and does not include full ‘lifecycle’ emissions. Lifecycle emissions include upstream, direct, and downstream emissions. Examples of upstream emissions are those released in the manufacture of motor vehicles and those associated with the mining and transport of crude oil, raw materials extraction, or those emanating from oil refining. Downstream emissions result from waste disposal, for example, the collection and disposal of the materials created by the sector. Such emissions are measured in the national GHG inventory (see, e.g., AGO, 2008) but are attributed to other sectors or are not measured because they are deemed to be international emissions.<sup>2</sup>

Estimates of lifecycle emission give, therefore, a more complete understanding of the environmental impacts of competing modes. As a report by the US EPA states (EPA, 2006: 36): ‘An LCA [lifecycle analysis] of transportation also should take into account emissions from three key components of transportation systems: fuels, vehicles, and infrastructure.’ Calculating such emissions is complicated; a study by the EPA of lifecycle emissions for fuels and vehicles found that for the transport sector, annual emissions were 27–37 per cent higher than direct fuel combustion emissions alone; for passenger cars using conventional fuels, the emissions were 35–43 per cent higher (EPA, 2006: 39). Lenzen’s (1999) study of GHG emissions from Australia’s transport is of particular interest as it measures both direct and indirect emissions. Overall, Lenzen found that for freight, indirect GHG emissions ranged from 10–50 per cent above direct emissions and indirect passenger transport emissions were 25–65 per cent of direct emissions (see Table 5).

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<sup>2</sup> So-called ‘bunker fuels’.



**Table 5 Greenhouse gas emissions and intensity: Australian transport sector**

Mode	GHG (Mt CO <sub>2</sub> -e)			GHG intensity (Kg CO <sub>2</sub> -e/pkm)		
	Direct from fuel	Indirect*	Total	Fuel	Operation	Total
Private car: petrol	29.13	33.63	62.77	0.21	0.14	0.34
Private car: diesel	1.33	1.34	2.67	0.24	0.14	0.38
Private car: LPG	1.42	1.68	3.10	0.22	0.14	0.35
Bus & coach: private	0.84	0.90	1.74	0.09	0.05	0.14
Urban: light rail: public	0	0.12	0.12	0.13	0.07	0.20
Urban: bus: public	0.37	0.34	0.70	0.15	0.07	0.22
Urban: bicycle	0	0.09	0.09	0.10	0.05	0.15
Urban: heavy rail: public	0.05	1.83	1.88	0.17	0.10	0.27

Source: Lenzen, M. (1999) Total requirements of energy and greenhouse gases for Australian transport. *Transportation Research Part D*, Vol. 4: 265–290: Abridged from Table 2.

Note: \* Indirect emissions are the sum of: Fuel, Operations Expenditure, and Public Expenditure.

## 2.2 Transport's dependence on fossil fuel

Essentially, Australia's motorized mobility runs on energy from fossil fuels; it technologically 'locked' into a dependency on this energy source, which, in turn, means that in this paradigm, urban mobility equates to GHG emissions. So tightly coupled is this relationship that GHG emissions and the level of urban mobility are metrics of each other, given the extent of passenger cars for personal urban transport and trucks for land freight transport. Broadly, passenger cars run on petroleum and to a lesser extent LPG, with diesel being used by trucks and buses. Suburban rail is mostly electric and the fuel stocks for electricity generation across Australia (for 2005/06 [fy]) are primarily black coal (54.5 per cent), brown coal (21.1 per cent), natural gas (15 per cent), hydro (6.4 per cent), with oil and the renewables making up the balance (about 3 per cent) (ABARE, 2008: 40). Passenger cars account for the bulk of road fuel consumption (over 60 per cent), while buses account for a little over 2 per cent (ABARE, 2008: 70), (see Table 6). Freight transport accounts for nearly all the remainder of fuel consumption. Light commercial vehicles (LCV) make a considerable number of passenger journeys when used in their capacity as 'light service vehicles' – such as when used by tradespeople to travel to job sites – as opposed to their freight task when used as 'light goods vehicles'.

**Table 6 Australian road fuel consumption by vehicle type, 2005/06, as percentages**

Vehicle type	Australian road fuel consumption (%)
Passenger vehicles	61
Light commercial vehicles	15.6
Articulated trucks	12.6
Rigid trucks	8.2
Buses	2.1
Motorcycles	0.3
Other trucks	0.2

Source: Australian Bureau of Agricultural and Resource Economics (2008) *Energy in Australia 2008*. Canberra: p. 70.

Total petroleum sales in Australia in 2006/07 were 19,251 ML, one-third higher than in 1977–78; diesel sales grew by almost 90% from 1987–88 to 2006/07 (BITRE, 2008: 134). With only 2336 ML sold in 2006/07, LPG remains a relatively minor transport fuel (see Table 7).

**Table 7 Transport petroleum sales, by fuel type, megalitres**

Financial year	Automotive gasoline (ML)	Automotive LPG (ML)	Automotive diesel (ML)
1977/78	14,411.3	NA	NA
1987/88	16,567.0	NA	9093.8
1997/98	17,912.7	NA	12,557.4
1998/99	18,202.1	NA	12,823.2
1999/00	18,476.6	1902.9	13,245.1
2000/01	18,167.6	2221.4	12,952.4
2001/02	18,668.8	2422.2	13,441.2
2002/03	18,872.5	2416.3	13,888.0
2003/04	19,962.0	2546.8	14,461.5
2004/05	19,875.7	2338.8	15,185.0
2005/06	19,047.9	2335.5	15,803.6
2006/07	19,250.7	2335.5	17,027.6

Source: Bureau of Infrastructure, Transport and Regional Economics (2008) *Australian Transport Economic Yearbook 2007*. Canberra: BITRE: Table 10.1

### 2.3 Car-dependent urban transport systems

'Car-dependency' was used by Newman and Kenworthy (1999) to describe the condition in which a city's development presumes the predominance of car use, so that transport planning and policy, infrastructure provision, and overall urban planning are to this end. In a similar way in which motor vehicle transport is dependent on fossil fuels energy sources, so too are our transport systems are dependent on motor vehicles for the bulk of urban mobility. There can be little doubt about the dominance of motor vehicles in the national transport system. In 2003/04 [fy], of the total 357 billion passenger kilometres (b/p/km) covered in Australia by all modes, some 74 per cent (265.43 b/p/km) were by passenger cars (BITRE, 2008: 36). Within the capital cities, in 2003/04 [fy], passenger cars covered 151.27 b/p/km (some 86 per cent) of the total of all modes of 175.68 b/p/km (BITRE, 2008: 46). Australians continue to travel more each year; in 1970/71 [fy], total passenger car use was 63.81 billion vehicle kilometres travelled (b/v/km), by 1980/81 [fy], it was 90.61 b/v/km; 1990/91 [fy]: 124.88 b/v/km; and by 2003/04 [fy] had reached 171.47 b/v/km (BITRE, 2008: 57). Car ownership, another indicator of car-dependency, is high in Australia: in 2006, there were 11,188,900 registered motorcars for a population of 20,671,000 (BITRE, 2008), which is about 5410 cars per 10,000 people. To these vehicles tallies could be added another 2.1 million registered light commercial vehicles, which perform many passenger trips, and 460,000 registered motor cycles (BITRE, 2008: 62), which would give an ownership rate of the order of 6580 motor vehicles per 10,000 population.

Another indication of the dominance of the motorcar is to consider the trip type where public transport is most used in cities, namely commuting. Census data on the journey to work shows that, over the past three decades, the use of public transport for commuting in the capital cities has grown considerably worse (see Table 8) – although since the 2006 census, there has been an increase in public transport use. Car use accounts for three-quarters of all commuting and almost 70 per cent of all commuting is done by driver-only vehicles (Mees et al, 2007).

**Table 8 Journey to work: Australia's capital cities, as percentages**

	1976 (%)	1981 (%)	1986 (%)	1991 (%)	1996 (%)	2001 (%)	2006 (%)
<b>Public Transport</b>	<b>23.6</b>	<b>21.1</b>	<b>19.3</b>	<b>17.5</b>	<b>14.6</b>	<b>15.1</b>	<b>15.2</b>
Train	10.5	10.4	9.9	9.2	9.2	9.6	9.4
Ferry/ Tram	2.4	1.9	1.7	1.2	0.7	0.9	0.9
Bus	10.7	8.9	7.8	7.0	4.7	4.6	4.9
<b>Car</b>	<b>68.1</b>	<b>71.3</b>	<b>73.9</b>	<b>75.0</b>	<b>78.0</b>	<b>76.6</b>	<b>76.1</b>
Driver	56.5	60.4	64.2	65.5	70.2	69.7	69.7
Passenger	11.6	10.9	9.7	9.4	7.8	6.9	6.5
<b>Bicycle</b>	<b>0.8</b>	<b>1.1</b>	<b>1.1</b>	<b>1.1</b>	<b>0.9</b>	<b>0.9</b>	<b>1.1</b>
<b>Walk only</b>	<b>5.6</b>	<b>4.4</b>	<b>3.9</b>	<b>3.9</b>	<b>3.5</b>	<b>3.5</b>	<b>4.0</b>
<b>Other</b>	<b>1.8</b>	<b>2.0</b>	<b>1.8</b>	<b>2.5</b>	<b>3.1</b>	<b>3.9</b>	<b>3.6</b>
<b>Total</b>	100	100	100	100	100	100	100

Source: After Mees, P., Sorupia, E. and Stone, J. (2007) *Travel to Work in Australian Capital Cities, 1976-2006: An Analysis of Census Data*. Melbourne: Australasian Centre for the Governance and Management of Urban Transport: Table 1.8.

Complicit in car dependency is the role of public expenditure. Long subject to debate, there can be little doubt that public (Commonwealth, State, and local) spending on urban transport has been predominantly directed towards roads projects and public transport has received comparatively little support for many years and certainly for all of the post-war period until this year. Some critics consider that public subsidy towards fossil fuels and car-based transport has greatly contributed to this state of affairs (see, e.g., Reidy, 2007). Indicative of the neglect of public transport expenditure by public agencies in favour of road-building is the absence of a comprehensive account of national transport expenditure by public authorities; however, some estimates are available.

Laird et al (2001) estimated that between 1975 and 2000 federal expenditure allocations to transport were (in 1999 dollars): Roads: AUD\$43b; Rail: AUD\$1b; and Urban public transport: AUD\$1b. It is noteworthy that during this period there was very little capital investment in rail transport. Russell (2008) states that under the federal Auslink 1 programme – and additional federal allocations – between 2004/5 and 2008/9, under which investment amounted to almost AUD\$15b for major roads and rail freight, none was for urban rail. Since the formation of Infrastructure Australia in 2008, the Commonwealth now provides support for urban public transport, with a list of priority public transport projects released (see Infrastructure Australia, 2009: 24–7). While supporting public transport investments, state government public spending seemingly retains its strong support of expanding and upgrading road infrastructure. In more recent times, particularly since 2000, public expenditure has been supplemented through various state-sponsored schemes for freeway building involving public-private partnerships.

Moriarty (2000) describes the historic changes in Australian cities in the post-war period; in 1947 each Australian travelled 3540km on average, comprising: Train: 1520km; Bus/ tram: 740km; Private vehicle: 1200km; and Air (domestic): 80km. By 1995, this distance had grown to 15,330 passenger/km/per capita, comprising: Train: 510km; Bus/ tram: 920km; Private vehicle: 12,400km; and Air (domestic): 1500km (Moriarty, 2000: 4). Moriarty and Honnery (2005) describe the transformation of Australia's urban transport that began in the late 1940s from public-transport domination to its current car-dependency. Examining the capital cities in the latter 1940s, they find that trips requiring vehicles were to the city centres as these locations were concentrated places of employment and retailing. There was considerable local transport during this time, for local shopping, services, and visiting, but these mobility needs were largely met by walking and cycling. As a result, personal travel distances by vehicles tended to be dictated by the distance of households to the city centre, although local geographic factors and the availability of rail services were influential.

Several factors are identified by Moriarty and Honnery (2005) as causing the shift to private motorcars for urban travel. One factor is that the expanding road network meant that the restrictions of the radial public transport system could be overcome, enabling for faster trips by car and access to greater locations within a time budget. Suburban growth reduced the importance of the CBD and city centre,

so that travel by car shows an association between higher speeds and greater annual travel. As the authors state (2005): 'Only for work trips to the CBD could public transport, especially rail, compete with car travel on speed.' Other instrumental advantages of car travel over public transport included greater security and privacy, greater all-weather comfort, and for children and goods transport. Despite the growth in travel distances by urban Australians, relatively little was for commuting or for education destinations; most has been discretionary car travel – as these new car trips were formerly local trips made by foot (Moriarty and Honnery, 2005).

At this time, per person urban travel may have reached, or is approaching, the level of stagnation. Partly this may be explained by travel time budgets, such as espoused in the Marchetti Constant, which holds that there is a fairly constant upper limit (1.5 hours/ daily) for the time devoted to travel. Metz (2008) offered empirical support for the concept of a 'travel time budget' from UK experience in *The Limits to Travel*, the implication of which is that time and distance are traded off, so that commuters 'invest' the opportunities for faster travel through public investments in freeways by undertaking journeys of greater distance. This interpretation is consistent with the findings of Moriarty and Honnery (2005) who identify an Australian urban trend during increasing car-dependency of greater distance travelled and greater average speed, but also state that average per capita travel – as distance – eventually stagnated.

#### 2.4 *Energy security and energy for transport*

As with much many features of contemporary views about energy policy, the implications of the security of supply came into clear view during the global oil crises of the 1970s. These crises highlighted the nexus between a high degree of dependency of the OECD nations on energy from a single form of energy and that oil reserves are concentrated in a relatively few locations outside the OECD.

Recently, the federal Department of Resources, Energy and Tourism released the *National Energy Security Assessment* (NESA) (DETR, 2009), which will be used in developing a new national energy policy. It defines energy security (DETR, 2009: 5): 'In the Australian context, energy security is defined as the adequate, reliable and affordable supply of energy to support the functioning of the economy and social development ...'. This is in line with conventional perspectives which typically tie energy supply to the goals of sustained economic performance and growth. Energy security is assessed currently, and in five, 10, and 15 year's time; for liquid fuels, energy security is 'high' for each time period, except for 2023, when it becomes 'moderate' (DETR, 2009).

Although some public transport runs on electricity and there are a few other very minor energy sources (such as LPG and NPG), it is a safe generalization that Australia's transport system is fuelled by oil.<sup>3</sup> Adequacy of energy supply for transport concerns the supply of sufficient energy for the current system to continue operating. Nationally, Australia has oil and gas reserves and these are mined and used in the transport sector. Our economic demonstrated reserves, as of 2006, were 173 GL of crude oil, 214 GL of LPG, 257 GL of condensate, and 2429 GL of natural gas (ABARE, 2008: 6). Domestic production is inadequate to meet demand and 53 per cent of crude oil and LPG is met by imports. Domestic reserves are in decline with crude oil production expected to decline over the coming decades. Future imported supply needs depend on the management of domestic production and total domestic demand; continuation of historic trends of increasing consumption of liquid fossil fuels will necessitate increased imports. Adequacy also embraces a depiction of demand; however, the NESA does not offer any information on this issue and depicts adequacy as being high because of supply-side conditions – including access to global markets, supply diversity, and increased regional refining capacity (DETR, 2009).

Reliability of supply, given the scenario of Australia's increasing future reliance on global markets for crude oil, will gradually become more of a function of global supply chains and less of domestic production. Through the long economic boom of recent years, global oil demand and supply has become increasingly tight, with strong upward pressure on prices. In the current Global Financial Crisis (GFC) demand has fallen – and the global oil prices have followed – lessening the competition for supply and thereby making greater supplies available. Doubtless the global economy will follow its long-run cycle and the GFC will be replaced by the next cycle of global economic growth in the next

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<sup>3</sup> 12 May 2009; Energy Information Administration, Available at: <http://tonto.eia.doe.gov/dnav/pet/hist/rbrted.htm>

few years and the intense competition for oil will resume as the supply and demand tension tightens again.

We can depict the global oil – both crude and refined products – market as a single entity possessed of aggregative qualities and build a picture of reliability of supply on this basis. In theory, this global perspective offers the virtues of a numerous and diverse set of suppliers, thus bolstering an optimistic outlook on future reliability. Other high-profile authorities share this outlook. *World Energy Outlook 2006* and *2007* consider that global production will satisfy global demand in the medium term (see, IEA, 2006, 2007). Similarly, the US Energy Information Administration (EIA 2005) considers global energy security to be relatively assured.

Affordability is the third element of energy security and, as with the other two dimensions, it involves subjective evaluation. Using the aforementioned NESAs definition (DETR, 2009: 5): '[A]ffordability is the provision of energy at a price which does not adversely impact on the competitiveness of the economy and which supports continued investment in the energy sector.' For households and firms the cost of energy for transport is the most obvious and pressing of the energy security issue, which for the most part means the cost of petrol and the other oil-based fuels. Prompted by the global oil crises of 1973 and 1979, the world's nations relying on imported oil have been made acutely aware of the laws of supply and demand on price. Frequent predictions have held that as global oil reserves dwindle, price will escalate, but this effect has been difficult to detect unequivocally, in no small part because global production is dictated largely by a cartel (i.e., OPEC) – and 'partial-monopoly' market conditions.

Since its formation in the mid-1960s, much of volatility of global oil price has resulted from the influence of OPEC. In the 1970s when OPEC had over 45 per cent of the global production, prices tended to be high, when this share fell in the 1980s, price also fell. Global oil prices remained low through the 1980s and 1990s (US\$20/bbl or lower), and although somewhat volatile through the 2000s, prices escalated rapidly, exceeding US\$130/bbl by mid-2008 (see Figures 1 and 2 for the two commonly-used 'marker' prices). In the wake of the GFC, global prices are less than one-half of last years'; at the time of writing the spot price is US\$53 a barrel.<sup>4</sup> Critical to understanding the implications of higher costs for imported oil is that the export of capital is a direct economic cost to the national economy – and a direct economic benefit to the exporter.



**Figure 1 Daily Europe Brent Spar spot price, US dollars per barrel, May 1987–May 2009**

Source: U.S. Dept. of Energy, Energy Information Administration; Accessed 12 May 2009.

Available online at: <http://tonto.eia.doe.gov/dnav/pet/hist/rbrted.htm>

<sup>4</sup> 12 May 2009; Energy Information Administration, Available at: <http://tonto.eia.doe.gov/dnav/pet/hist/rbrted.htm>



**Figure 2 Daily Cushing Oklahoma West Texas intermediate spot price FOB, US dollars per barrel, December 1985–May 2009**

Source: U.S. Dept. of Energy, Energy Information Administration; Accessed 12 May 2009.  
 Available online at: <http://tonto.eia.doe.gov/dnav/pet/hist/rbrted.htm>

Some commentators in Australia and overseas don't share the NESAs optimism regarding Australian and global energy security. To begin, to believe that the cost of imported oil will be affordable in the future (i.e., 'affordable' means without causing disruption to the national economy) is to assume something of the character of future price increases and the capacity of the economy to respond. Offsetting this view is the influence of geo-politics; global reserves and production are overwhelmingly concentrated in relatively few nation states. According to the *BP Statistical Review of World Energy 2008* OPEC had about 76 per cent of the world's proven oil reserves in 2007 and 43 per cent of 2007 production (BP, 2008: 6 and 8). Further, developing nations in the non-OPEC group also have significant reserves. Future increased global oil demand is expected to be met by increasing OPEC production (IEA, 2007). Under the assumptions of NESAs (DETR, 2009), during the forecast period OPEC, for instance, will not replicate its behaviour of the 1970s nor will there be political instability that will significantly interrupt production in the key production regions – which includes prominently the nations of Kuwait, Nigeria, Iran, Iraq, Saudi Arabia, United Arab Emirates, and Venezuela. Higher future prices certainly have the potential for domestic economic loss through transfer of wealth overseas, through higher costs for domestic production, and for costs created by rapid and high increases in costs ('disruption costs') – as opposed to slower and predictable price rises which can be more readily absorbed. NESAs formulation of energy security as a supply-side issue neglects the place of demand and the association that, as domestic demand grows, so does the national dependence on imported oil.

### 2.5 *The end of cheap oil*

Expiration of abundant mineral resources never occurs in a strict sense, rather the costs and difficulties of obtaining increasingly scarce resources become unacceptable. Australia, along with most other nations of the developed and newly industrialized world, has contemplated the expiry of the world's oil resources over many decades.

During the oil crises of the 1970s and the associated global economic recessions caused by restrictions in Middle East oil supply and later during the Iran–Iraq war, the prospect of the world running out of oil caught the attention of governments, corporations, and the general public alike. This coincided somewhat with the burgeoning environmental movement and the debates it spawned over resource conservation. More recently, the escalation of oil prices and global demand combined with the decline of reserves in several nations has rekindled wider interests in future oil supply and the ultimate question about the availability of oil in the future.

Opinions differ over the size of available global oil reserves. Most of this difference concerns the estimates of known reserves, particularly the largest, rather than speculations over the discovery of further reserves. Moreover, independent assessment of many reserves is difficult and some observers believe that there are considerable economic incentives for oil-exporting nations to exaggerate the scale of their reserves, leading to global reserve over-estimation (Deffreyes, 2001). OPEC and Saudi Arabian estimates have, in particular, been subject to scepticism (e.g., Salameh, 2004). Similarly, the same

incentives apply to major oil corporations; Royal Dutch/Shell's January 2004 downward revision of its estimated proved oil reserves by one-fifth proved expensive for the corporation with the resulting fall in its stock market value; BP followed suit soon after with a downward revision of its own reserves. One simple indicator of the scale of these reserves is the rate of discovery of new fields, and while this rate can reflect variations in investment in exploration over shorter time periods, the longer trends are indicative of the size of reserves. It is clear that the era of finding significant new fields is now long past; global oil discoveries peaked several decades ago. As Heinberg (2004) observes, today's rate of oil consumption exceeds the rate of discovery of new oil by several fold.

Measurement of oil production is less contentious than reserve estimation and provides an insight into the condition of the reserves. Although there are a great number of oil fields globally, the bulk of production is from a relatively few very large fields. Production figures are used in the scenario of 'Hubbert's Peak' to predict overall production within a region comprising a number of wells, an approach that has been applied to global oil production. Hubbert's Peak holds that aggregate production in a region will follow a bell curve, so that once peak output occurs future production declines, so that predicting the decline in global oil output can be reckoned once the point of maximum output is identified and total reserves estimated. Developed by its namesake, Hubbert successfully predicted the path of US oil production, whose peak output occurred in 1971 and after which it declined. It follows that once peak output occurs, reserves are about one-half depleted.

Campbell and Laherre (1998), Deffreyes (2001), and others believe that global peak production has already occurred or is imminent because the majority of the major producers have passed their peak output. Not surprisingly, the claims of peak oil advocates that global oil production is in decline are disputed. Some critics hold that large new fields await discovery, but this seems entirely contrary to the established trend of declining discovery, but the other counter-claims have more substance. Technological improvements will increase the volume of recoverable oil, thereby extending production, it is argued. Campbell and Leherre (1998) agree to some extent, but consider the gains to be modest and suggest to some extent such expectations are already built into the reserve estimates. Replacing conventional oil with exploitation of abundant unconventional oil reserves – such as from tar oils and oil shale – could greatly extend the age of oil, runs the other counter argument. Campbell and Leherre (1998) doubt that unconventional resources will be developed with sufficient speed and extent that the gap of declining conventional production can be filled; further, they note that high environmental costs of extraction and processing will slow development.

To return to the proposition stated above, the issue of declining oil production is not that oil will disappear, but rather that the laws of supply and demand mean that declining supply and increasing demand mean that there will be no cheap oil on the global market. Estimates by the US Energy Information Administration (EIA, 2005) of future global demand forecast consumption to reach 103 million barrels a day by 2015 and 119 m/b/d by 2025, the latter of which is 50 per cent higher than that of 2002. It is in this highly competitive future market that Australia will be purchasing oil; predicting future prices is extremely difficult, but it is safe to say that last year's record spot price of over US\$130/bbl will be easily exceeded in coming decades. CSIRO's (2008) *Fuel for Thought* suggested a possible future petrol price of AUD\$8/l by 2018, for example. Oil from unconventional sources will supplement increasingly scarce conventional supplies, but will not provide price relief as unconventional sources only become economically viable when conventional oil carries a high price. Given the attributes of oil as a transport fuel – such as its high energy density, relative ease of transport and storage, ease of transformation into energy for mobility – the end of cheap oil seemingly implies the end of cheap motorized mobility. Of course, some might argue that oil has never been cheap, but rather it is a commodity whose price has never reflected the social and environmental costs of its use in the transport sector.

Under long-standing national policy, petroleum prices in Australia track international crude oil prices, whether sourced locally or from imported products or feedstock. Australia both exports and imports crude and refined products, essentially because local production does not match local requirements. As stated above, Australia is a net importer – primarily from Vietnam, Malaysia, and Indonesia – and increasingly so, as reserves decline. Under the Import Parity Pricing policy (begun in 1977), the national fuel price is based on the price of imported refined petrol, to which is added an excise duty (about 38.1 cents/litre) on imported fuel and the same amount on local fuel; the national Goods and Services Tax is also applied (a flat 10 per cent of the retail price) (ACCC, 2007). Since 1988 petrol and

diesel prices have been deregulated, but some states have retained regulatory powers over pricing (ACCC, 2007).

As a result of the IPP policy, the value of the Australian dollar, taxation, and the international price of oil, retail costs for petrol basically doubled over the past decade before the recent effects of the GFC. In the mid-1980s, national retail prices were around AUD\$0.70/litre for unleaded petrol and climbed to around AUD\$1.50/l by mid-2008, based on price surveys. Much of this increase occurred relatively quickly, prompting considerable public and governmental attention. Indeed, there were worldwide protests over the cost of fuel in May and June 2008. Despite local protests over petrol prices and calls for petrol tax relief, Australia enjoys low fuel prices because of its relatively low petrol tax regime. Nearly every other OECD nation has higher fuel charges than Australia.<sup>5</sup>

Refining in Australia occurs under an oligopoly of four refiner-marketers (BP, Caltex, Mobil, and Shell have 98 per cent market share) (ACCC, 2007). Production activity, therefore, is highly concentrated; see Table 9.

**Table 9 Australian refinery capacity, 2006/07, megalitres per annum**

	Operator	Year commissioned	Capacity (megalitres per annum)
<b>New South Wales</b>			
Clyde	Shell	1928	4980
Kurnell	Caltex	1956	7220
<b>Queensland</b>			
Bulwer Island	BP	1965	5125
Eromanga (mini refinery)	IOR	1985	85
Lytton	Caltex	1965	6120
<b>Victoria</b>			
Altona	Mobil	1949	7800
Geelong	Shell	1964	6960
<b>Western Australia</b>			
Kwinana	BP	1955	8010

Source: Abridged from: Australian Bureau of Agricultural and Resource Economics (2008) *Energy in Australia 2008*, Canberra: ABARE: Table 19.

High retail prices for petrol brought protestations in the community and calls for government action, with some seeking taxation relief. One response by the federal government occurred in June 2007 with the Australian Competition and Consumer Commission inquiry into the price of unleaded petrol (ACCC, 2007). In 2008, the federal government attempted to introduce a national fuel price monitoring known as 'FuelWatch'; a similar institution has operated in Perth for several years, although it is unclear whether it has exerted any market influence in lowering prices in that city. In any event, the federal Senate rejected the FuelWatch Bill in November 2008.

## 2.6 Federal system of governance of urban transport and climate change

In Australia, both the climate change and transport policy realms are crowded with initiatives that are rarely subject to formal coordination and, moreover, often operate in contradiction to each other and to other important policies. Two features are critical to understanding climate change policy and the urban transport sector. First, there are the problems of attempting to understand this system of governance as a coherent and rational arrangement of institutions and expressions of authority. There are the constraints and complications of the federal system of government, with three spheres – Commonwealth, state/ territory, and local – of policy formulation, policy implementation, financial resources, political stakeholders, and political accountability. There are no comprehensive accounts of the institutional arrangements of the transport and climate change policy functions across the nation; we don't know, for example, how many of the 700-odd local governments have climate change strategies and policies. Second, the bulk of strategy and policy that comprises the climate change

<sup>5</sup> See Department of Industry Tourism and Resources Australian Petroleum Statistics and the International Energy Agency.



policies of Australian governments involves a wide range of portfolios and has largely, up to the present, simply incorporated existing policies and initiatives in these portfolios, particularly in energy, transport, urban planning, and environmental protection. Undertaking an audit of these initiatives at the federal and state levels is a task bordering on the impossible, given the paucity of publicly available public financial reporting data across the nation.

Federal government climate change policy concentrates on international relations and national environmental policy, specifically the GHG emissions inventory, climate change science and impacts research, and several relevant national standards and guidelines for equipment and services. State/territory governments are responsible for the delivery of most of the functional services – including education, energy, emergency management and state policing, environmental protection, health, law enforcement, land planning, most public land management, urban and regional transport, and water supply. It follows that states/territories have the most direct influence over GHG emissions through existing political and administrative apparatus. Of the three spheres, arguably it also the states/territories that will have the greatest governmental responsibility for dealing with climate change impacts, and therefore will also have the greatest role in adaptation strategies and responses. Importantly, state government also has the primary responsibility for urban land use planning policy and transport planning. Local government provides primarily local services, including community health, local parks and recreation, local planning, local roads, waste collection. This sphere of government can, therefore, play an important role in aspects of GHG emissions mitigation and has an interest in avoiding certain climate change impacts.

#### *Commonwealth climate change policy*

Australia's first national policy was the *National Greenhouse Response Strategy* (COAG, 1992) which, as an output of the Council of Australian Governments, represented the views of federal, state/territory, and local governments. It featured voluntary measures and 'no regrets' policies, meaning that policies had net benefits in addition to addressing climate change. In 1995 an additional *Greenhouse Challenge Program* involved industries volunteering to reduce GHG emissions and was a central element of the government's *Greenhouse 21C* policy.

Under the incoming federal coalition government, *Safeguarding the Future: Australia's Response to Climate Change* was released in 1997, establishing the Australian Greenhouse Office and putting forward a package of AUD\$180m of climate change measures. In the following year a new *National Greenhouse Strategy* (COAG, 1998) was released. And in 1999, an additional financial package was released, known as *Measures for Better Environmental Program*, with some AUD\$655m for climate change and energy policies and programs.

In 2007, the Howard Government released *Australia's Climate Change Policy* (Australia, 2007). Key features of the policy included commitments to set an emissions reduction target in 2008, establishing an emissions trading scheme by 2012, continued support for established programmes of research and development in climate change and energy sector, and support for a national programme and flagship on climate change adaptation.

The election of the Rudd Labor government in November 2007 brought several changes to national climate change policy. At the COP meeting in Bali later that year, the government announced that it would ratify the Kyoto Protocol and thereby accept the national emissions reduction target set by the protocol. A Department of Climate Change was created and a Minister appointed. Priorities are described in the Department's 2009/10 budget statement (DCC, 2009) which states that the CPRS will be the primary means to reduce GHG emissions, with the funds garnered being directed towards 'a low pollution future' (AUD\$4.5b in year #1 and AUD\$13b in year #2) (DCC, 2009). Other initiatives include: a revised Renewable Energy Target Scheme of 20 per cent of electricity supply by 2020, a AUD\$4.5b Clean Energy Initiative – covering renewable energy research and carbon storage research – and a National Energy Efficiency Initiative. Relating specifically to transport, under the government's AUD\$6.2b New Car Plan for Greener Future initiative, AUD\$1.3b is allocated over 10 years to improve fuel efficiency, starting in 2009 (DCC, 2009). Holden have been given AUD\$149m to develop a fuel-efficient small car and Toyota AUD\$35m for the manufacture of the hybrid Camry model (DCC, 2009). In addition to the Kyoto Protocol GHG target, the government has set a long-term target of a 60 per cent reduction of 2000 levels by 2050.

### *State/Territory and local government climate change policy*

Each state and territory has some form of climate change strategy, although these are not coordinated or integrated either with each other or with the national policies, other than sharing a common emissions reduction target. At the 2007 Council for the Australian Federation (CAF), the states/territories adopted a uniform target of 60 per cent reduction from the 2000 levels by 2025 as part of its commitment to national carbon emissions trading (CAF, 2007). An account of best practice climate change policies by the states and territories was published by CAF (2008), including planning and transport sector initiatives.

With more than 700 local government areas in the nation and there being no single body with policy oversight of these bodies, there can be no easy reckoning of the status of climate change policy. A couple of bodies can provide some guidance, however. Under the ICLEI–Local Governments for Sustainability is the Cities for Climate Protection programme; there are over 230 participating local governments in Australia, although after 12 years, this voluntary programme will end in mid-2009 (ICLEI Local Governments for Sustainability, 2008).<sup>6</sup> As part of the Cities for Climate Protection there is the Australian Mayors Council for Climate Protection. Additionally, there is the Australian Local Government Association – which represents more than 600 councils – and there are state-based organizations representing local governments, although not all councils are necessarily members of these groups. These groups do not provide information on specific programmes or overviews of local government activity, save for isolated case studies and the like. Many local government programmes are only directed at the activities of the council itself, while some aim to reduce emissions from the whole municipality.

### *2.7 Social and environmental costs arising from urban transport*

In addition to its contribution to global warming, there are a number of other social and environmental costs generated by urban transport. Arguably, these costs have rarely been directly met by transport users. One exception was the phase-out of leaded petroleum in Australia in 2002 to reduce the health impacts, particularly the effect of elevated bloodstream levels in children, where the higher fuel costs are paid by fuel consumers.<sup>7</sup> Another example might be the state and national efforts on transport safety, covering vehicle design, vehicle certification and regulation, infrastructure design, construction, and maintenance, research and monitoring, and policy formulation and implementation. However, the majority of the public costs of transport safety investments are borne by taxpayers, rather than directly by transport users. As a generalization, the social and environmental costs of transport are externalities to transport users.

Before addressing these social and environmental costs, an outline of the direct costs of transport may be useful. Urban transport using private motor vehicles imposes considerable direct financial costs on many of its users. In Australia's car-dependent cities, to enjoy the mobility required to access employment, services, such as health and education, shopping and commerce, administration, recreation and social activities, often requires access to a motor vehicle. Some insight into these costs is shown in the latest survey of Australian household expenditure, for 2003/04, where transport costs were the third-highest expenditure group (after food and housing costs at #1 and #2) at AUD\$139 average weekly expenditure, comprising 15.6 of total spending on goods and services (housing costs: 16.1 per cent and food and non-alcoholic beverages: 17.1 per cent) (ABS, 2006: Table 1). By way of reference, mean gross household weekly income in Australia in the same period was AUD\$1128 (ABS, 2006: Table 2). An indication of typical vehicle costs – covering major items such as depreciation, registration, maintenance repairs, and fuel – is provided by the National Roads and Motorists Association: For these vehicle types travelling 15,000km annually using the fuel costs of 2008 (e.g., PULP: AUD\$1.61/l) over five years and purchased from new were: Light: AUD\$129/week; Small: AUD\$148/week; Medium: AUD\$193/week; Large: AUD\$222/week; and Sport utility vehicle (medium-sized): AUD\$219/week.<sup>8</sup> Annualized, such a medium-sized car would cost a household some AUD\$10,036.

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<sup>6</sup> Available online at: [http://www.iclei.org/index.php?id=ccp\\_australia\\_home](http://www.iclei.org/index.php?id=ccp_australia_home)

<sup>7</sup> Under the *National Fuel Quality Standards Act 2000*.

<sup>8</sup> NRMA, 2008 Car Operating Costs, Available at:

[http://www.mynrma.com.au/cps/rde/xchg/mynrma/hs.xsl/about\\_operating\\_costs.htm](http://www.mynrma.com.au/cps/rde/xchg/mynrma/hs.xsl/about_operating_costs.htm)

A large number of studies have identified a range of these social and environmental costs:

- *Transport trauma and fatalities*; nearly all results from road transport (see, e.g., ATSB, 2007; Dora and Phillips, 2000).
- Motorized transport is a major source of urban *air shed pollution*, notably over the larger cities, comprising airborne emissions dangerous to human health – notably carbon monoxide, nitrogen dioxide, ozone, benzene, and fine and coarse suspended particulates (BTRE, 2005b; Ciccone et al, 1998; Dora and Phillips, 2000; Krzyzanowski et al, 2005); in addition to routine pollution, there are smog events (e.g., in Victoria, Melbourne/Geelong had 29 smog events in 2006 and 19 in 2007, according to the state’s Environment Protection Authority).
- Motorized transport generates considerable *noise pollution* in urban areas and can lower quality of life and may contribute to diminished physical and psychological health (Dora and Phillips, 2000).
- *Ecological losses* result from transport system construction and operation, such as watercourse pollution from surface runoff from paved road and parking areas, the loss of native vegetation and areas of ecological value during freeway construction, and habitat fragmentation and disturbance (Spellerberg, 1998).
- *Urban amenity* can be reduced through transport corridors and vehicle use, such as through the generation of noise and visual pollution, the loss of open space for roads and car parks, the loss of pedestrian access, and the high proportion of urban land devoted to motorized transport and motor vehicles.
- *Inefficient energy use* is itself an environmental cost, as it necessitates avoidable fuel production, shipping and transfer, and storage, all of which generate associated environmental costs and unnecessary material consumption and throughput.
- *Inequitable access to mobility* results from urban transport systems that have neglected collective transport in favour of private (motorized) transport. For those without access to a car – about one-third of Australians who aren’t able to drive because of their age, mobility restrictions, or are without a vehicle. Higher fuel costs combined with high home mortgage commitments and the lack of access to public transport has produced an outer-suburban ‘oil vulnerability’ (Dodson and Sipe, 2008).
- Another social cost of inadequate public transport services is *social isolation* and loneliness (Stanley and Stanley, 2007; Stanley and Lucas, 2008).
- An indirect consequence of increased car-dependence is the health effects of reduced active transport and a sedentary lifestyle which has been associated with the rise in obesity, cardiovascular disease, diabetes, and hypertension (Earls et al, 2005; McCann and Ewing, 2003); the reduced mobility of children has received particular attention (Mackett et al, 2002).

Ideally, a national emissions trading scheme (NETS) will promote environmentally sustainable transport and thereby address these other social and environmental costs arising from conventional transport policies and practices. Broadly, such an outcome would be expected according to the economic theory underlying the NETS, because making the price of mobility using fossil fuels less attractive – in an economic sense – will promote: fewer motorized journeys of reduced length and duration, use of more fuel-efficient and alternative-fuel vehicles, greater use of collective transport, more passengers per vehicle, and more walking and cycling. However, to be effective, a NETS must produce a net GHG emissions saving, i.e., it needs to be without significant perverse incentives. Further, the reduction of environmental costs of transport should ideally not produce greater social costs. This latter requirement may be quite difficult given that the NETS uses higher prices to change consumer behaviour – for moving passengers and freight. As an economic instrument, a NETS can also ameliorate the environmental and social costs of transport through investment of the funds gathered by the state through the sale of emission permits. Income generated by a NETS can be directed towards policies and programmes to reduce these environmental and social costs.

### **3 Carbon pollution trading scheme**

#### *3.1 Carbon emission trading and Australia: a brief history*

At the conclusion of the international negotiations over how to implement the United Nations *Framework Convention on Climate Change* at the third Conference of the Parties (COP-3) in Kyoto the basic approach had been determined and the decision to use market-based policy approaches was

cemented in the form of the *Kyoto Protocol*. Under the *Kyoto Protocol* all the essential elements for a global system for trading GHG emissions were established. These elements included identification of the GHGs to be reduced, a system to evaluate different GHGs, setting of individual national targets for GHG reduction, a timetable for GHG emissions reduction, and a system for GHG accounting and reporting. Only developed nations are given emission reduction targets – these nations are listed in the Protocol.

Most political attention given to Australia's position during COP-3 at the time focussed on the emissions reduction target it had negotiated, it being one of the few nations allowed an increase of emissions. Under the *Kyoto Protocol*, Australia was to achieve total GHG emissions that were 108 per cent of its 1990 emissions by 2008–2012. Australia benefited from the decision under the Protocol that GHG emissions from land use be included, as this particular source was high in Australia during the baseline year (1990) due to widespread vegetation clearance, but this activity that had been subsequently greatly curtailed under state government legislation limiting native vegetation removal. As a consequence, whereas most nations had to seek GHG mitigations from the energy-related sectors, Australia would be largely obviated of this difficult task in efforts to meet national GHG emission targets. Environmentalists and other critics highlighted the inability of the *Kyoto Protocol* to require significant GHG emissions reductions in Australia.

In order for the *Kyoto Protocol* to come into force as a binding international agreement (i.e., *ratification*), sufficient nations with sufficient net GHG emissions had to sign; opened for signatures in 1997, ratification was achieved in early 2005 after many years delay. Australia refused to ratify the Protocol under the four-term Howard federal government (1996–2007); with the election of the Rudd government in late 2007, ratification occurred shortly afterward. Although the Howard government's position on climate change drew considerable disapprobation from its critics, much of this political rhetoric was a sideshow to the reality that the federal and state governments continued to make steady progress in developing GHG emissions trading system entirely in accordance with the goals of the *Kyoto Protocol*. Very little criticism was directed at the use of market-based policies as an effective policy tool to address climate change. Australia also continued to participate fully in the UN FCCC activities and to comply with the requirements of the Protocol – such as reporting on its GHG emissions – and other agreements, as if it had ratified the Protocol.

There were several key aspects of this activity to develop emissions trading. In 1998 the Commonwealth Government House of Representatives Standing Committee on Environment and Heritage conducted the 'Inquiry into the Regulatory Arrangements for Trading Greenhouse Gas Emissions' which recommended early trialling of emissions trading in Australia (Senate Standing Committee on Environment and Heritage, 1998). New South Wales independently launched the NSW Greenhouse Gas Abatement Scheme (GGAS) in 2003. Under the Council of Australian Governments, the states – using the advantage of the majority being of the same political party – created the National Emissions Trading Taskforce (NETT) which undertook activity on a National Emissions Trading Scheme (NETS). This group established much of the intellectual and practical foundations for GHG emissions trading in Australia in its 2006 discussion paper (NETT, 2006) and then in its framework report (NETT, 2007). There was also a Prime Ministerial Task Group on Emissions Trading and their final report canvassed key issues for Australia (PMTGET, 2007). A part of the output of these groups was supported by federally funded research by consultants (e.g., Allen Consulting Group, 2001, 2004) and government agencies. Finally, the national climate change policy announced (Australia, 2007: vi): 'The Government will introduce an emissions trading scheme, no later than 2012, as the primary mechanism for achieving the long term emissions reduction goal.'

While in Opposition, the Australian Labor Party, commissioned (in April 2007) the well-known economist Professor Ross Garnaut to investigate the national response to climate change. Around this time, the British government's climate change policy advisor, Sir Nicholas Stern – also an economist – published a major work espousing the extensive use of market-based policy tools to address climate change (Stern, 2006). On assuming office, Rudd government made the Garnaut project into an official inquiry, the Garnaut Climate Change Review. Following extensive consultation, public meetings, publication of several issues and working papers, the *Final Report* (GCCR, 2008) was published in September 2008. Intellectually, the Garnaut review produced an antipodean's version of the Stern Report promoting the introduction of national GHG emissions trading scheme.

Outputs from the Garnaut Review bolstered the federal government's efforts to produce a national

emissions trading scheme. In forming the new Ministry, the Government created a Ministry for Climate Change and a new Department of Climate Change under Minister Penny Wong, reflecting the emphasis that the ALP had placed on the issue in its election campaign. Work on developing emissions trading continued and soon in the term of the new government, Minister Wong announced the forthcoming Carbon Pollution Reduction Scheme (CPRS). This was to follow the usual procedures of green and white papers, followed by legislation.

Until recently, this activity had broadly followed the announced timetable, with implementation of the scheme due in 2010. A *Carbon Pollution Reduction Scheme Green Paper* (DCC, 2008b) was released in July 2008 and the two-volume *Carbon Pollution Reduction Scheme: Australia's Low Pollution Future White Paper* (Australia, 2008) in December 2008. Also in December 2008, the government released its economic modelling of the CPRS: *Australia's Low Pollution Future: The Economics of Climate Change Mitigation*, together with nine consultant's reports. In early May 2009, Prime Minister Rudd announced a one-year delay for the CPRS 'to manage the impacts of the global recession'; it is to be phased in from July 2011.<sup>9</sup>

Particular attention has been given to the emissions reduction target. Under the CPRS, the target was an unconditional 5 per cent below 2000 levels by 2020. Under the revised timetable for the CPRS the Government announced a revised emissions abatement target. In the words of the Prime Minister's *Press Release*:

The Rudd Government has today committed to reduce Australia's carbon pollution by 25 per cent below 2000 levels by 2020 if the world agrees to an ambitious global deal to stabilise levels of CO<sub>2</sub> equivalent at 450 parts per million or lower by mid century.<sup>10</sup>

Such a target would be met through the CPRS, an expanded renewable energy target, investment in renewable energy, carbon capture and storage, and energy efficiency measures. A further concession was fixing the carbon permit price under the CPRS at AUD\$10/tonne for the first year of the scheme (i.e., July 2011–July 2012); the trade-exposed emissions intensive industries group will receive further assistance in the form of free permits and AUD\$22m will be available for business under the Climate Change Action Fund.<sup>11</sup>

There are two federal Senate inquiries into the CPRS. First, the Senate Economic Committee (under the Economics legislation sub-committee) is conducting the Inquiry into the Carbon Pollution Reduction Scheme Bill 2009 and Related Bills<sup>12</sup> – which comprise some 11 bills in all – to report in mid-June 2009. Second, the Senate appointed the Select Committee on Climate Policy to inquire into climate change policy, specifically the choice of emissions trading as the nation's central policy tool, the role of complimentary policies, whether the CPRS will be effective in meeting emission targets, considering equity dimensions of global emissions reduction, and the impact on the creation of 'green' employment.<sup>13</sup> This Inquiry is also to report in mid-June and received over 8000 submissions.

### 3.2 *CPRS: an overview*

Based on several prior reviews, the Garnaut Review, consultancy reports, commissioned research, the Green Paper on the CPRS and the submissions and other advice, the government released the White Paper on the CPRS. Emissions trading schemes for GHG are highly complicated affairs, given that their role is to place a price for carbon emissions and create a market for emissions trading that is integrated into the national and, ultimately, the global economy. Further, this market activity does not seek merely to benefit the participants, but ultimately seeks to curb the emissions under the rubric of the 'cap and trade' model of emissions trading.

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<sup>9</sup> Press Release. Prime Minister, Treasurer, Minister for Climate Change and Water, 'New measures for the carbon pollution reduction scheme', 4 May 2009.

<sup>10</sup> Press Release. Prime Minister, Treasurer, Minister for Climate Change and Water, 'A new target for reducing Australia's carbon pollution', 4 May 2009.

<sup>11</sup> Press Release. Prime Minister, Treasurer, Minister for Climate Change and Water, 'Carbon Pollution Reduction Scheme: Support in managing the impact of the global recession', 4 May 2009.

<sup>12</sup> [http://www.aph.gov.au/senate/committee/economics\\_ctte/cprs\\_2\\_09/index.htm](http://www.aph.gov.au/senate/committee/economics_ctte/cprs_2_09/index.htm)

<sup>13</sup> [http://www.aph.gov.au/Senate/committee/climate\\_ctte/index.htm](http://www.aph.gov.au/Senate/committee/climate_ctte/index.htm)

Designated companies and facilities that release GHG to the atmosphere are required to purchase a permit for these emissions, based on one permit for each tonne released annually – as carbon or the equivalents (as CO<sub>2</sub>-e), thereof. There are a limited number of permits made available each year and the total of emissions permitted are therefore ‘capped’ in this way. At the end of each compliance period (one year), the firms and facilities are required to surrender a permit for each tonne of CO<sub>2</sub>-e released during that year.

Participants in the trading scheme are allowed to trade permits. In the most basic model, those whose emissions have exceeded the number of permits held can make up the shortfall through purchasing additional permits from other participants in the trading scheme. And those whose emissions are less than the permits held can capitalize on the potential value of these surplus permits through their sale in the marketplace. Investments by participants can reduce their GHG emissions, therefore reducing the need to hold permits; in this way, the ETS offers an incentive for emissions reduction. Participants can make economically rational choices as to the optimum strategy in choosing between emissions reduction through abatement or through permit purchase/sale. It follows that emissions-intensive goods and services will become more expensive relative to those with a lower emissions intensity, thereby sending a price signal to consumers to favour less emission intensive consumption. A key rationale for emissions trading is the market ensures that the cheapest abatement measures are undertaken first, thereby ensuring the least cost to the national economy. Permit prices are those established by market trading.

Specifically, key details of the CPRS include (Australia, 2008) are:

- It will be a ‘cap and trade’ system, with Government-issued permits to polluting industries issued up to an agreed cap (as of 2012 a carbon tax without a cap, but phasing into a ‘cap and trade’)
- All six Kyoto Protocol gases are covered by the CPRS.
- Every tonne of GHG emissions by participants will require a permit and there will be monitoring verification, reporting, and auditing provisions.
- Participants will be required to surrender a permit for each tonne of emissions emitted.
- About 75 per cent of Australia’s emissions will be covered by the CPRS.
- Entities with direct emissions above 25,000 tCO<sub>2</sub>-e annually will included in the CPRS; this is about 1000 firms and facilities.
- There is broad sectoral coverage, including stationary energy, transport, fugitive, industrial processes, waste, and forestry.
- Agriculture will not be included; a review will determine whether it might be included from 2015.
- Deforestation will not be included.
- Permits can be banked indefinitely; i.e., there is no expiry date.
- Market oversight will be provided by the Australian Securities and Investments Commission with powers to investigate and prosecute market malpractice.
- A price cap of AUD\$40 tCO<sub>2</sub>-e will be set for the first five years, rising at 5 per cent per annum (since amended, see above).
- Scheme caps will be set five years in advance, extended by one year, every year – these will be set with ‘gateway’ ranges.
- Participants will be able to trade within international schemes without quantitative restraint; these cover the mechanisms under the Kyoto Protocol, emissions trading, and two project-based schemes: the Clean Development Mechanism and Joint-Implementation.
- Export of CPRS permits is not allowed at this time.
- Most permits will be auctioned, but around 25 per cent will be allocated to EITE activities.
- All revenue from the CPRS will be used to assist in household adjustment to the CPRS and for investing in ‘clean energy’.

Provisions applying to assistance are worthy of particular attention; the *Green Paper* provisions for the EITE firms and facilities attracted considerable submissions to the government and media coverage. Although the *White Paper* recounts the government’s economic studies that found that few industries were likely to migrate overseas as a consequence of a national ETS – thereby causing ‘carbon leakage’ from a ETS: ‘Nevertheless, the Government intends to guard against the risk of carbon leakage and provide some transitional assistance that will help protect jobs in those important industries while also encouraging these industries to make a contribution to Australia’s emissions reductions.’ (Australia,

2008: xxxiii). Translated, ‘transitional assistance’ means the free allocation of permits to the EITE industries.

A number of concessions were made to the EITE industries in the *White Paper*, outlined below, following the response to *Green Paper* – as described above, further concessions were made following release of the *White Paper*. ‘Trade-exposure’ was defined as having a trade share (i.e., the import/export value: domestic production value ratio) greater than 10 per cent in recent years (Australia, 2008). ‘Emissions intensity’ is assessed on the emissions-to-revenue or emissions-to-value added above a threshold level, using historic averages for a particular industry.

Strongly affected industries are also to receive assistance, but in this case, only one industry will receive such help: coal-fired electricity generators, on the rationale that they cannot pass on the costs of an ETS. Under the so-called Electricity Sector Adjustment Scheme, a once-off payment comprising a fixed allocation of permits will be made, with a value of around AUD\$3.9b. This assistance won’t apply to all generators, but to those above a threshold level of emissions intensity – namely the average emissions intensity of all fossil fuelled generators: 0.86 tCO<sub>2</sub>-e/MWh.

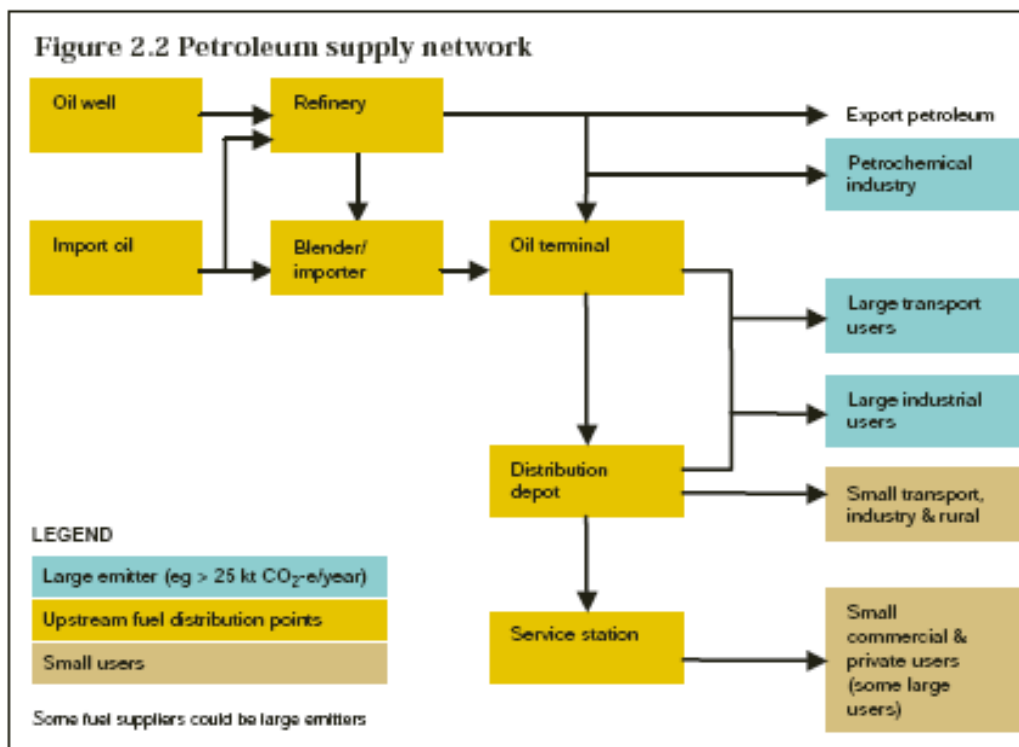
Transport fuels also receive special treatment. Federal fuel taxes will be cut on a cent-for-cent basis to negate the effect of the CPRS on fuel prices, with these reductions being made permanent after three years. A new ‘CPRS fuel credit’ scheme will also be introduced for agriculture and fishing businesses for three years and there will be one-year scheme for heavy on-road transport. A fuel credit scheme will also be introduced for three years for LPG and for one year for CNG and LNG.

### 3.3 *CPRS and the transport sector*

That Australia’s NETS should include all economic sectors was a principle espoused in essentially all the major preliminary investigations by the government and by the Garnaut Review, and the Green and White papers adopted this principle and included the transport sector in the CPRS. Having made such a decision, the government then determined that it would apply the CPRS to the ‘upstream’ providers, namely the refineries and marketers. Figure 3 (below), from the *Green Paper*, depicts the structure of the transport fuel distribution system and the division applied to upstream and downstream entities. As raised in a Department of Climate Change Issues Paper (DCC, 2008c), the prospect of high transaction costs was a factor in deciding to delimit the ETS to the large unit GHG emitters in the sector and to forgo individual downstream consumers.<sup>14</sup>

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<sup>14</sup> One English study of GHG emission allocations to individuals speculated that using contemporary information technologies, such as ‘smart cards’, the transaction costs of individual carbon allocations and debits need not be high, see Starkey and Anderson (2005).



**Figure 3 Distribution network for standard petroleum products**

Source: Department of Climate Change (2008b) *Carbon Pollution Reduction Scheme: Green Paper*, Canberra: page 110.

Several important issues are canvassed in the *Green Paper* and, by and large, the policy positions expressed there were endorsed by the *White Paper*. On the question of the elasticity of transport to price signals, the *Green Paper* states that (DCC, 2008a: 16):

It is often claimed that transport is unresponsive to changes in prices. The evidence indicates that people respond slowly to price changes when making their transport decisions, but that over time price changes affect their decisions. The results of international studies vary, but show that a ten per cent increase in price leads to a fall in transport fuel use in the longer term of up to ten per cent. Australian studies have come up with lower figures, but those studies have all been conducted in periods with more stable and much lower prices. The key is to encourage consumers to adopt greater fuel and energy efficiency measures over time.

Being 'mindful of the adjustment costs facing Australian households and businesses' the Government proposed to cut fuel taxes to exactly offset the costs of CPRS on transport fuel in the *Green Paper*, a position subsequently endorsed in the *White Paper*. As the *Green Paper* states (DCC, 2008b: 16):

Over this period many people will have the opportunity to make decisions – for example, over the purchase of a new car – informed by the longer term implications of the Carbon Pollution Reduction Scheme, with consequential impacts on their future demand for fuel.

It was proposed that this arrangement be in place for three years after the CPRS commences and adjusted periodically to take into account changes in the value of the permit price. A similar arrangement was to be granted to agricultural and fishing businesses, using a rebate system, given that these industries do not attract the fuel excise. There will also be compensation to families most affected by the CPRS, particularly low-income families. Those receiving pensioner, carer, senior and allowance benefits will receive additional government payments; low-income families will be assisted by adjustments to the taxation system.

An indication of the reasoning behind some of key decisions concerning the architecture of the CPRS is shown in a discussion paper released by the Department of Climate Change during the community



consultation phase of the CPRS. It deals with the coverage for an ETS and describes the relevant attributes of the transport sector (See Table 10).

**Table 10 Preliminary assessment of sectors for ETS coverage**

Source	Reliability of standard emissions estimations	Number of emission measurement points	Estimation and transactions costs per tonne of emissions	Preliminary observations
Transport	Good at facility level and fuel supplier level.	Very many at point of emissions both commercial & residential. Relatively few upstream fuel suppliers.	Moderate. Low if indirect coverage.	Practical coverage possible. Requires assessment of optimal liability points given many small emitters.

Source: Department of Climate Change (2008c) *Agenda Paper: Initial Coverage Issues in the Australian Emissions Trading Scheme*. Released for the emissions trading roundtable, Sydney, 18 April 2008.

There are several major implications of this decision. Arguably, the refinery business is ‘trade-exposed’ because of the significant amount of fuel importation that occurs in Australia. As a result, the industry would be likely to press the government with the claims that it is ‘emissions-intensive and trade-exposed’ and seek appropriate compensation under the CPRS. These industries will be potentially among the largest corporate purchasers of carbon permits under the CPRS. Each of the refiners/marketers will pass the costs of the permits through to their customers, but the customers will not bear this cost because the government has decided to reduce tariffs so as to make the CPRS cost-neutral on motorists (as discussed above).

Each of the four refining operators – BP, Caltex, Mobil, and Shell – made submissions to the *Green Paper*. Several issues were identified by these firms. Imported products from refineries, which are around one-third of Australian products, will be produced by firms not facing the CPRS, placing Australian-based firms at a competitive disadvantage. Prominent in these submissions was the exclusion of refineries from EITE status in the *Green Paper*.

Further, the Garnaut *Final Report* deals specifically with transport (GCCR, 2008: 503–29) and offers some pertinent observations. In summary, Garnaut states that over this century there will be dramatic change in the transport sector, regardless of climate change, due to high oil prices, population growth, and the influence of different transport modes. There will be a shift to lower-emission modes and changes to urban structure. Travel frequency and distance reduction will be a major factor in these changes. Emissions trading will ‘guide this transformation’. One effect of oil prices and emissions trading will be to promote changes to vehicle technologies and fuels; the ‘prospects for low-emissions vehicles are promising’. Garnaut believes that zero-emission vehicles will become economically viable and will be the ‘most important source of decarbonization from the transport sector’. Government planning of urban form and transport service provision has a particularly large role in these changes, through lowering the costs of adjustments to high oil prices and responding to population growth and the effects of the carbon emissions price.

Garnaut (GCCR, 2008: 508–10) describes the factors that will respond to market forces under an ETS: 1) vehicles: improved fuel efficiency and uptake of alternative fuels; 2) mode switching: from current to ‘greener’ options; and 3) reduced transport demand. In addition to the aforementioned role for government, Garnaut also identifies the need to address price distortions that are impeding the uptake of more fuel-efficient and lower-emission vehicles, including existing vehicle tariff structures for imported vehicles, vehicle registration and insurance practices, and instruments such as the effect of fringe benefits tax that encourages increased vehicle use.

### 3.4 Targets and timetables for GHG emissions reductions

A central debate in climate change concerns the GHG emission reduction targets and when they are to be achieved. These elements are typically enshrined in climate change policy and many consider such

policies invalid in the absence of such targets and timetables, such as the criticism levelled at the previous Howard government's policy. It follows that the CPRS is also founded on an explicit emissions reduction target and for many commentators and observers it is this aspect that draws the greatest attention.

In many ways, the problem of climate change is one of pollution, albeit at a global scale and with an unusually high number of emissions types and sources. Modern states have developed considerable expertise in dealing with pollution through institutional responses involving dedicated agencies, legislation, regulation, monitoring, enforcement, incentives/disincentives, and review. Central to this response – sometimes known as 'ecological modernization' – is the role for science in identifying the problem, its causes, and possible responses. In dealing with pollution, governments draw on science in formulating institutional and policy responses, and such is the case with climate change and the issue of GHG emissions mitigation.

Much of the debate over addressing climate change is determining the overall goal for stabilizing the atmospheric concentrations of GHG and when this might be achieved. Underlying this goal is a rationale that the level of stabilization – and when this is reached – will determine the rate and extent of global climate change and its associated impacts. Thus, the objective of UN FCCC is (UN, 1992): '... stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropocentric interference in the climate system.' And while this rationalization is sound, namely that the extent of GHG emissions will determine the eventual scale of climate change impacts, scientific knowledge is insufficient to be able to offer a finely graduated cause-and-response model of this relationship. Governments seeking to control pollution are typically required to make judgements over the permissible levels of pollution; in some cases there is no acceptable level and pollutants are banned, but more commonly the issue is to find a compromise that entails a continued release of pollutants – and/or their precursors – that is considered 'safe'. There may be legislative guidance on defining such 'safety', but more usually it entails a political judgement involving many conflicting claims, stakeholders, and values. Such is the case with climate change, but there are further confounding factors impinging on these decisions.

Among the complicating factors for governments seeking to establish GHG targets and timetables on a rational basis are those created by the 'chaotic' character of the global climate system. It cannot be assumed that there is a linear relationship between GHG concentrations and global climate change or with climate change impacts; rather, a safer assumption is that these systems contain a number of thresholds, most of which will be unknown. Many future climate change impacts remain undiscovered and unpredictable, as 'unknown unknowns'. A small increase in atmospheric concentrations, therefore, could be sufficient to trigger major change.

Further, CO<sub>2</sub> – the primary GHG – has a long residency in the atmosphere – several hundred years and longer (IPCC, 2007). Pre-industrial (i.e., before 1750) CO<sub>2</sub> concentrations were between 275–285 ppm and reached 379 ppm in 2005 ppm (IPCC, 2007: 137). Current annual increase in concentrations is almost 2 ppm CO<sub>2</sub> annually. Lying between the goal of stabilising GHG concentrations in the atmosphere and contemporary emissions reduction lies a lag period of several hundred years – i.e., stabilization at today's concentrations, around 384 ppm,<sup>15</sup> could not occur within a century if all CO<sub>2</sub> emissions ceased immediately.

While the causal chain established in climate change science is that the rate and magnitude of GHG emissions will determine the rate and magnitude of – eventual – climate change impacts, it is also widely held that the impacts on ecological systems will be greater the longer emission cuts are delayed. Importantly, the reducing GHG concentrations will reduce the risks and the magnitude of climate change, but the climate system is dynamic and progressive, so that these actions will not necessarily 'undo' the climate changes set in train by higher GHG concentrations. In the jargon of the field, allowing for higher emissions before returning to a pathway of emissions reductions is known as 'overshoot'.

As a consequence of these challenges and uncertainties, and the limitations they impose on decision making over emissions abatement, international negotiators on climate change have espoused the 'precautionary principle'. This concept has many interpretations and applications, but usually there is

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<sup>15</sup> Carbon Dioxide Information Analysis Centre. Available online: <http://cdiac.ornl.gov/>

assumption that decision makers anticipate potential harms and take necessary avoidance actions even when scientific support is lacking. Article 3.3 of the FCCC establishes one of the principles of the framework convention as (UN, 1992):

The Parties should take precautionary measures to anticipate, prevent or minimize the causes of climate change and mitigate its adverse effects. Where there are threats of serious or irreversible damage, lack of full scientific uncertainty should not be used as a reason for postponing such measures, taking into account that policies and measures to deal with climate change should be cost-effective so as to ensure global benefits at the lowest possible cost.

Although this clause reduces the burden of proof from science and ostensibly removes the use of uncertainty as an excuse for inaction, it scarcely makes decision making over setting targets and timetables for emissions reduction any easier.

There are many suggestions for emissions reduction targets and timetables and a variety of targets have been established. In some respects, every target represents an interpretation of what 'dangerous' interference in the climate system means. As is well known, the *Kyoto Protocol* produced a set of targets for individual industrialized nations that collectively amounted to a 5 per cent reduction in CO<sub>2</sub> equivalents – i.e., a 'basket' of the six nominated key GHG converted to CO<sub>2</sub> on the basis of their contribution to global warming – from a 1990 baseline, to be achieved as an average over the period 2008–2012 (UN, 1998).

IPCC (2007) estimated the climate sensitivity of a doubling of CO<sub>2</sub> from its pre-industrial concentrations was an average global warming somewhere in the range of 2–4.5°C – with its 'best guess' being 3°C. A number of parties have adopted the target of limiting global warming to 2°C over pre-industrial levels as being necessary to prevent 'dangerous' change, notably the European Union. Estimates vary as to the extent of GHG emissions reductions necessary to prevent such warming. Meinshausen et al (2009) calculate, for example, that between now and 2050 total emissions must be limited to 700 GtCO<sub>2</sub> to have a 75 per cent chance of keeping warming below the 2°C target. To give a sense of the scale of the reduction task, global emissions are currently around 9 GtCO<sub>2</sub> annually, so that it will take only around two decades to reach the amount of emissions that will cause a 2°C warming.

Modelling for the UK's Stern Report found that at the current rate of GHG emissions, their atmospheric concentrations would reach 550 ppm CO<sub>2</sub>-e by 2050, but because emissions are accelerating, this concentration could be reached as early as 2035. At that level, there is a 77 per cent chance that global average temperature would increase by over 2°C (Stern, 2006). As for emission reductions, Stern found that annual global emissions in the long term would have to be below 5 GtCO<sub>2</sub>, the level at which stabilization can occur, which is over 80 per cent below current emissions. Stern considered the implications of stabilization in the 350–450 ppm CO<sub>2</sub>-e range; stabilization at 550 ppm CO<sub>2</sub>-e would require GHG emissions to peak in the next 10–20 years and then fall by 1–3 per cent annually, so that by 2050 emissions were 25 per cent below today's levels. Stabilization at 450 ppm CO<sub>2</sub>-e – and without previously exceeding this level – would require greater cuts; within a decade, global emissions would have to peak then decline to 70 per cent lower than today's levels by 2050.

Findings by the Garnaut Review (GCCR, 2008), similar to those of Stern (Stern, 2006), endorsed a global target of 450–550 ppm CO<sub>2</sub>-e. It found that for a 550 scenario, Australia would require an 80 per cent reduction from the 2000 levels (a 90 per cent per capita reduction); this would be a 25 per cent cut from 2000 levels by 2020 (30 per cent per capita). For a 450 ppm CO<sub>2</sub>-e scenario, reductions would be 90 per cent from 2000 levels (a 95 per cent per capita reduction) by 2050; for 2020, the cuts from 2000 levels would be 10 per cent (40 per cent per capita). Because Australia's emissions in 2000 were fairly similar to those of 1990, adopting 2000 as a new base does not greatly alter the level of commitment – although it does make comparisons with the original baseline a little more difficult.

Where future international negotiations at Copenhagen for the second commitment period take the final decision is anyone's guess, but there are some guidelines. At COP-13 (held in Bali in 2007), there was a proposal that developed nations (Annex I nations in the Kyoto Protocol) adopt a reduction target somewhere in the 25–40 per cent from 1990 range, based on the IPCC analysis of the cuts required for a stabilization target around 400 ppm CO<sub>2</sub>-e.

As stated above, under the CPRS and as subsequently amended, Australia's emission reduction targets are as follows:

- Kyoto Protocol First Commitment period – 1990 emissions baseline to a five-year average over 2008–2012: 108 per cent of 1990 levels
- Government's long-term goal: 60 per cent below 2000 levels by 2050
- CPRS: mid-term target: between 5–15 per cent of 2000 levels by 2020 – 5 per cent is an unconditional commitment regardless of international agreements; 15 per cent is a conditional commitment depending on developed nations assuming a similar target and all major emitters commit to substantial emission reductions
- CPRS near-term target (indicative) for 2010/11 [fy]: 109 per cent of 2000 levels
- CPRS indicative target (indicative) for 2011/12 [fy]: 108 per cent of 2000 levels
- CPRS indicative target (indicative) for 2012/13 [fy]: 107 per cent of 2000 levels
- Amended mid-term target (conditional): 25 per cent below 2000 levels by 2020 if the world agrees to stabilize levels of equivalent at 450 ppm CO<sub>2</sub>-e, or lower, by 2050.

Under the CPRS, it is intended that these near-term indicative targets will be modified annually to provide guidance for the following five years.

In this context, the national policy commitment of a 60 per cent GHG reduction by 2050 is insufficient to reach the more ambitious goals for reducing the extent of future global warming. Australia's national target of 108 per cent of 1990 emissions in this first commitment period of the Kyoto Protocol will inevitably be set significantly lower following the deliberations at COP-15 at Copenhagen in late 2009. Further, for the next commitment period under the UNFCCC Australia will not have the opportunity to lower its emissions through land use-related emissions as occurred for the first commitment period and this source of emissions reduction is likely now to be seen as a singular and historically anomalous outcome for Australia. Significant GHG emissions reductions in Australia will be overwhelming be from net overall fossil fuel use reductions.

For the nation to succeed in making emissions cuts of the magnitude suggested by these targets in the middle and longer terms, the transport sector, as a significant emissions source, will be required to make proportional cuts of a similar magnitude – such as a net 80 per cent cut between 2000 and 2050.

## **4 Potential market failures in the CPRS for transport: an overview**

### *4.1 Market failure and emissions trading*

GHG emissions from transport are the result of many interrelated factors. Under the logic of emissions trading, decisions by private, public, and institutional consumers of transport energy will be influenced by the price attached to its GHG-related emissions component – as carbon equivalents. These price signals will favour mobility with lower carbon contents, because economically rational actors will be drawn to these cheaper mobility options – and discouraged from options with higher prices resulting from their comparatively higher carbon emissions. All those held responsible for their GHG emissions in the trading scheme will make rational decisions over meeting GHG emissions targets by either investing in changes to reduce emissions, with an option to sell these reductions to other firms, or alternatively forgo making their own emission cuts by purchasing emission credits from another party if that proves to be economically attractive. As stated by the *White Paper*, efficient markets require the following conditions (Australia, 2008):

- Transparent and secure property rights
- Well-informed market participants and transparent policy framework
- Intertemporal flexibility (i.e., the ability to shift the timing of emissions and abatement actions), and
- Competition and freedom from manipulation.

Any weakening of this logic in actual decision making will reduce the effectiveness of emissions trading. Broadly, there would appear to be several ways in which such failures might arise:

- Decisions don't respond effectively to price signals
- Decisions do respond to price signals but don't result in reduced emissions, and
- Decisions indirectly cause increased emissions.

Our inquiry is, therefore, an investigation into the extent and character of potential market failures in the CPRS. 'Market failures' refers to conditions when markets are ineffective, because there are values not reflected within the market that those involved expect to be recognized (externalities) or the market fails to meet expectations of performance. Long a subject of interest to economists, there is a well-established listing of conditions that give rise to such failures. Price signals become distorted when competition within a market is distorted, such as by the presence of monopolies who exploit their market power. Markets fail when they don't recognize particular values – either positive or negative. Pollution is a classic example of such a negative externality, wherein the polluter imposes a cost on another party; a positive externality occurs when benefits created go uncompensated to the creator. Suppliers of particular goods and services are not well serviced by markets when access cannot be effectively controlled and if the good or service is not diminished by additional consumers – such non-excludable and non-rival conditions are associated with public goods. When consumers have inadequate information about markets their decisions may well be imperfect, leading to another instance of market failure. There can also be conditions where the different interests of participants produces market failures, such as how landlords and tenants can respond differently to the same price signals. Conditions within the markets themselves can be a source of inefficiency, such as when the actual costs of a market transaction are excessive.

There has been some consideration of the potential for such market failures in considerations of carbon emissions trading, and the CPRS specifically. Stern (2006) identifies two relevant market failure types; first there are innovation market failures occurring when carbon is given a market value, arising from knowledge spillovers, infrastructure barriers, market structure, and risk and urgency. Second, there are other market failures and barriers to changing behaviour when carbon is given a price, such as information asymmetry, capital constraints, misaligned incentives, and established behaviour.

Garnaut (2008: 314–19) addresses the causes of market failures potentially occurring from ETS design weaknesses and political concessions made during its implementation, namely:

- Exempting economic sectors or particular GHG
- Inequity in permit distribution (i.e., offering free permits to some parties), and
- Decisions that would undermine the credibility of the emissions limit, such as by poorly defined emission reduction trajectories, weak enforcement of conditions.

Garnaut argues that such an outcome would undermine the effectiveness of the scheme and that this would 'erode business confidence', causing the imposition of GHG mitigation costs for little environmental benefit, and damaging Australia's international credentials.

Garnaut strongly endorses emissions trading to correct the market failure that results in 'the unfettered release of greenhouse gases to the atmosphere', but cautions (GCCR, 2008: 303): 'By itself, this is unlikely to be a sufficient policy response for reducing emissions.' Review of existing policies, including state and federal taxes, procurement policies, assistance programmes, product and technology standards, and public investment in research, is needed to identify perverse incentives that would inhibit the effectiveness of an ETS. Government commitments for reducing regulatory burdens on businesses, infrastructure investment, federal tax review, and human capital formation are endorsed by the GCCR *Final Report*.

Great confidence is placed in the effectiveness of an ETS; the primary roles are assigned thus (GCCR, 2008: 317): 'The very purpose of a market-based approach to mitigation policy is to enable producers and consumers throughout the economy to determine the most effective response to meeting a mandated emissions limit.' Criticisms offered to alternative approaches and the success of future emissions reductions are placed firmly in the realm of consumer sovereignty (GCCR, 2008: 317):

Programs and other regulatory interventions – whether federal, state or territory – that seek to reduce emissions from specific activities covered by the emissions trading scheme will not result in lower emissions. They will simply change the mix of mitigation activities that deliver the same, required level of emissions reductions. Such interventions presuppose that government officials, academics or scientists have a better understanding of consumer preferences and technological opportunities than households and businesses. This is unlikely and can never be guaranteed.

Additional to its call for reviewing policies working against the ETS, the GCCR also calls for a review of existing policies that would compete with an ETS. Three market failures are identified (GCCR, 2008: Chapter 13):

- 1 End use of energy as a result of misplaced incentives and in gathering and analysing information about known technologies (i.e., in information and principal-agent problems)
- 2 Research, development, and commercialization of new technologies – when investors cannot capture the full value of their innovations – requiring public investment, and
- 3 Investment in network infrastructure (e.g., electricity transmission, natural gas pipelines, and transport infrastructure) and capture of external benefits.

While the first two will require public investment, the third ‘may or may not’ require public investment.

By a subtle turn, these reviews of the ETS market have invariably become reviews of the policies that give a NETS its basic architecture, and are based on beliefs and expectations about the respective roles for governments and markets. Potentially, the market failures that might occur with emissions trading systems are wide and various. Policy makers are aware of such potential problems, recognizing that emissions trading will need to be modified in the light of operational experience. As the National Emissions Trading Taskforce (NETT, 2006: 203) stated: ‘Emission trading would not be a “silver bullet” that would alone reduce greenhouse gas emissions.’ Emissions trading is to be but one element of a programme that would include regulatory, fiscal, and voluntary measures needed to lower emissions, according to the Taskforce. In the language of climate change policy, these other measures are deemed to be ‘complementary’ to emissions trading – hence, the ‘complementarity’ of these measures vis-à-vis the trading scheme. NETT identify several strategies to implement such complementary measures where the efficacy of emissions trading will be overly limited:

- International negotiations
- Research, development, and demonstration
- Where a national ETS is impossible or impractical
- Where ‘non-price’ barriers predominate, and
- Where there are significant price inelasticities – and here the NETT exemplify transport emissions and short-term fuel prices.

Many of these responses are already well established in public policy and have been implemented by state/territorial and the Federal governments and the NETT (2006).<sup>16</sup> NETT identify three broad types of these measures: 1) measures applying to sectors covered by a national ETS; 2) measures applying other sectors; and 3) international engagement. It is perhaps worth reiterating here that judgements of this type are not, in fact, technical assessments, but outputs of political processes. Economic theory alone cannot resolve the issue of how and when governments should intervene in the marketplace; the resolution of such problems has given rise to a vast array of institutional responses.

#### 4.2 *Market failure and emissions trading: urban transport*

Considering market failures in emissions trading in the context of a specific sector, such as transport, requires some type of framework of that sector. Given our basic inquiry of determining how the various components of the transport sector will respond to the CPRS price signal, we need to understand what the urban transport system comprises. We can identify the basic elements of urban transport systems:

- Urban form and function which determines much of the demand characteristics for mobility
- Transport infrastructure that comprises the layout of roads, rails, and other physical components, together with the location of stations and stops, and the connectivity within the urban transport network
- Policy, planning, and operational functions that determine how the system is run, influencing such factors as capacity, service frequency, trip distribution, demand forecasting, financing, modal integration
- Technology options for vehicles, propulsion units, fuel types, fuel efficiency, vehicle capacity, and

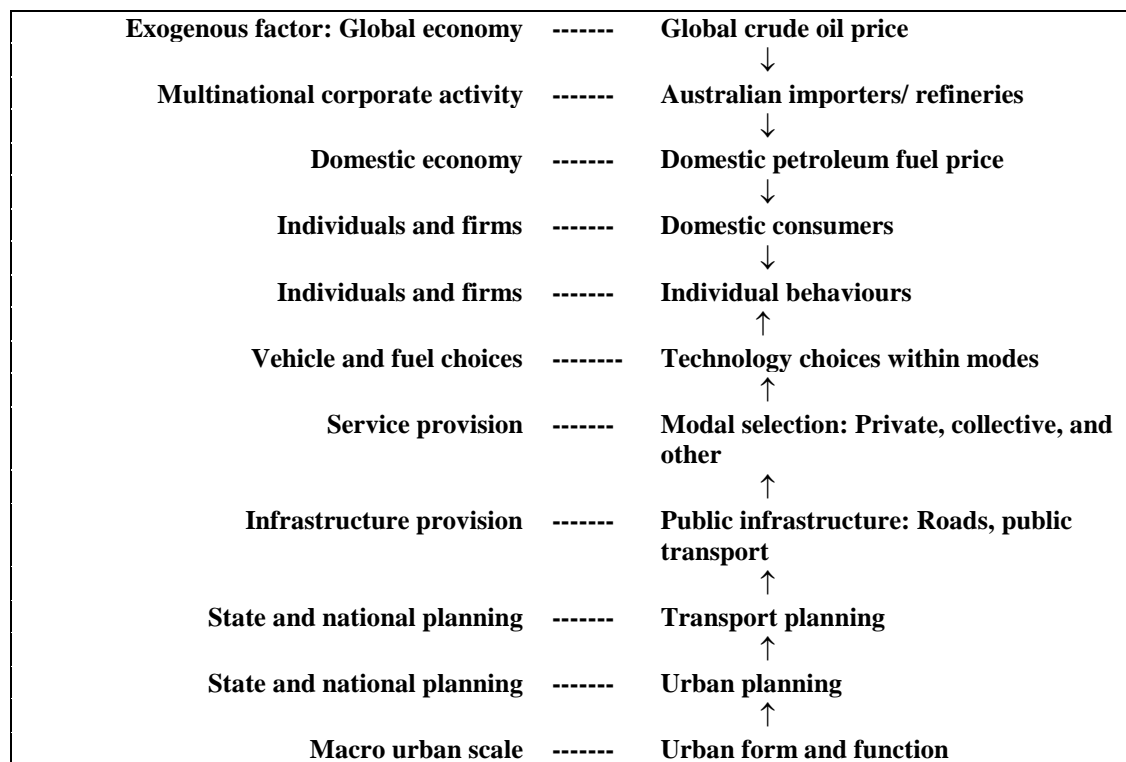
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<sup>16</sup> Refer to the Federal government’s *Fourth National Communication* (AGO, 2005) for an account. Local governments have formulated and implemented climate change policies and other policies with climate change implications; many of these efforts have been supported by state and Federal funds, but the role of local government should be acknowledged as it has an important role to play in land use planning and in promoting active transport modes.

- Human behaviour which influences individual and collective choices over mobility, embracing such elements as psychology and culture.

Counterpoised against the elements of the transport system is the market for transport energy through which the price mechanism operates. This contains many elements, given that transport energy is imported and produced domestically, it involves refining and distribution, and is made up of several different sources.

Rather than attempt to capture this system in a realistic description, a simple schematic arrangement is offered (see Figure 4). Several of basic elements of the transport energy system are identified and the realms in which decisions are made, beginning with the machinations of the global economy that influences the spot price for crude oil. At the end of the chain of decisions that culminates in the price of transport energy faced by consumers – individuals, firms, and public bodies – are those consumers. In essence, this is the primary market that the considerations of market failure typically consider. Yet the urban transport system comprises a great number of elements in which there are many different decision makers for which the price of transport energy can be considered as an indirect influence. While the arrangement of these elements offered here might well be contested, it suggested that there is a systematic lessening of the influence of energy price signals as the ‘planes’ of this system become less tightly coupled to decisions based on energy price.



**Figure 4 A simple schematic of decision-making realms and scale in an urban transport system**

We have identified several of these market failures which are described in the following chapters: Urban systems and CPRS market failure (Chapter 5), technology issues (Chapter 6), behavioural and information issues (Chapter 7), and other barriers (Chapter 8).

## **5. Urban systems and CPRS market failure**

### *5.1 Common goods and market failure*

Conventional economic theory holds that public transport, and transport infrastructure more generally, are ‘public goods’. Two economic dimensions define public goods; an absence of rivalry between potential consumers and exclusiveness of consumption. Consumers of public goods do not have their consumption diminished by the addition of another consumer because the character of the good – or service – is such that consumers are not rivals. Public goods cannot be practically made for exclusive

use. In essence, public goods lack the capacity to give exclusive private gain – or loss – within a market; they exist external to the market; an alternative description is ‘collective consumption good’. In practice, there are few perfect public goods that are entirely ‘non-rivalous’ and ‘non-excludable’; the textbook example of a public good is national defence.

Public transport and transport infrastructure is subject to crowding or other capacity limits so that, past a certain level of use, additional consumption is not possible, or that the benefits of consumption are increasingly diminished. In this way, there are often conditions of ‘rivalry’; in response, Ostrom (1990) calls such goods or services ‘common pool resources’ or ‘common goods’. It follows that these goods share features of both public and private goods and that aspects of these goods and services can be treated like private goods and made subject to supply and demand in a market setting. Roadways, for example, can be subject to tolls and railways can use differential pricing to encourage load shifting throughout the day as a demand management tool.

Where public goods and common goods are in limited supply or are susceptible to loss or damage through unsustainable use, there is a need for management. In traditional societies there is an array of approaches used for such purposes, whereas in industrial societies this is a task of government. Environmental protection and public transport/transport infrastructure both involve public institutions in such activities as providing public and common goods, monitoring the condition of natural resources, regulating the use of public and common goods, ensuring equity in access to public and common goods, ensuring that private benefits of public or common goods use are distributed fairly, and so on.

Our interest here is in those aspects of the urban transport system and urban system more generally that constitutes these common pool resources and do not fit readily into the CPRS market for carbon emissions.

## *5.2 Public transport infrastructure and public transport service provision*

Most Australian strategies seeking to reduce transport’s GHG emissions and overall energy consumption include the goal of shifting passenger journeys from private motor vehicles to public transport active transport (i.e., walking and cycling). Similarly, the strategies for the freight sector usually feature shifting the task from road transport to the more energy- and emissions-efficient rail transport, where appropriate. Providing for urban public transport has been a function of state government for much of the past century, usually beginning with state government assuming control or acquiring the fledgling and piecemeal services established in the capital cities around the turn of the twentieth century. Consolidation and expansion of these urban rail services – for either train or tram – was typically conducted by large post-colonial type bureaucracies, an activity that eventually came to a halt around the time of World War II. In the latter half of the last century public transport went into decline as governments turned their attention to freeway and highway construction and promoted the suburban expansion based on private motor vehicle use.

Consequently, Australia’s major cities express a distinct transport geography, with the inner and inner-middle areas typically having more dense public transport services, usually oriented towards the city centre, with the outer-middle and outer suburbs being car-dependent and with few public transport services (see, e.g., Scheurer and Curtis, 2008; Dodson and Sipe, 2008; Laird et al, 2001; and Newman and Kenworthy, 1999). Bus public transport provides services across the entire city areas, but the coverage of these services is generally quite thin and the services fragmented and less frequent, particularly in areas most distant from the CBDs. These circumstances create a simple deterministic condition; the sort of transport services provided by heavy and light rail occurs within relatively concentrated catchments in Australian cities. Within these catchments, modal shift to rail-based public transport is possible under the right conditions, but beyond these catchments the infrastructure does not exist and this modal shift is not possible.

To emphasize this point, where there is no market for public transport, the preferences and the spending power of individual consumers – as citizens or firms – makes no difference. No matter what the price is given to petroleum as a result of government policy, this alone has no impact on the opportunities for certain types of modal shift.



### 5.3 *Transport planning and public transport operations*

Transport planning is a public good in a general sense, as are public transport services. There can only sensibly be one source of overall transport planning and this is provided by governments. Indeed, as the history of urban transport shows, it was the failures of competing private providers in cities that gave rise to public control over this essential urban service. All spheres of government have a role in transport planning, but state governments provide the bulk of planning for the major cities, especially as this pertains to urban and regional public transport and most of the road network. Major exceptions are federally funded projects, which to date have almost exclusively been for urban freeway construction and for interstate road and rail services.

While it would be an overstatement to claim that the cost of transport energy had no influence on transport planning, its effect operates at the broadest level in terms of shaping some basic parameters of our choice of transport technologies over the past century or so. At the level of providing transport planning, economic factors come into play as being important, but transport energy costs are usually not considered and are taken as background conditions. Policies that influence transport energy costs do not influence transport planning in the short term.

For land use planning, the same general observations apply regarding public goods and the absence of transport energy price signals on decision making. As many commentators have described, in Australia transport and land planning are usually entirely separate activities, despite the wide recognition by policy makers and professionals of the need for coordination. There are some exceptions, of course, such as a number of 'transit-oriented-developments' around the country, although, interestingly, these are often redevelopments in areas with reasonable existing public transport, rather than new developments. Clustering of different urban land uses is another approach that seeks greater co-location of residential areas with common transport destinations as a means to reduce net travel and open up mobility choices that involve reduced motor vehicle transport. For a number of years, state governments have espoused policy goals to reduce private vehicle use in land use plans (Gleeson et al, 2004). Despite such intentions, there is a considerable 'implementation gap' wherein the resulting land use planning around the nation has usually fostered continued car dependency, especially in new developments on the urban fringe.

Public transport operations also fall within the realm of common goods – and services. Although a location may be within the catchment of public transport services – rail, light rail, bus, and ferry – many factors determine whether the demands of a potential user can be satisfied by the available services. At the simplest level there are such service variables as: service availability (e.g., frequency, reliability, and punctuality), access to a specific destination, route directness and journey duration, connectivity and integration with other services and routes, the fare, level of personal security, comfort and cleanliness of stations, stops, and vehicles, information about services, relations with staff, and so on. Added to these aspects of service provision are the needs of individual travellers; segments of the community have special needs for using public transport, including the elderly, non-English speakers, children, and those with disabilities. Such operational issues concern policies and practices of the service providers, which can be public or private, or a combination of both. None of these issues of effective public transport operations is directly impinged upon by the cost of transport fuels; again, this is an area of CPRS market failure because no market exists.

### 5.4 *Urban form and function*

Urban form and function influences transport energy consumption through such factors as city size, the distribution of land uses, access to the CBD, and car-based urban design (see, e.g., ECOTECH, 1993). Land use zoning has resulted in greater separation of residential, employment, and service areas, with resultant increases in travel distance and number of trips. Continued outward urban growth has formed broad swaths of car-dependent suburbs and satellite developments in the major Australian cities. Poor urban design has discouraged walking and cycling for short journeys and made access to public transport difficult. So-called 'transit-oriented development' has been generally overlooked in urban development, being largely restricted to redevelopment opportunities around existing rail infrastructure. However, in the case of the forthcoming CPRS, the question is: How much will the price of energy influence urban form and function? In the short term, the answer is that energy costs do not influence urban form and function. In the longer term, the influence is largely unknown, because our cities' development through the modern era has been premised on relatively cheap fossil fuels for transport. Moriarty (2002) found that the most significant positive impact of land use planning on future urban sustainability was likely to be its influence on the environmental costs of transport.

However, given that most of the planning controls reside in state and local government authorities, it is unlikely that energy price signals in and of themselves will influence form and function. Over time, political pressure from private developers and the community in response to changes in travel costs may shift planning practices, but realistically, such lobbying will be in response to an array of concerns.

## **6 Transport technology and CPRS market failure**

### *6.1 Role of technological change*

Transport's high level of GHG emissions are usually held to be the outcome of our choices in motor vehicles and the fuels they consume. Casting the problem in this light leads to the search for alternative vehicles and fuels. However, the role of technology is considerably broader and there is value in considering the emissions as an outcome of an interconnected set of technology decisions and their consequences that comprise urban transport systems. If the longer term emission reduction goals are of the order of 80–90 per cent across the nation and for the transport sector by 2050, then major changes in the transport system will be necessary. Our present level of vehicle ownership of over six for every 10 citizens with each private car covering an average 15,000km annually is incompatible with scenarios of greatly reduced GHG emissions using alternative fuels and vehicles. Technology change needs to be seen as being broader than the development of alternative vehicles and energy sources, but involving changes to the urban transport system as a whole.

Technology change can be responsive to market signals, but much innovative research and development for environmental protection and social benefit comprises a public good and as such is only possible at a significant scale when supported by government funding (as discussed above). Other aspects of technology change that appear largely unresponsive to the immediate price of transport energy concern the scale and type of technology change required and the problems of technology 'lock-in' and associated market failures of path dependencies. Despite the expectations of the proponents of an Australian ETS as a promoter of technology change, there are groups for scepticism.

### *6.2 Technological lock-in and path dependency*

Transport systems exhibit a degree of technological 'lock-in', meaning that there are a number of self-reinforcing and interconnected components to the system that function to resist change.<sup>17</sup> Several factors can contribute to the dominance of particular technologies or technological systems which provide a lasting advantage over competing technologies, including those having superior performance. These factors can include the advantage offered by achieving large scale over smaller competing technologies, advances due to constant development and learning experiences mean that refinement of the known is cheaper than innovation, the reliability and predictability of established systems makes them less risky than new ideas, and the benefits of using the same technology as others operating in the same field. Nearly all of the motor vehicles on the road today share the basic design principles of those of those nearly a century ago, including the use of the internal combustion engine running on petroleum products. Many of the features of technological lock-in are evident in this technology, including the difficulty of technological change.

Motor vehicle design, manufacture, and assembly around the world has generally followed a trend of greater internationalization, along with a greater concentration of ownership among the established North American, European, and Japanese corporations. An exception to this trend is the emergence of new market entrants from developing or newly industrialized nations, with established industries in South Korea now being joined by Chinese and Indian ventures. In large part, Australia is a 'technology-taker' in motor vehicles; technological innovations in vehicle design, engine design, and fuel formulation adopted in Australia were generally developed either in Europe or North America or by international collaborations involving multinational corporations in vehicle manufacturing and transport energy. Australia has insufficient economic power to provide the necessary incentives to act independently as a market leader in these capital-intensive research and development endeavours.

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<sup>17</sup> 'Lock-in' refers to conditions where several factors interact to make a system resistant to change; path dependency captures the institutional aspect of this concept (e.g., Low et al, 2005). 'Technological lock-in' refers to conditions where a technology establishes a dominant position despite changes in the wider environment, social expectations, or competing technologies. Economists have been particularly interested in this form of market failure that fails to conform to several precepts of classical economic theory (e.g., Arthur, 1989).

Australia's transport fuel economy performance is a good exemplar, in many ways, of the restraints of technological lock-in. Despite general declarations of the role of improving fuel efficiency in a variety of conservation and environment protection policies by several federal governments over several decades, national fuel economy performance has and remains exceptionally poor. There are about 15 million motor vehicles in Australia – cars make up 77 per cent – and average passenger vehicle fuel efficiency was 11.2 l/100km in 2005. Efficiency has not improved much in a decade, for although there have been gains from more efficient new passenger cars; 'However, 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' (ATC & EPHC VEFWG, 2008: 16). Australia does not have a fuel efficiency standard, but currently uses the National Average Fuel Consumption Target. Negotiated with the Federal Chamber of Automotive Industries in 2003, the Commonwealth Government set a voluntary target of 6.8 l/100km for Australian-manufactured passenger cars by 2010. It is debatable whether this target will be met; further, there is the limitation of this approach to technological change. Australian-made vehicles made up only 19 per cent of all 2007 new vehicle sales and about 11 per cent of private sales; 60 per cent of Australia's vehicles are imported from Japan, Thailand, and South Korea (ATC & EPHC VEFWG, 2008: 12). Australia's passenger fleet averages 9.7 years in 2007; about 20 per cent of passenger vehicles are 15 or more years old; commercial vehicles are slightly older (ATC & EPHC VEFWG, 2008: 8). Lifting national economy, under these technological constraints and policy approaches, will not occur quickly.

Technological lock-in plays a part in the path dependency of the urban transport system, a condition described by Low et al (2005), in which institutional and other factors mean that established trends are continued. Key actors in these institutions come to believe that the existing path is the only rational option. Australia's car-dependent cities exemplify this path dependence, with the scale of investment in road infrastructure and the resulting urban design and planning based on road transport serving to reinforce the continued use of private motor vehicles.

Another dimension of lock-in is created by the characteristics of the investment by households in motor vehicles. Domestic – and small business – expenditure on motor vehicles is typically a major purchase and ownership – in its various forms – represents both a large capital outlay and source of debt servicing. Motor vehicle purchase costs and associated depreciation have usually far exceeded the operating and fixed costs of ownership.<sup>18</sup> Fuel – or energy – costs of vehicle operation are, therefore, not the major financial aspect of vehicle ownership and use. Decisions over vehicle purchase involve a number of aspects, including complex economic, psychological, socio-economic status, household size, intended uses, and other variables, which further diminishes the impact of fuel prices on purchase decisions. Households also don't purchase motor vehicles very often; the average age of the Australian motorcars is around ten years, so that achieving widespread technological change under normal circumstances would take many years.

To date, the major policy emphasis for technology to address GHG emissions has been concerned with efficiency improvements of the existing technologies. Improving fuel efficiency offers GHG emissions reductions for distance travelled and there have been several significant improvements for vehicles, but little in overall fuel consumption. Vehicle fuel efficiency has been undermined by increases in vehicle weight and power, and the effect of additional powered equipment. As of today, Australian car fleet fuel efficiency is at the level of the Model-T Ford of the early twentieth century, being some 11.4 litres/100 kilometres in 2006 (ABS, 2007: Table 1). There is a considerable range of fuel efficiencies and GHG emissions in the Australian vehicle fleet; GHG emissions range from around 60 gCO<sub>2</sub>-e/km to around 450 gCO<sub>2</sub>-e/km. This suggests that from a strategic perspective, the easiest way to reduce GHG emissions through fuel efficiency approaches is to switch to those more efficient models.

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<sup>18</sup> Ausroads' *RoadFacts 2005: An Overview of the Australian and New Zealand Road Systems* (Ausroads, 2005: Table 1.3) reports that annual private motoring expenditure in 2004 was AUD\$10,426 for a 'medium-sized car' (comprising depreciation, fuel, registration, insurance, motoring association membership, interest, service and repairs, and tyres). Motoring organizations also conduct this research, such as the RACV and NMRA, and their findings are similar to those quoted here, with around a 75/25 per cent split between standing and operating costs for the first five years of ownership being common.

Technological lock-in and path dependency in Australian urban transport systems make them, by definition, highly resistant to change, including the response to economic signals. Increasing the costs of fuel as a means to promote technological change, through the CPRS, will have to contend with this considerable barrier. Operating costs are but one element in decision making over vehicle purchase. There is a considerable 'distance' between consumer preferences for reduced expenditure on vehicle operating costs and technological change for transportation vehicles and their fuel – and energy – sources. To date, most of the influence of increased fuel prices appears to have been minor developments of existing technologies, rather than wholesale development of alternative vehicles and fuels, so that a CPRS would have to achieve something that other fuel price signals seem not to have achieved to any great extent to date. Substantial changes to the transportation system will involve broad changes to the transport system and it seems unlikely that minor increases in vehicle operating costs will promote systemic change beyond that of modifications to existing technologies. Promoting technology development of less polluting private vehicles appears not to address the problems of car-dependency; there may well be a risk of promoting technological development in ways that reinforces the existing transport system without achieving the significant reform that is sought.

### 6.3 *Constraints on alternative fuels and vehicles*

Notwithstanding the problems of car dependency, our cities and their citizens are going to continue to use private motorcars for the bulk of transport trips in the immediate future and perhaps for a reduced level of use thereafter. If follows that technological change will have a major role to play in enabling urban mobility with lower GHG emissions. In the long term, there may be substantial changes to the character of individual mobility in cities, but in the immediate future there is a great need to reduce the per-distance and per-trip emissions from private vehicle fleets. Achieving such an objective requires technological change to reduce net GHG emissions per unit of fuel consumed<sup>19</sup> and reduce fuel consumption per kilometre through changes to vehicle fuels, the fuels types consumed, and engine and vehicle design. To date, reform in this area has been driven by regulatory standards, federal support for research and development, and the importation of best available technology.

Alternative transport fuels from fossil fuels include diesel, LPG, CNG, electricity generated from fossil fuels (typically coal and gas in Australia) – and possible methanol produced from natural gas or coal, and ethers produced from natural gas and butane. Non-fossil fuel sources are hydrogen, and ethanol and methanol produced from biomass.

Many different vehicle propulsion technologies and energy sources are under development to compete with conventional vehicles (i.e., the internal combustion engine (ICE) fuelled by petroleum products). There is also a range of technological options for increasing the efficiency of existing vehicle technologies. What is sought is a vehicle/energy source with a small GHG 'footprint' that is without major environmental costs, one that can be introduced to the market relatively quickly, provides viable urban mobility, and will find ready market acceptance. Debate over these alternative vehicle technologies has centred on technological assessments, typically with regard to costs, emissions, and performance characteristics relative to the ICE. Success of the alternatives to conventional vehicles will be determined by the rate and degree to which industrial restructuring takes place in the motor vehicle industry and this will be heavily influenced by government industry policy in Australia and overseas. Implicit in the alternative vehicle scenarios is the assumption that these will be viable substitutes for conventional vehicles. If this assumption proves to be false – namely that there is no low-GHG vehicle available in the near term that is nominally affordable – then there is a technological market failure of an absolute kind.

Australia's federal government, in a manner similar to many other developed nations, has invested in the development of alternative fuels. Currently, two programmes, the Biofuels Initiatives (including the Biofuels Capital Grants programme and the Ethanol Production Grants programme) and the Alternative Fuels Conversion Program are aiming to increase the national biofuel capacity. There is a government

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<sup>19</sup> Fuel use efficiency and emissions production by mode and vehicle measures important aspects of performance but a more complete understanding uses 'full fuel cycle' analysis which calculates not only vehicle energy use and emissions, but includes the energy and emissions associated with the production and transport of different energy sources. It follows that such net emissions calculations differ from vehicle fuel efficiency calculations. For example, critics of biofuels have pointed to the energy and emissions costs of biofuel production. Further insights are available from 'life-cycle' analysis that includes the energy and emissions associated with the production of the vehicles, such as mineral extraction and vehicle manufacturing.

target of 350 ML of biofuel consumption by 2010 – current production is perhaps one-half of this amount;<sup>20</sup> however, this target would be less than 1 per cent of transport fuel consumption. Currently, the government has set at 10 per cent limit on the ethanol component and this blend (as E-10) is now being retailed by BP, Shell, Caltex and others. Vehicles that can use mixtures of biofuels or petroleum are not that much more expensive to produce than conventional petrol-driven vehicles and are common in some countries, such as Brazil, but conversion of existing vehicles is expensive and somewhat difficult.

Opinions differ over the GHG emissions from biofuels, although clearly the E-10 initiative will not have any significant impact. There is considerable variation in the GHG from biofuels due to differences in biomass types, biofuel production and refining techniques, delivery systems, and how the lands used for producing biofuels might have been used otherwise. Further, there are a variety of assessment methodologies which given an array of results for emissions associated with biofuels (Union of Concerned Scientists, 2007). Depending on these factors, biofuels might increase or decrease GHG emissions when used as transport fuels. Earlier studies have suggested that up to 10–20 per cent GHG emission saving might be possible using biofuels, but these did not include land use factors which can substantially alter the findings.

Ethanol is the world's most popular alternative fuel, mostly derived from biomass sources, such as crops containing sugar (e.g., sugar cane, sugar beet), treated starch crops (e.g., corn, wheat), or treated cellulose to produce sugars. Fermentation can be used to convert sugars into ethanol and CO<sub>2</sub>. Although waste products can be used to produce ethanol, there are other problems. There would seem to be multiple issues with the prospect of broad-scale agricultural production of biofuel crops in Australia, beginning with whether there could ever be sufficient production to meet national demands for transport fuels. Calculations of the GHG emissions vary considerably as there are many ways of producing biofuels and the production process itself emits GHG.

In their review of the future of the motor vehicle, Moriarty and Honnery (2008b) identify the problems of biofuels and note that ethanol from cellulosic sources may have lower energy costs and GHG emissions and has greater potential than ethanol from starchy crops, but note that this commercially unproven energy source is unlikely to become a major source of transport fuel in the short and medium term. There are additional problems, such as if high prices for biofuels promotes the conversion of grasslands and forests into cultivated areas for biofuel production, thereby adding to global GHG emissions (Searchinger, et al, 2008). Unless broad-scale production of biofuels in Australia can demonstrate considerable GHG emissions advantages over conventional fuels and without high energy costs, which at present it cannot, then it cannot provide a climate change rationale for its support through public policy and public subsidy. In any event, Australia's nascent biofuel industry cannot be scaled-up with sufficient speed to displace a significant amount of conventional fuels.

Some experts consider that the indigenous supplies of gaseous fuels should be given a high priority for development as the replacement fuel for oil in Australia in the short-to-medium term. Australia already has an extensive uptake of liquid petroleum gas (LPG) – comprising mainly propane and butane – and compressed natural gas (CNG) – which is mostly methane – within the transport sector, largely by commercial vehicles. There is extensive CNG use in some nations, notably Argentina, Brazil, and Pakistan. Such arguments have a strong logical basis on economic, engineering, and energy security grounds. Additionally, these fuels are relatively clean burning, producing low levels of particulates in vehicle emissions when compared to petroleum, and lower levels of oxides of sulphur and nitrogen. Further, in addition to these fuels being proven and affordable, Australia has considerable reserves. Although nearly all production is currently exported, these fuel sources could be developed domestically as a fuel stock for transport, thereby alleviating the need for increased oil imports to meet future demand and declining domestic oil production.

From a GHG perspective, CNG and LPG are of less appeal as a means to cutting transport emissions. LPG has marginally fewer GHG emissions than petroleum – perhaps 15 per cent less; there do not appear to be great benefits from LPG for other forms of emissions of concern. Fuels derived from natural gas may not offer particularly large GHG saving over conventional fuels. An MIT study found that a mid-sized hybrid sedan could have a well-to-tank energy efficiency of 1.09 vehicle-km/MJ for diesel and 0.97 for CNG (Weiss et al, 2000). In terms of CO<sub>2</sub> emissions, the results favoured CNG with

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<sup>20</sup> [http://www.biofuels.apec.org/me\\_australia.html](http://www.biofuels.apec.org/me_australia.html)

17.6 vehicle-km/kg CO<sub>2</sub>, compared with 14.2 for diesel. However, the same study found that this advantage will be offset by any methane leakage emissions from natural gas distribution, compression, refuelling, and on-board storage.

Many commentators consider that the front-runner in alternative vehicles is the electric car and pure battery electric and electric-ICE hybrids are mature technologies. Electric vehicles using only energy stored in batteries cannot yet provide the range of conventional vehicles, despite considerable research into battery technology. Greatest interest is in hybrid technologies, as exemplified by the successful Toyota Prius,<sup>21</sup> and the new-generation 'plug-in hybrids'. Clearly, the available hybrid vehicles offer an immediate means to significantly lower GHG emissions. For example, the Toyota Prius emits 89 gCO<sub>2</sub>/km with a fuel efficiency of 3.9 l/100km, compared with the popular locally manufactured Holden Commodore and Ford Falcon, whose various model options produce emissions between 220–306 gCO<sub>2</sub>/km.<sup>22</sup> As stated above, the national fuel efficiency for passenger vehicles is an average of around 11 l/100km, which underscores the potential of savings available from existing vehicle model choices. Prospects for 'plug-in hybrids' are far more uncertain.

Whether electric vehicles can offer GHG emissions savings depends significantly on what is revealed by the 'well-to-wheels' type evaluations that include the energy source for electrical generation. Electricity from the national grid is overwhelmingly generated from fossil fuels, mostly coal. Modelling in the GCCR (2008: 519) found that an electric car using power from the national grid at its average GHG emissions intensity would be 30 per cent higher than a similar car using petroleum; if electricity was from Tasmania's predominantly hydropower grid, the electric vehicles GHG emissions would be 15 per cent less than a conventional vehicle equivalent. At present, plug-in electric vehicles do not appear to offer any GHG emissions savings; further, they have the potential to increase electricity demand and worsen the nation's overall GHG emission levels and add to peak-load demand.

Hydrogen has received considerable research investment to date, but commercially and practicable vehicles have yet to be produced. While the 'energy-carrying' technology of the hydrogen fuel cell offers the promise of low GHG emissions, considerable problems remain (Romm, 2004, 2006). Not least of these are those providing a fuelling infrastructure. At present, most commercial hydrogen is manufactured from natural gas; future 'green' hydrogen will need to be produced from renewable sources, not fossil fuels. Most of the major projections for the future of transport (see the review of Moriarty and Honnery, 2008), such as the IPCC, have only a negligible market share of transport being met by hydrogen vehicles by 2030. Service (2004) is one commentator sceptical that hydrogen will become a major transport energy source.

## **7 Behaviour, information and price signal market failure**

### *7.1 Social and behavioural barriers*

Human behaviour can be resistant to economic signals and social factors can inhibit the influence of such signals. Once established, certain behaviours can become routine and at the social scale we recognize these within specific social contexts as 'social norms'. Around these behaviours are a number of associated expectations, institutions, and symbols, many of which become incorporated into cultural forms (see, e.g., Davison's (2004) examination of the rise of motorized transport in Australia). No doubt there are a great number of these cultural impediments to changed behaviour in the transport realm, but one that has received considerable attention is the association of freedom with individual motorized mobility. A decade of growth in large four wheel-drive (4WD) vehicles for personal transport demonstrates that many motorists have placed a lower priority on fuel economy and environmental responsibility than other values that they find expressed in this class of vehicles. An effective ETS would seek to produce at least two major changes in behaviour in urban mobility, a significant reduction in motor vehicle use – thereby delivering a lower net urban VKT – and a change in preference from individual transport modes to collective transport.

Essentially the ETS is a demand management tool that seeks to use a price signal to reduce demand for fossil fuel energy by promoting shifts in the mobility-related consumer preferences. Interestingly, although there has been a considerable array of transport demand management measures used in

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<sup>21</sup> Over one million have been sold worldwide since its introduction in 1997 (GCCR, 2008).

<sup>22</sup> See <http://www.greenvehicleguide.gov.au>

Australia, there has great political reluctance to deploy energy price measures. Among the types of economic and non-economic management tools used for private road transport that have been used or debated are toll roads, road space rationing (e.g., priority lanes, bus lanes), car-pooling, taxes and restrictions on car parking, flexible working hours, traffic calming, and workplace travel plans. Debate has recently focused on congestion pricing. Some experts also include policies to promote collective and active transport use as demand management. Consumers do respond to transport price signals, but the influence of these signals is not always clear, nor are they necessarily uniformly effective over time and across society.

One determinant of the response of consumers is the information that they have available and there are several aspects of the costs of owning and operating motor vehicles that are not always immediately clear. For example, there are differences in the ways that standing and operating costs for private vehicles are perceived. Standing costs comprise depreciation, interest on loans for vehicle purchase, insurance, registration, and driver's licence fees are the most expensive aspect of car ownership and operation, while operating costs are primarily fuel, tyres, servicing and repairs are less expensive. For more expensive vehicles, such as the large 4WD Toyota LandCruiser, the annual running costs are only 9 per cent of total costs, yet for the small Toyota Yaris, the annual running costs are 31 per cent of total costs.<sup>23</sup> Owners of more expensive vehicles are less sensitive to running costs and demand management that targets running costs is likely to be proportionally less effective than that addressing standing costs.

Knowledge and perceptions of alternatives to motor vehicle travel play a significant role in whether motor vehicle users will respond to the ETS and change their mobility behaviour. Important aspects of this knowledge are the availability/reliability of public transport services and what choices are available. Some studies have shown that the motorists' perceptions of relative trip times are prejudiced against public transport, for example, and such an outlook serves to make switching from car use to public transport less attractive.

Social factors, such as socio-economic status, gender, age, household size and composition, can all influence mobility decisions. A broader point is that mobility behaviour is shaped by personal values and attitudes, which can impinge on the evaluation of direct aspects of specific trips – such as its purpose, cost, travel time – as well as other choices, such as mode selection. These variables evoke complex matters of 'moral norms', attitudes towards the environment and worldviews, aspects of personal autonomy, personal identity, and norms of behaviour (see, e.g., Anable, 2005). As Anable (2005) describes, it is possible to devise distinct strategies for particular profiles of travellers, ranging from 'die-hard drivers' with little intention of reducing car use, to 'car-less crusaders' who favour alternative transport and perceive few difficulties with such choices.

While the cost of travel is an important factor in mobility decisions, it is but one of many variables and often of less importance than popularly depicted. Data collected by the NSW 2007 household travel survey on the reasons why people chose public transport for commuting gave the following reasons: almost one-half of respondents (47 per cent) said it was to avoid parking problems; 28 per cent said it was faster; 23 per cent did not have a car; 17 per cent lived or worked close to public transport; 17 per cent said it less stressful than other forms; 14 per cent found it arrived closer to their destination; importantly, 27 per cent of respondents said it was cheaper (TDC, 2009: Figure 3.8). We can use this same data source to learn something of the perceptions of car commuters. Of the reasons for using the car to travel to work, the major responses were as follows: prefer the convenience and independence of the car (44 per cent); public transport services are indirect (26 per cent); public transport services are too slow (18 per cent); car is used for work trips (14 per cent); public transport doesn't go where required (14 per cent); public transport is unavailable (13 per cent); and the employer provides or subsidises car parking (12 per cent) (TDC, 2009: Figure 3.9). Interestingly, although economic values could be attached to these more popular responses, none directly concern the costs of operating motor vehicles and the influence of the cost of petroleum would seem unlikely to immediately or directly alter these reasons.

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[http://www.racv.com.au/wps/wcm/connect/racv/Internet/Primary/my+car/advice+\\_+information/vehicle+operating+costs/](http://www.racv.com.au/wps/wcm/connect/racv/Internet/Primary/my+car/advice+_+information/vehicle+operating+costs/)

## 7.2 *Split incentives*<sup>24</sup>

One of the classic policy issues in energy policy, especially in energy conservation, seems likely to apply to the CPRS, namely the limitations of price signals in markets where conditions known to economists as ‘split incentives’ exist. Such problems emerge when investors and consumers are associated but do not respond to prices in the same way. This situation typically arises when an individual/household or some firm – acting as a ‘principal’ – pays another party – acting as an ‘agent’ – for a service, but the principal can’t be certain that the agent will act in the principal’s best interests; i.e., the parties have different or ‘split’ interests and incentives to act (e.g., between developers/builders/owners and between owners/tenants).

In the case of the CPRS, some parties will be exposed to its influence and some will not, and some parties will be able to make decisions in response to the CPRS price signal and others will not have that option. An example is that private developers can design and build new subdivisions without regard to changes in the price of transport energy, whereas households who take up residence in these areas may be exposed to higher transport costs. Garnaut (GCCR, 2008: Chapter 18.5) identifies this problem and – drawing on a recent IEA report – postulates that there are four categories of split incentives (as shown in Table 11 below).

**Table 11 Categories of split incentives from the Garnaut Climate Change Review *Final Report*.**

	<b>Principal chooses technology</b>	<b>Agent chooses technology</b>
<b>Principal pays the energy bill</b>	<i>Type 1</i>  Principal has an incentive to invest in energy efficiency and to reduce energy use [No split incentive]	<i>Type 2</i>  Agent does not have an incentive to select efficient equipment; e.g., landlords and tenants
<b>Agent pays the energy bill</b>	<i>Type 3</i>  Principal does not an incentive to select efficient equipment; e.g., company cars chosen by firms	<i>Type 4</i>  Principal does not have an incentive to lower energy use [agent selects equipment on behalf of the principal]; e.g., patrons of a hotel

Source: After: Garnaut Climate Change Review (2008). *Final Report*, Melbourne: Cambridge University Press: Table 18.1.

Addressing such split incentives can be particularly difficult because there are no universal solutions; rather, policy responses require careful design to deal with local conditions and circumstances. Garnaut (GCCR, 2008) states that such problems should be addressed by either better monitoring and enforcing of contracts by principles, or devising contracts that ‘better align the interests of principals and agents’. Where such contracts are problematic, suggests Garnaut, then governments may elect to develop standard contracts. However, problems can still persist due to such factors as differences in power and high costs of enforcing contracts.

## 7.3 *Pollution and other perverse incentives problem*

There is a risk in any scheme to reduce one source of pollution that this is achieved at the cost of creating additional pollution from another source. With our interest in transport, we need to recognize that such additional or new pollution could occur within or beyond the transport sector. For example, one of the intended influences of the CPRS is to encourage the purchase of less-polluting motor vehicles, but the ecological costs of motor vehicles are greater than those arising from fossil fuel combustion. A rapid turnover of the national vehicle fleet could result in a net increase in the ‘ecological footprint’ of motorized transport, such as might arise because of the embodied energy and pollutants in motor vehicles. Or the use of hydrogen as a transport energy source could create greater net GHG emissions if fossil fuels are feed stock for commercial hydrogen manufacture, as is currently

<sup>24</sup> In economics, this is the ‘principal–agent’ problem that arises from what economists call ‘information asymmetries’; in energy studies the different incentives between landlords and tenants in investing in energy efficiency is an oft-cited example of this problem.



the case. Or fuels with lower GHG emissions than conventional fuels could have higher levels of other pollutants, and so on.

In practice this problem is quite common; many actions to reduce emissions incur an environmental cost of some form, so that the path of pollution reduction is frequently one where progress is marked by continual trade-offs. Existing – and future – environmental protection law and regulation serves to limit the extent of increased pollution. However, these types of protection tend to set upper limits on point-source polluters and are generally less effective in confining total pollutant loads created by multiple and/or diffuse polluters. Environmental regulation also tends to be relatively less effective in addressing the combined ecological costs associated with goods and services, such as assessed by ecological footprints, embodied energy, materials intensity, and the like.

‘Embodied GHG emissions’ are a particular problem for the national CPRS. So long as the CPRS covers all major GHG emitters, then GHG emissions at different points of the domestic commodity chain and manufacturing processes are captured. As it turns out, the EITE group are effectively excluded, thereby allowing upstream emissions from these sources to ‘escape’. Possibly greater sources of embodied emissions that will not be covered by the CPRS are those associated with imported goods and products – and the international transport services that delivered them. Such goods and services would enjoy an advantage over domestic equivalents that would carry the CPRS price. Moreover, domestic firms could shift production offshore, so that their goods made available for consumption would not be subject to the CPRS. There has been debate over such a likelihood and it is the opinion of the federal government’s economic advisors that very few Australian industries would shift offshore as a consequence of the CPRS. However, Australia will continue to import considerable quantities of manufactured products from nations whose production does not involve an ETS or other price signal on GHG emissions.

Although the CPRS seeks to increase the costs of GHG-intensive forms of travel relative to lower-emitting transport activities, one outcome may be to produce technological changes and consumer choices that lower the – marginal – costs of transport, most notably the use of motorcars and trucks. This occurs by promoting the use of more fuel-efficient and energy-efficient vehicles that more than offset the operating costs imposed by the CPRS. Total mobility costs to motorists can therefore be lowered and provide financial savings that can be spent on greater travel. In these circumstances, there is a risk that the ‘rebound effect’ that results from efficiency gains designed to conserve resources cancels out the intended gains. In practice, this may not be a great risk of increased travel because other factors, such as the valuation of time spent travelling, may act as a restraint of greater vehicle use. Nonetheless, the possibility that the CPRS will not discourage motoring to the extent expected would seem to be quite possible.

## **8. Barriers to an efficient and effective CPRS**

### *8.1 Governance policy and practice conflicts with the CPRS*

As a consequence of considerable fragmentation in the governance of Australia’s transport sector a number of problems for the efficient and effective management of the sector are evoked. Urban transport and land use planning is primarily the subject of state – and some local – governance, except for major road and rail freight infrastructure that involves Federal funding, and such projects are usually as put forward by the states/territories. While it would be unrealistic to expect uniformity of purpose and direction across broad portfolios in such complicated issues, nonetheless the potential of problems arising from the CPRS being undermined by other extant policies may be serious, especially when arise in different jurisdictions.

A number of submissions to the GCCR identified such conflicts between the CPRS goals and other policies, such as arising from current road transport subsidies in the fuel tax credit scheme, fringe benefits tax for company cars, public authority fleet purchases from Australian vehicle manufacturers, and roads expenditure that all encourage road vehicle use. On this issue, the GCCR *Final Report* (GCCR, 2008: 527) states:

Some policies reduce the costs of vehicle use or create incentives for use. Fringe benefits tax provisions attempt to value benefits provided by employers to employees as part of salary packages in order to appropriately tax them. However, the current treatment of vehicles and

parking spaces distorts decisions towards private vehicle use and greater demand for transport overall.

Phasing out of these taxes has been recommended in the Australian Senate committee report of 2000 (Australia, 2000), *The Heat is On: Australia's Greenhouse Future* (Recommendation 47) and in the Federal House of Representatives Standing Committee on Environment and Housing Report, *Sustainable Cities*.

For the most part, the CPRS assumes a single market for the transport sector, yet there are a number of potential barriers to the operation of a seamless ETS in the transport sector created by the sector's governance. Potentially, these governance issues include:

- State and Territory governments have primary public policy responsibility for urban transport and urban planning portfolios, together with other relevant portfolios that influence transport policy and activity
- Federal funding for major transport infrastructure exerts a critical influence on urban transport systems, notably the support of road projects – the future activities of Infrastructure Australia will be critical in this regard
- Federal financial resource allocation has not provided support for public transport infrastructure until the recent creation of Infrastructure Australia, thereby creating a considerable historical market distortion in infrastructure and service provision between private and collective transport modes (Russell, 2008, and the historical activities of Auslink)<sup>25</sup>
- Urban passenger and freight transport are typically planned, managed, and operated as separate entities
- There is considerable mixing of public and private sector involvement across the urban transport sector between states/territories, between passenger/freight services, between road and public transport modes, between public transport service provision, and other features, and
- Urban transport is effectively a collection of separate individual markets which share common features, such as fuel and vehicle technology choices, but are strongly differentiated by governance and other local factors.

To these issues, we can add the role of local government. Many local transport-related and land use – and service provision – decisions by local governments play a major role at the scales of the individual citizen, single household and individual firm. These factors that influence transport decision making by consumers include the provision and cost of car parking, restrictions on vehicle access and use, local traffic control measures – including speed controls – and, importantly, the provision of facilities for active transport – pedestrians and cyclists – and often for public transport users.

## 8.2 *Internal contradictions within the CPRS*

Effective functioning of markets requires regulation; 'free markets' at the macro-scale exist only in theory. As the major inquiries by Garnaut (GCCR, 2008), Stern (2006) and others emphasize, the effectiveness of any carbon trading market depends greatly on the design and operation of its regulatory regime. A few obvious areas requiring careful attention to prevent failure in any ETS include:

- Reliable and thorough measurement of emissions, independent verification of such measurements, and information handling and storage systems
- Inclusion of major polluters and GHG
- Public accountability of carbon permit trading, and
- Prevention of 'perverse incentives' through which routine operations of the ETS give rise to increased overall GHG emissions.

There are, in effect, two broad ways in which the integrity of the CPRS can be undermined. First, through poor design and/or operation, the CPRS may be plagued by illicit behaviour by its participants, or by behaviour that is legal, but nonetheless seeks to game the system for private advantage. Further, there is the problem of allowing major polluters or economic sectors to operate outside the ETS,

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<sup>25</sup> Under the recently formed federal Infrastructure Australia, it is possible that urban public transport projects may receive federal funding in the future.

thereby undermining the effectiveness of the scheme and increasing the burdens on ETS participants. Second, there is the problem of perverse incentives, in which the effectiveness of emissions-cutting in one area is undone by incentives that encourage – or fail to control – emissions in another sector.

On the first way of how the integrity of the CPRS can be compromised, a few major issues have been highlighted in current debate, namely the granting of exemptions to particular firms/industries from participation in the CPRS.

Another potential weakness in the CPRS occurs through the use of international trading in emission permits. Under the FCCC, international GHG emissions trading and emission credit formation have begun, but to some extent this trade has preceded a full and effective system to ensure the legitimacy of all transactions. As Garnaut notes, measures will be necessary to protect the integrity of a national ETS within an international ETS (GCCR, 2008: 229):

With international trading, incentives to under-report emissions are heightened. An international authority, possibly under the auspices of the FCCC, would have to assess whether minimum standards are met, similar to existing procedures under the Kyoto Protocol.

Activities that produce emissions savings in sectors beyond the transport sector can be legitimate, but some will be more difficult to verify. For instance there are many schemes offering to offset emissions generated by car or air travel by tree planting and other non-transport measures.<sup>26</sup> Initiatives that involve carbon offsets through international projects can be especially problematic in this regard. Critics have argued that the estimation of carbon sequestration in the land use, land use change, and forestry sector is imprecise, sometimes highly so, and as such unsuitable for being regarded as a carbon credit in emissions trading. Bio-sequestration projects would seem questionable for their capacity to produce permanent and verifiable carbon reductions, and while some geo-sequestration options show promise, any potential use lies in the future.

An example of the second type of problem (i.e., perverse incentives) arises from a feature of the government's decision that road transport will be effectively exempted from the CPRS influence by virtue of the cent-for-cent CPRS offset through fuel excise reduction, which is that rail transport isn't included in this exemption. In other words, the CPRS will apply to fuels used for rail, but not to road, which has most implications for freight haulage. There would now appear to be an incentive through the CPRS for road freight transport use over that of rail. Such an outcome is particularly unfortunate from a GHG-cutting perspective, because it is exactly the opposite of what needs to occur, namely the shift of the freight task from road to rail as much as practicable, especially for long-haul journeys. Whether the CPRS disincentive for rail use will be significant can only be assessed over time, but what is clear is that the CPRS does not provide any incentive for the greater use of rail for freight transport, despite it having a lower GHG-signature per unit of freight/distance than road transport.

### 8.3 *Weak or absent CPRS price signals*

One of the most obvious points of failure of a price signal is that it simply undervalues the cost of carbon emissions relative to the cost of changing energy consumption, so that those energy consumers rationally decide not to alter their existing practices; in other words, the permit price in the CPRS could be too low to be effective. This real-world problem can confound economic theory, for although there may even be economic benefits from cutting GHG emissions (such as shown in the report of the Australian economy by McKinsey and Co, 2008), other considerations can overwhelm these potential benefits. Whether a weak price signal constitutes market failure appears to somewhat a matter of interpretation, although it seems that the failing here is not with the market mechanism per se, as its logic dictates that a low price would cause such an outcome.

There are two factors that will ensure that the CPRS will exert only a weak influence on retail consumers of transport fuels. First, the CPRS will be small in comparison to the current and likely future retail price of petroleum. Second, the CPRS will be small in comparison to other transport fuel

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<sup>26</sup> See, e.g., a recent comparison of 20 carbon offset schemes available in Australia by the consumer magazine, *Choice*: see <http://www.choice.com.au> and comments by the Australian Competition and Consumer Commission to the effect that consumers may be facing misleading and deceptive claims in this emerging market.

taxes and this influence will be entirely negated because the government has taken a policy decision to ensure that the CPRS does not increase the costs of transport fuel. Australian petroleum retail prices already carry a significant taxation into which the CPRS would be rolled (see Section 2.5). As described above (see Section 3.2), the government has decided to swap out the costs of the CPRS on petroleum on a cent-for-cent basis with the federal fuel excise, so as to neutralize the cost of the CPRS on transport fuel consumers.

Regarding the scale of the CPRS, there are some studies suggesting that it will not add greatly to current fuel prices. Parliamentary debates over the CPRS and the costs of petrol in late 2008 produced very widely differing estimates, although the evidentiary source for some claims is unclear. A simple calculation based on petroleum's carbon content shows that the additional costs per litre of petroleum are a few cents if carbon is valued between AUD\$20–40 a tonne (See Table 12).

**Table 12 Value of petroleum based on carbon content**

Value of carbon per tonne (AUD\$)	Value of one litre of petroleum based on carbon content (AUD\$)
20	0.013
25	0.016
30	0.019
50	0.032
100	0.064
200	0.13

Note: Assuming that one litre of petroleum has a carbon content of 0.6385 kg

One earlier study found that a permit price of AUD\$30/tonne of CO<sub>2</sub>-e would equate to around 8 cents/litre at the pump (Allen Consulting Group, 2001). Garnaut (GCCR, 2008: 507) in the *Final Report* stated:

An emissions price of \$20 per tonne CO<sub>2</sub>-e would increase the cost of petrol by around 5 cents per litre, and the cost of travel in a medium-sized car by less than 1 per cent. The impact of an emissions price will become more substantial as it rises over time. For example, an emissions price of \$200 per tonne of CO<sub>2</sub>-e would increase the cost of petrol by around 50 cents a litre.

A study for the Australian Automobile Association produced similar results, with a AUD\$25 permit price giving a 6 cent price rise at the pump for petrol; diesel: 6.8 cents; LPG: 4 cents; and biofuels: 5.3 cents; for a permit price of AUD\$50, these values doubled (AAA, 2008). Given that the average Australian motor vehicle covers 15,000km with an average fuel consumption around 11l/100km, annual fuel consumption is some 1500 l; at a nominal 6 cents/l charge arising from the CPRS (at AUD\$25), the average motorist will face a weekly increase in their fuel bill of less than AUD\$2.

On the first point of a weak price signal, on the available evidence, the position of the advocates of the CPRS is that for Australian motorists is that a CPRS that would add AUD\$90 to the existing annual expenditure of AUD\$10,036 for a medium-sized vehicle (see Section 2.8) will be effective in changing transport-related behaviour. For those with large cars and sport utility vehicles, arguably a high-priority group for strategies aiming at reducing fuel use, the aforementioned CPRS would be less than an additional AUD\$2 weekly costs for running costs of AUD\$219 and AUD\$222, respectively.

On the second factor, namely, that the CPRS will in all likelihood be small in comparison to existing transport fuel taxes and that the government's decision that the CPRS will not increase transport fuel costs to consumers. Australian petroleum retail prices already carry significant taxation – although considerably less than nearly all Australia's OECD partners – into which the CPRS would be rolled (see Section 2.5). As described above (see Section 3.2), the government has decided to swap out the costs of the CPRS on petroleum on a cent-for-cent basis with the federal fuel excise, so as to neutralize the cost of the CPRS on transport fuel consumers. Arguably, the result of this decision is to remove the influence of the CPRS entirely as a means of using price to influence behaviour, leaving the role of the CPRS as a revenue-raising initiative to support investment in for carbon emission reduction. Garnaut (GCCR, 2008) was seemingly unconcerned by such problems when considering that the consumer's

response would be influenced by income and that (GCCR, 2008: 508): 'The higher the oil price, the lower the emissions price will need to be to make the transition to lower-emissions options competitive.' Few would dispute this functioning of the price mechanism, but it leaves open the question of what might constitute a high enough oil price to change behaviour, and does not unequivocally amount to a rationale for emissions trading.

To what extent have transport consumers responded to oil prices? A survey of the research into the elasticity of demand for transport energy by Graham and Glaister (2002) found quite different responses between the short and long term, with relatively little response to price in the short term but a greater response over the longer term. These authors also find most studies report that price tends to exert a greater effect on reducing fuel use than in reducing vehicle use and that the demand for car ownership is strongly tied to income.

One implication of this phenomenon is that when income growth outstrips fuel price rises, the level of car ownership will be largely unaffected by operating costs, including fuel. Given that if there is to be response to the CPRS energy price, a proposition that seems somewhat tenuous given the reasoning above, there would need to be sufficient time for fuel users to respond to the economic signals of the CPRS. For those operating and monitoring the effectiveness of the CPRS this is a particularly acute challenge, as sufficient time must be allowed to elapse so that tolerated short-term failure becomes realized longer term success. In such circumstances, the detection of system poor performance due to design and operational causes will be difficult.

## **Conclusions**

Each Australian motorist at the wheel of some 15 million motor vehicles covers around 15,000km a year at 11 l/100km fuel efficiency, giving rise to some 4 tonnes of CO<sub>2</sub> emissions.<sup>27</sup> Given that motor vehicles comprise the bulk of our transport emissions, this gives us an individual measure of our relationship with national GHG emissions.

Climate change has emerged as the greatest experiment of all time for the application of environmental economics as a major policy tool. Yet, even before Australia has begun this bold policy change, it seems that it will be an unmitigated failure in the transport sector. Even by adopting the most optimistic outlook and the most helpful of assumptions, it remains that there is no effective carbon emissions market in this sector. It matters little what economic theory means in the abstract if it fails in application. Emissions trading has been clothed in the language of neutral technique and being devoid of values or vested interests, and thus promoted as having the imprimatur of science. Nothing could be further from the truth; environmental economics is but one of many policy approaches, each representing different values, interests, and with differing outcomes. Implementation of all policies involves political processes and choice made in the political arena; nowhere is this clearer than in the efforts to devise carbon trading for the transport sector.

Australia has no experience in operating a national emissions trading scheme; indeed, its experience in using market-based policies for environmental protection and resource conservation is restricted to a relatively few cases, perhaps most noticeably for water allocations. As a pioneer programme, the CPRS design is based largely on economic theory and what might be learned from other trading systems, including existing carbon emission trading schemes overseas. It follows that the CPRS is experimental and, as such, the question of how its early performance is to be monitored and assessed will be critical to experiential learning. It follows that if modifications to the CPRS are required, then the system must be able to be changed, although the degree to which this may be possible is problematic.

Indeed, in the Rudd government's efforts to find wider acceptance of the CPRS among critical constituencies, especially those large corporations involved in the energy sector, a great number of compromises to the scheme have already occurred. Decisions over the EITE, for example, have not arisen from the dictates of economic theory but seemingly from political sensitivity and pragmatic considerations. Sensitivity over the costs of motor fuel in a nation with some 15 million licensed drivers, nearly all of whom are required to vote, was no doubt prominent in the government's calculations to neutralize the CPRS by reducing the fuel excises.

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<sup>27</sup> <http://www.environment.gov.au/settlements/transport/fuelguide/environment.html>

Compromises made in the political sphere don't invalidate the rationale and reasoning behind policies, but the time must come for the realization that the point of emissions trading is to place a price on externalities. And ultimately, there cannot be painless change; as a community we have to either accept that we want to find a way to value the costs of transport emissions to the global climate system and pay that price, or continue to mouth the rhetoric of rational market systems and seek ways to avoid the economic pain of adopting such a rationality. The other option is to consider other policy approaches, which in this case would seem to be not only prudent, but essential.

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