Sustainable Living: A Review of Behavioural Influences and Policy Options for Australia

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1. EXECUTIVE SUMMARY

This document presents a review of current policies that could be applied in Australia to promote increased sustainability amongst individual households, community and business groups. The major focus of the report is on issues of energy consumption, with water, waste and mobility issues included where relevant. The report assesses relevant research on behavioural drivers and behaviour change, and draws on international and local initiatives that have been successful in promoting such change. The report identifies best practice and success factors for each of these initiatives, and makes recommendations for possible solutions to achieve more sustainable living in Australian households.

By way of background, Australian consumption of resources is high, with per person levels of energy and water consumption, greenhouse gas emissions and more general environmental impact amongst the highest in the world. The majority of this impact is not from direct use of resources, but from indirect use; that is, the energy and other resources that are used to provide the food, goods and services consumed by Australian households. Given this high level of impact, there is clear scope for a shift to more sustainable living in Australia. However, the low visibility of the impact of indirect consumption, as well as limits to peoples' willingness and capacity to change, sets a substantial challenge in shifting to more sustainable behaviour.

In pursuit of such behaviour change, the majority of policy measures in Australia and overseas tend to be based on the economics-derived model of humans as rational actors. Thus, policy measures have focussed most strongly on external factors of incentives, regulation and information provision to change behaviour. However, limitations in the adequacy of the rational actor model suggest that a broader range of internal and social influences are important, both because they can reduce or prevent desired reactions to external factors, and because if used appropriately they can shift behaviour in their own right.

External influences

Provision of **information** can influence behaviour, but is unlikely to be enough to encourage change without additional measures; information is best thought of as a necessary but insufficient condition for change. Providing targeted and personally relevant information is more effective, so feedback represents an important means of encouraging change in some instances.

Use of **incentives**, especially financial incentives, to encourage sustainable behaviours has had limited success. This probably reflects a combination of factors related to habits, values, and the nature of people's relationship with energy and water. Evidence suggests that incentives may sometimes backfire, and that there are other drivers that may be more effective as a means of promoting some behaviour.

Internal influences

Habits are difficult to change, since it operates without conscious awareness. Unfortunately, many of the behaviours that are relevant to sustainable living involve habitual consumption and usage. Carefully designed interventions can change habits by raising awareness and/or leveraging the disruption of normal patterns, which makes habits easier to change.

Various aspects of perceived and actual **personal agency**, including capacity to process information, are important in determining whether people will actually change behaviour. Targeting interventions to specific groups, allowing for tailoring to individual people, restricting the range of information and choices provided, and promoting a sense of efficacy can all help interventions to be more successful.

Heuristics are systematic errors in judgement that people make under conditions of uncertainty. Knowledge of the nature of these errors can allow them to be leveraged to encourage behaviour change in interventions, by adjusting how choices are presented, described or structured.

Whilst **attitudes** can in some instances predict sustainable behaviour, the relationship between attitudes and behaviour is inconsistent and complex. Interventions that rely solely on the impact of existing attitudes, or that attempt to shift attitudes, are often unlikely to succeed without additional behavioural drivers in place. Attitudes to climate change, in particular, have features that in many instances make them unsuitable for influencing behaviour change.

Values can promote or discourage sustainable behaviour depending on various features of the context, the person involved, and even their country of origin. Values are quite stable, so are unlikely to be amenable to influence by any policy intervention; rather, it is important to acknowledge that the impacts of interventions can be moderated by the prevailing values of individuals and community groups.

Social influences

The perceived or actual behaviour and opinions of other people have an extremely strong influence on individual behaviour, despite the fact that people assume such social influences are negligible. Interventions can leverage social influence in a number of ways that are likely to dramatically increase impact and behaviour change. The presence of social influences can also act to improve the effectiveness of other influences on behaviour.

Policy Review

Issues of policy design are considered, including evidence-based development and management of risks, followed by a detailed assessment of Australian policies and programs, including examples of education/information, financial incentives, regulatory

instruments, tradeable permits and voluntary agreements. Some international case studies with relevance to Australia are also presented.

Best practice policy making for sustainability requires a process that allows stakeholders representing diverse interests to share research, data, knowledge and experience. Policy networks that meet and discuss regularly can help facilitate this process. Ultimately, policy makers must find a way of valuing a policy intervention that weights the diverse interests of Governments stakeholders and overcomes analytical bias that can result from the dominance of a single analytical discipline.

It is suggested that policy makers need to engage stakeholders, and set clear, long term policy to achieve sustainability objectives. These objectives must be based on sound data, and need to be cognisant of real environmental, social and economic constraints that affect how the objective is set, or the ability to achieve the outcome.

When setting policy to motivate behaviour, policy makers need to be aware of the limitations of assuming people respond rationally to financial signals. A range of psychological and social forces (detailed earlier) influence how individuals and groups process information and make decisions. Where possible, a complementary suite of policy measures may be required to ensure individuals and groups have the information, motivation and capacity to respond effectively to policies. This often requires thorough planning and coordinated policy action across departments.

Finally, the specialised issues associated with transport and mobility are described, along with an assessment of policy options in this area.

2. OVERVIEW

This document presents a review and assessment of current policies and programs that could be applied in an Australian context to promote increased sustainability amongst individual households, community and business groups. These include initiatives that relate to specific technologies (e.g. feed-in tariffs), contexts (e.g. building regulations), and behaviour change programs and information campaigns. The major focus of the report is on energy, with water of secondary importance and waste and mobility issues included where particularly relevant. In terms of context, householders are of primary interest, followed by suburban communities and SMEs.

More sustainable use of energy and other resources can improve energy security, foster long-term economic gains and help to reduce anthropogenic CO_2 emissions. Although the opportunities for change are large, there are also a number of barriers that continue to exist, including the low priority given to sustainability issues, financial obstacles, information asymmetries, and a lack of motivation for change. This report examines these issues in an Australian setting, and draws on international and local initiatives that have been successful in bringing about the required behaviour changes. The report identifies best practice and success factors for each of these initiatives, and makes recommendations for possible solutions to achieve more sustainable living in Australian households.

Where possible, the project uses consistent metrics to assess the impact of changes towards more sustainable living. Also where possible, we provide evaluation of the effectiveness and benefit-cost of the policies and programs, and recommendations for synthesis of certain policies.

The report is divided into eight sections, beginning with the executive summary and this overview. Section 3 describes the notion of sustainability, and considers various indicators of consumption in Australia, including indices of ecological footprint, energy use, emissions, water and waste, and provides a brief description of the sorts of behaviour change that would be expected to have a substantial impact on these measures.

Section 4 describes various drivers of behaviour, and distinguishes between external factors, internal factors, and social factors. Research findings are assessed, and conclusions are drawn about the application of these drivers to policy aimed at behaviour change.

Section 5 presents an overview of policy-making principles, and Section 6 provides an analysis of specific case studies from Australia and overseas that relate to behaviours relevant to sustainability.

Section 7 presents background information on transportation separately, since it involves a number of issues that are distinct to other areas of behaviour change, and Section 8 presents evaluation of transport policy options.

3. CONSUMPTION IN AUSTRALIA

The notion of “sustainability” can be difficult to define precisely, but there is broad agreement internationally that the term embodies notions of:

- a concern for the triple-bottom line: economic, social and environmental outcomes all should be considered when planning and assessing human actions,
- intergenerational equity: the future impact of human actions should be considered, so that current activity does not restrict the potential activity of future generations, and
- striking a balance between manufactured capital, natural capital and human capital *(WCED, 1987).*

In recent years, the rapid increases in global population, associated increases in resource demand, a growing awareness of the serious potential impacts of climate change, and threats to the future security of food, water, and energy supplies have placed a renewed emphasis on the importance of sustainability concepts, and on the notion of “sustainable living”.

To provide a background for our discussion of sustainable living in Australia, it is useful to consider current levels of consumption in this country. More specifically, it is the *impact* of consumption that is most relevant to sustainability. This section discusses four measures of consumption impact that are particularly useful in this regard:

1. Ecological footprint: the overall impact of human consumption assessed against the productive capacity of the planet.

2. Energy use and greenhouse gas emissions: levels of energy use, along with the associated levels of CO_2 and other gasses that influence global warming released by human activities.

3. Water use: the total amount of water that is used in human activity, including water used in the production of food, goods and services, as well as water directly consumed in households.

4. Waste production: the amount of solid waste produced and levels of recycling.

Where available, information on likely future changes for each of these areas is also presented.

3.1 Ecological footprint

Ecological footprint is measured by assessing the total amount of productive land area required to support the consumption of a group of people. The total productive

capacity used on the earth in 2005 has been assessed at 17.5 billion global hectares[1], which represents an average of 2.7 global hectares per person (GFN, 2008). Since the total productive capacity available in 2005 was only 13.6 billion gha, or 2.1 gha per person, this means that the total population of the earth is using more resources than the planet can sustainably provide. Figure 1 below, shows how humanity's ecological footprint has changed since 1961. Since 1986 the consumption of global resources has outstripped the planet's total productive capacity, and has continued to rise fairly consistently since the early 1990s.

Australia's ecological footprint in 2005 was 7.8 gha per person. This figure puts Australia fifth in the world in terms of per person consumption, behind the United Arab Emirates, the USA, Kuwait and Denmark (GFN, 2008). Figure 2 shows the contribution of various activities to the average household ecological footprint. Almost half the household ecological footprint in Australia is attributable to food production, and over one-third for goods and services. It is notable that it is not simply the resources that Australians use directly in their own homes that produce such high levels of impact; rather, it is the resources used indirectly to supply our consumption of food, goods and services (ACF, 2007).

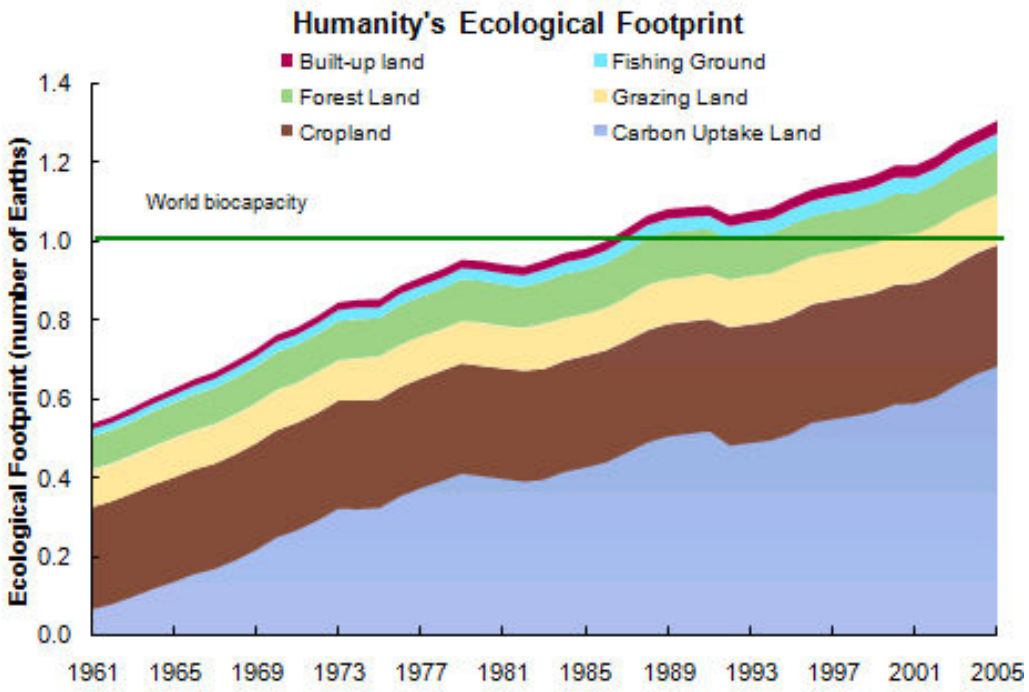

Figure 1: Humanity's Ecological Footprint by component, 1961—2005. (Source: GFN, 2008).

[1] Global hectare (gha) is a standardised measure of the productive capacity of land resources. This measure takes into account the different levels of productivity on different types of land (e.g. crop land is more productive than grazing land).

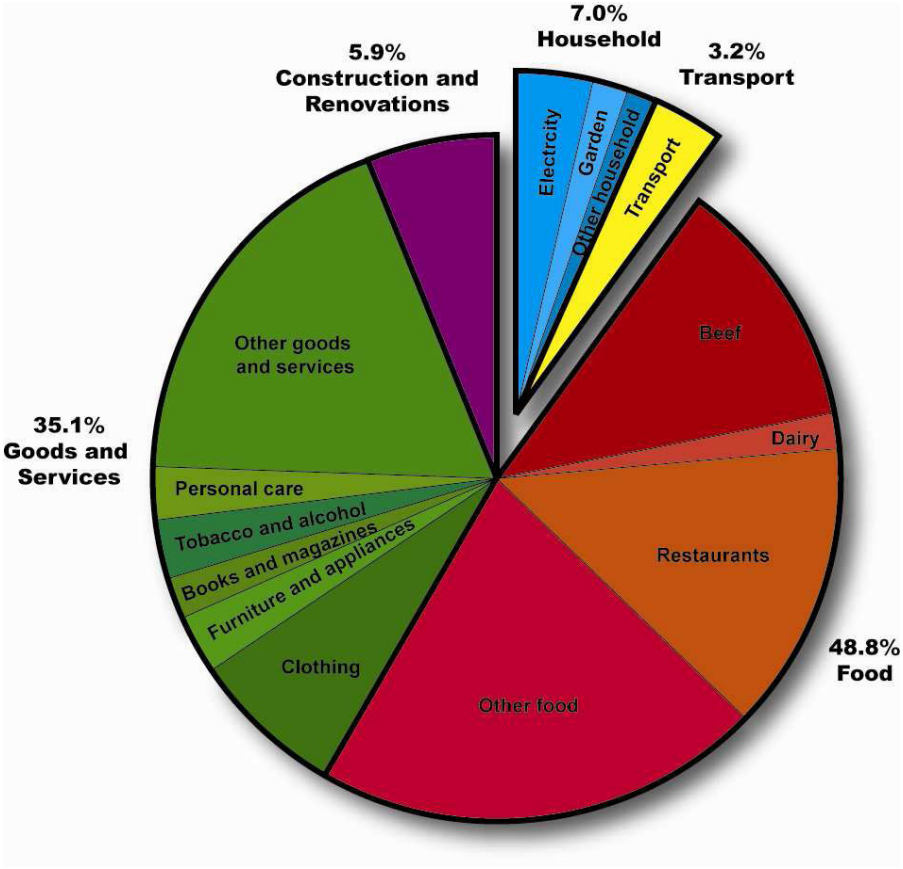

Figure 2: Australia's average household ecological footprint by end use. (Source: ACF, 2007).

3.2 Energy use and greenhouse gas emissions

The vast majority of energy used in Australia is sourced from the combustion of fossil fuels (coal, oil, and natural gas in particular), and it is this combustion that represents the major source of greenhouse gas emissions produced by human activities. Thus it is sensible to consider energy use and greenhouse gas emissions together.

In 2006, the total greenhouse gas emissions produced by Australia (including fossil fuel combustion, land use, and forestry) was reported as 576 million tonnes of carbon dioxide equivalent (CO_2-e)[2], or an average of 28.1 tonnes CO_2-e per person (DCC, 2008a). This per person rate of emission was the sixth highest in the world, and was twice the OECD average and four times the world average (Garnaut, 2008). Australian per capita emissions have consistently been amongst the highest in the world. In 2002, for example, our per capita emissions were reported as the 3rd highest in the world behind USA and Saudi Arabia (UNEP/GRID-Arendal, 2005).

[2] Greenhouse gases are reported in terms of "carbon dioxide equivalent" or "CO_2-e", which brings a wide range of human emitted gases (e.g., methane, nitrous oxide etc.) under one metric.

Although arguments are made that per capita emissions do not reflect Australia's real impact because of our relatively small population, this argument is misleading. Based on 2001 data, Australia's total emissions were higher than many countries with larger populations, including France and Italy (each with about three times Australia's population; Turton, 2004). More recent data on emissions related to fossil fuel use only (and excluding the impacts of exports and land use) places Australia 16th in the world in total emissions (Boden et al, 2009).

There are a number of ways to estimate residential sector emissions, with differing assumptions and methodologies. One key assumption deals with how responsibility for emissions is assigned. Are household emissions simply those that arise from energy-related consumption that takes place *in the home*, such as electricity, gas, and car use, or should household emissions be broadened to include the production and distribution of household goods and services? This summary of residential sector emissions draws on two reports, each representing one of these approaches:

- The Department of Climate Change (DCC, 2008a) greenhouse gas *Inventory by Economic Sector 2006*.
- The Australian Conservation Foundation (ACF, 2007) *Consuming Australia* report. These data arose from ACF commissioned research conducted by The University of Sydney's Centre for Integrated Sustainability Analysis (Dey, Berger, Foran et al., 2007).

The DCC reports Australia's emissions according to the *Greenhouse Gas Protocol* (WBCSD, 2004), which broadly defines emissions in terms of 'direct' and 'indirect' sources. 'Direct' greenhouse gas emissions are those that arise from burning of energy fuels within or under the control of a specific entity. In the residential sector this relates to combustion of natural gas and wood in the home, and the use of petrol in privately owned vehicles. 'Indirect' emissions come from energy used for activities that occur within the specific entity, but where the combustion to produce the energy occurs outside the boundary and control of the entity. In the residential sector, this includes consumption of electricity from coal- and gas-fired power plants.

Under the Protocol, these direct and indirect emissions are referred to as scope one and two emissions respectively. The Protocol makes a further distinction, referred to as scope three emissions, which includes 'up stream' emissions brought about by the extraction and transportation of energy fuels. It is important to note that there can be variability in the application of the 'scopes' as they are often subject to interpretation. For example, waste disposal may or may not be included under scope three emissions.

The DCC report provides sector emissions arising from scopes 1 and 2 for the 2006 calendar year. In contrast, the ACF report extends the consideration of residential emissions beyond the 'scopes' to the embodied energy consumption (based on expenditure) of goods and services in the sector during the 1998-99 period. Consequently, the ACF report shows a far higher estimate of emissions per household than the DCC report.

According to the Federal Department of Climate Change (2008a), the residential sector contributed about 105.4 million tonnes of carbon dioxide equivalent emissions (CO_2-e) in 2006, or about 18% of Australia's total emissions in that year. This estimate includes both scope 1 and 2 emissions, and equates to approximately 5.3 tonnes CO_2-e per person, or 12.5 tonnes CO_2-e per household[3]. Figure 3 shows the residential sector emissions compared to other sectors in the Australian economy.

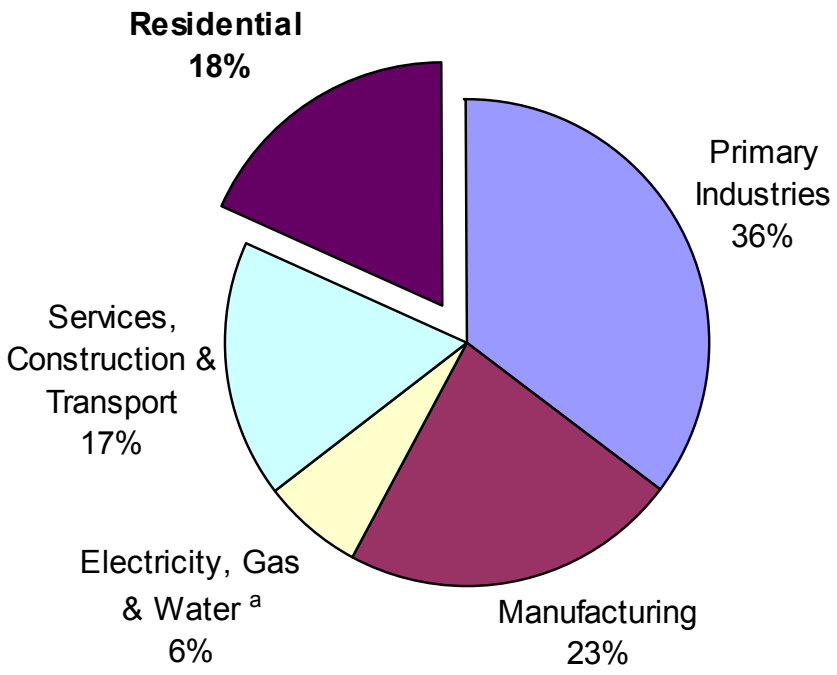

Figure 3: Residential sector emissions (scope 1 and 2 combined) as a proportion of the Australian economy (Source DCC, 2008a[4]).

[a] Emissions not consumed by other sectors, but associated with the generation and provision of these services.

The DCC report examines 2005 household energy emissions data, and allocates energy emissions to end use based on a 'full fuel cycle' analysis, which adds scope 3 emissions. Figure 4 depicts these emissions, plus direct transport-related emissions, for the residential sector.

[3] Calculations based on Australian Bureau of Statistics 2006 Census data, with a population of 19.9 million spread across 8.4 million households.
[4] Additional data supplied by the DCC was used in the generation of this figure, and is used with permission.

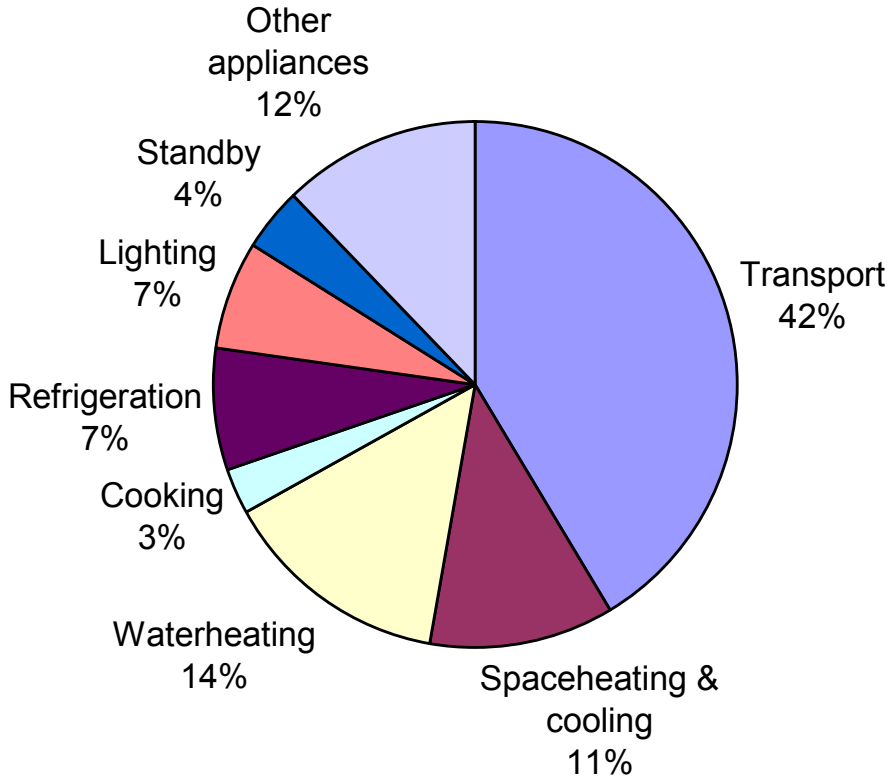

Figure 4: Breakdown of emission sources (scopes 1, 2 and 3) for the residential sector by end use. (Source: DCC, 2008a).

According to the ACF report, the average Australian is responsible for 18.9 tonnes CO_2-e annually (a much higher figure than the 5.3 tonnes reported by the DCC). As discussed above, the difference between the two estimates reflects the different assumptions made regarding who is responsible for emissions. In the case of the research used by the ACF report, responsibility for emissions arising from the production of goods and services is assigned to the household consumer.

In going beyond the 'scopes' (additional to direct and indirect household energy use) in the sector, the ACF report effectively identifies the major sources of emissions amongst major household products and services (see Figure 5). As the figure shows, the consumption of household energy under the 'scopes', particularly in electricity and transport, accounts for roughly 30% of household emissions, which equates to 5.8 tonnes per capita. This result is comparable to the DCC reported figure above, and to another study (GWA, 2003), which estimated residential sector emissions for the ACF reporting period (1999) to be 102.4 Mt, or 5.4 tonnes per capita. As Figure 5 shows, other major contributors to emissions derived from this assessment of household consumption include general goods and services (29%), food (28%), and construction and renovations (12%).

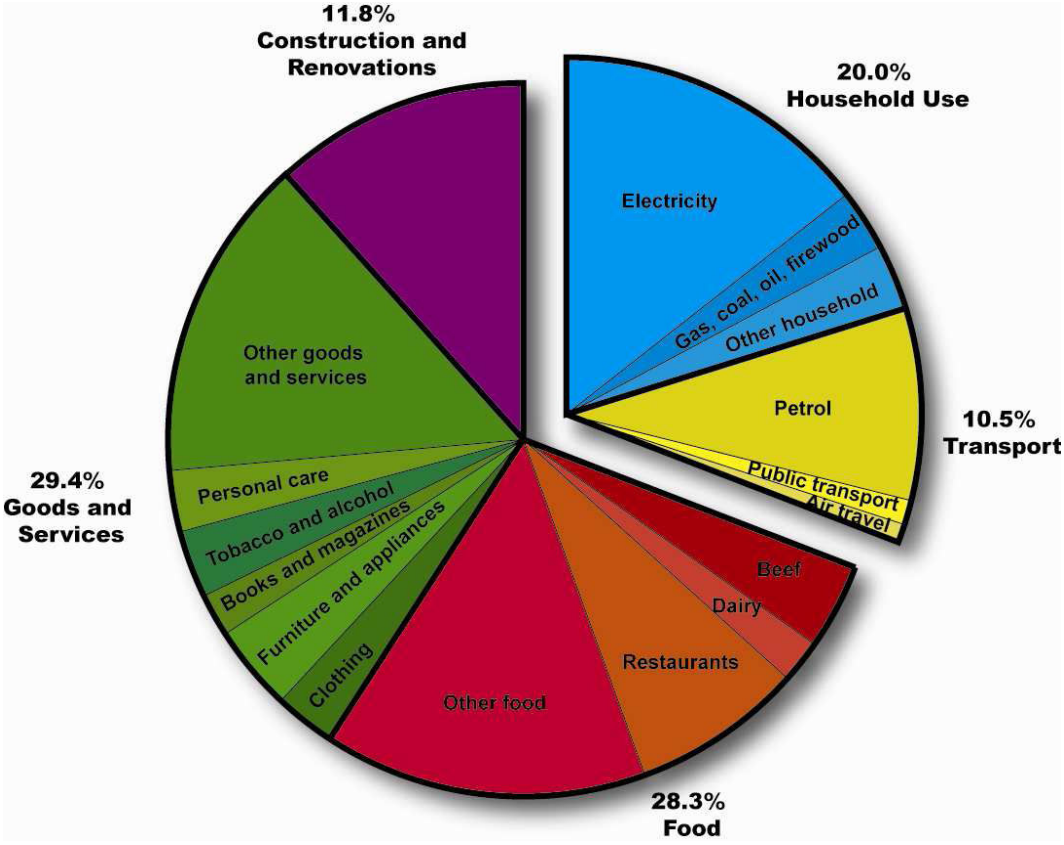

Figure 5: Breakdown of the average household greenhouse gas emissions by end use in Australia. (Source: ACF, 2007).

It is noteworthy that household energy use (not including transport fuels) in Australia is projected to grow by 18% from 2007 levels to 2020, and the majority of this increase is expected to come from a large increase in the electrical energy used by other appliances (televisions, computers, clothes dryers, home entertainment systems, etc; DEWHA, 2008). More generally, worldwide demand for energy is expected to increase by 50% by 2030 (IEA, 2005), unless there are substantial changes in energy-related policy.

Overall demand for electricity in Australia is projected to double by 2020 (CSIRO, 2006). However, studies suggest that by 2050, reductions of 40% to 60% of greenhouse gas emissions could be achieved across OECD countries by the combined application of energy efficiency, the management of energy demand, and the introduction of low emissions technologies (DTI, 2007; McKinsey & Co., 2007). In Australia in particular, there are known to be substantial improvements in energy efficiency that could be gained at little or no net cost (EEGWG, 2003).

The expected increases in demand for electricity, along with the planned introduction of the Federal Government's Carbon Pollution Reduction Scheme (CPRS), will result in changes in retail electricity prices. Figure 6 below show the estimated national electricity price that is faced by residential customers between 2006 and 2050[5]. Note

[5] Estimated retail electricity prices are available for all States and Territories. Presented here is the weighted national average for illustrative purposes.

that all prices are in real 2006 dollars and measured in c/kWh. Five scenarios are considered: the business as usual case (BAU); two scenarios based on CPRS goals of 5% and 15% reduction in emissions, and two scenarios based on the Garnaut report (2008), aiming for stabilisation of CO_2 levels at 450 parts per million (ppm) and at 550 ppm respectively.

In regard to the carbon price scenarios, the earlier start date for the CPRS scenarios is clearly visible in the chart, with the price trace for CPRS-15 above that of CPRS-5. With commencement in 2013, the increase in prices is greatest under Garnaut 450ppm with the price trace for Garnaut 550ppm following a similar trajectory to that of CPRS-5.

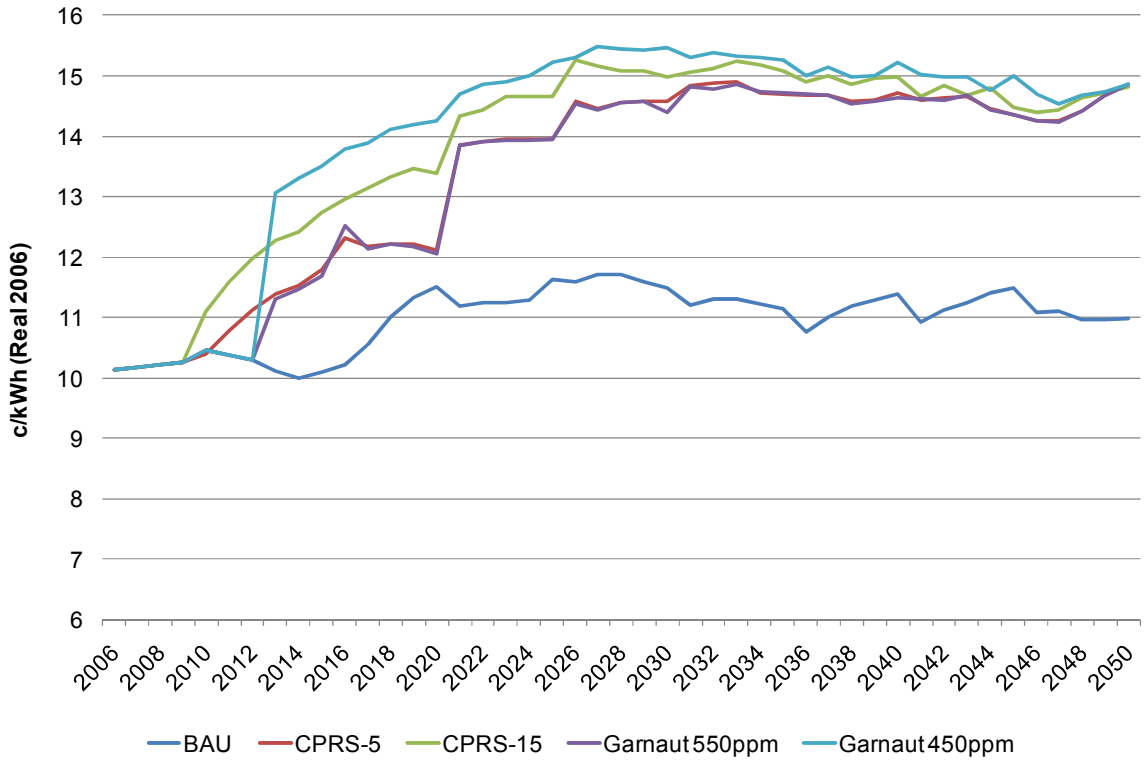

Figure 6: Estimated national average electricity retail prices, Residential customers, 2006-2050

3.3 Water consumption

The average Australian consumes 722,000 litres of water per year, although less than a quarter of this volume is used directly in the household. This consumption is the third highest per person consumption of water in the world (ACF, 2007). Similar to emissions, most of this water use is indirect: embodied in the food, and goods and services consumed by households (see Figure 7). The extensive indirect use of water

for production means that any changes in general consumption patterns will be reflected in changes in water use.

Direct household use makes a relatively small contribution to total consumption, but this type of use (especially outdoor use for watering gardens) is highly discretionary. Such usage can change markedly, as evidenced by the extensive reductions in household consumption over recent years in South East Queensland. Average Brisbane household consumption, for example, dropped from 264 kilolitres (kL) per household in 2004-5, to 128 kL per household in 2007-8 (National Water Commission, 2009).

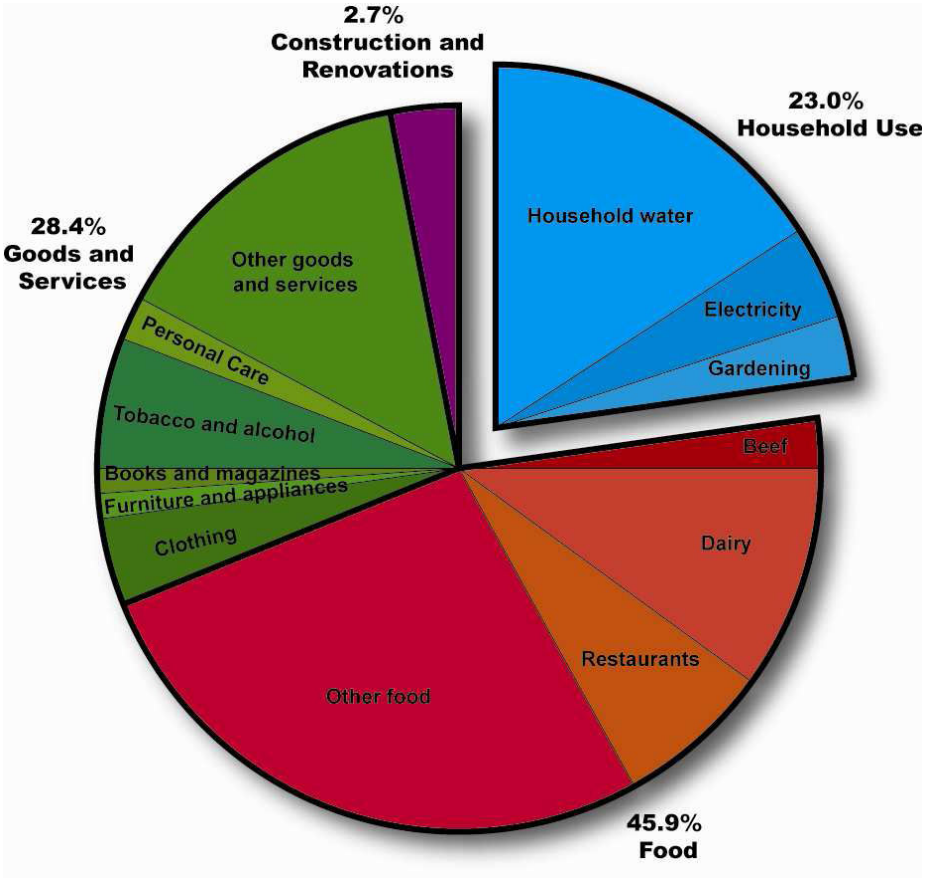

Figure 7: Breakdown of the average household water consumption by source in Australia. (Source: ACF, 2007).

Generation of electricity via coal-fired power stations is a substantial source of water consumed in Australia. According to the ABS water accounts for 2004-05 (ABS, 2006b), the water consumed by the electricity generation sector was 271 gigalitres for that year – approximately half the total water used by a major Australian city.

Lower water consumption for power generation is possible using a variety of existing technologies, including the shift of power generation away from large centralised facilities to smaller local facilities (called distributed generation). Baynes et al (2007)

estimates that deployment of distributed generation technologies could reduce water consumption in electricity generation by 20% in 2050.

3.4 Waste production

The total solid waste sent to landfill in Australia has been estimated at about 20 million tonnes per year[6]. The largest single source of landfill is direct residential waste, which represents about 30-40% of total landfill waste, depending on the state (ABS, 2004). The remainder is waste from construction and demolition, and from commercial and industrial operations.

On average, 36% of all solid waste is recycled (and thus represents waste that is "diverted" away from landfill), although there is a lot of variability between states, with recycling rates ranging from 20% to 60% of all waste (Beeton et al, 2006). This extensive variation suggests that total landfill volume in Australia could be dramatically reduced if states with poorer rates of recycling pursued different waste management strategies.

3.5 Potential behaviour changes

With the above data in mind, it is worth noting the range of specific behaviours that individual householders could perform in Australia to reduce environmental impact, greenhouse gas emissions, water consumption and/or waste production. Although an evaluation of the precise impacts of all potential behaviour change is beyond the scope of the current report, it is possible to specify some individual behaviours with relatively high levels of impact, based on guidelines developed for Australia (CSIRO, 2008; DEWR, 2007) and overseas (DEFRA, 2008). The behaviours, which are indicative rather than exhaustive, include:

- *For energy*: install insulation, use solar- or gas-powered water heating, use more efficient appliances, turn appliances off at the wall when not in use, consider passive design principles when building, use discretionary appliances less often and less intensively (e.g. air conditioners, clothes dryers).
- *For water*: repair leaks, install low-flow shower heads, reduce discretionary consumption (e.g. in the garden).
- *For waste*: waste less food, compost organic waste, re-use or recycle more waste.
- *For mobility*: use more efficient vehicles; avoid short car trips; avoid short-range air travel, increase use of public transport.
- *For food*: eat less red meat and dairy products, buy fruit and vegetables in season.

Just as these various actions have different levels of potential impact, they also have different levels of likely uptake by Australian householders. Thus, the expected impact

[6] Waste Management Association of Australia, 2005. See http://www.pc.gov.au/__data/assets/pdf_file/0016/21904/sub028.pdf

of any behaviour change that is promoted or encouraged needs to incorporate the impact of the change, the number of people potentially able to make the change, and the likelihood of the change actually being made and maintained.

In very general terms, it appears that changes that have more impact on peoples' lifestyles and expectations are less likely to be adopted than those changes with lower impact. For example, changing to a more efficient vehicle has a very large potential impact on environmental measures, but recycling waste represents a much easier behavioural change and is much more commonly adopted (Friedland, Gerngross & Howarth, 2003).

3.6 Summary

Australians consume a lot of resources. Our per person levels of consumption, greenhouse gas emissions and more general environmental impact are amongst the highest in the world. Much of this impact does not come from direct use of resources, but from indirect sources: the energy and other resources used to provide the food, goods and services that are consumed by Australian households. Further, while direct resource consumption tends to flatten out with rising income, indirect consumption continues to rise (SEI, 2009), suggesting that changing indirect consumption is liable to be more effective in promoting sustainable living.

Overall, this information suggests that that there may be substantial scope for improvement in Australia. There are already regions and states within Australia with rates of water use and waste production that are much lower than the national average. Further, there are a number of overseas countries with lower per capita emissions and environmental impact that enjoy a comparable standard of living to Australia. Notwithstanding differences in geography, population density, and economic environment, it is reasonable to suggest that Australia as a whole could substantially reduce consumption and the associated waste and Greenhouse gas emissions.

However, some obvious barriers to such changes exist. Firstly, much of our consumption and its impact are not directly visible to us, but are embodied in the goods and services that we consume. This will make it harder to change behaviour, since the link between environmental impact and purchasing food, other goods and services is not obvious. Secondly, peoples' willingness and capacity to change set an important limitation on the impact of potential behavioural changes: people tend to be most willing and able to make relatively small changes to their lifestyles, while they may be much less able or willing to make changes that have more substantial impacts on environmental impact and resource use. The following section considers these and other barriers to behaviour change in more detail.

4. REVIEW OF RELEVANT BEHAVIOUR CHANGE RESEARCH

4.1 Overview

Extensive research in the social sciences over many decades has produced a vast array of theories, models and mechanisms related to explaining and changing human behaviour. A number of previous reviews have attempted to synthesise this research, with varying degrees of success (e.g. Darnton, 2008; Jackson, 2005; Prendergast, Foley, Menne, & Karalis Isaac, 2008; Shipworth, 2000; Stern, 2000). The intention of this review is to focus most directly on behaviour that is relevant to household consumption and sustainability, research in the Australian context, and implications for policy options.

Previous cross-disciplinary reviews have taken widely different perspectives on this issue, but have tended to reach consensus that there are three major types of influence on human behaviour: external factors, internal factors and social factors. External factors involve features imposed from outside the individual that promote or restrict behaviour. These features are the purview of traditional economics, and can be further divided into costs (and incentives) and provision of information. Internal factors have been derived largely from the discipline of psychology, and involve features within individuals that influence their behaviour. These features include habits, heuristics and biases, issues of personal capacity, and emotions, attitudes and values. Social factors, derived from anthropology, sociology and psychology, include the influence of social norms and culture.

The large majority of policy formulations, driven by a close association with the economics discipline, have concentrated on the external influences on behaviour (Darnton, 2008, Jackson, 2005). However, the broader range of internal and social influences are important, because they can reduce or prevent desired reactions to external factors, and because if used appropriately they can shift behaviour in their own right. All these factors need to be considered to comprehensively assess methods of behaviour change that are relevant to policy formulation.

A final note should be made at this point. In this review we are discussing methods of influencing behaviour, and there can be a negative overtone associated with such suggestions: that they reflect an unethical control or manipulation of people. However, it is important to recognise that all governmental policy represents an attempt to influence people's behaviour – there is no inherent ethical distinction between using a tax incentive to encourage behaviour change, and using a public message designed to influence attitudes and thus promote the same behaviour change. Indeed, there may well be an argument that policy using non-traditional mechanisms of influence may be more effective or efficient, and at the very least a focus on internal or social influences provides a broader array of policy options.

4.2 External influences on behaviour

Traditional economic theory involves a view of people as "rational actors" – that is, they deliberately assess the available information, evaluate the costs and benefits of alternative choices, and make logical and balanced decisions that maximise their own self-interest. Although the most obvious application of this model is the understanding of consumer choices amongst different products, it has also been applied to a much broader array of human behaviour and decision making (Darnton, 2008).

The methods of influencing behaviour that flow from this model are fairly straightforward. Increasing the information that is available about choices, or adjusting the (perceived) relative costs of different choices will influence individual decision-making and hence behaviour. In this model, "costs" include not only financial costs (e.g. the amount of money involved in purchasing a product), but also effort costs (e.g. the time, effort or other imposition involved in purchasing a product).

Further, it is acknowledged that when people act in their own self-interest, there can be a cost imposed to the larger society; such social costs can be made to influence individual behaviour by passing them on to the individual. Thus, for example, people are likely to litter because there is a benefit to them (it avoids the effort cost of clearing away their rubbish), but fines applied to littering impose an additional financial cost (or at least the threat of a cost), which in turn changes the balance of relative costs and makes littering less likely.

The rational actor model makes a number of assumptions. Firstly, the source of individual preferences is not considered, only the impact of those preferences on behaviour – sources of preferences are considered to be "outside the model". Secondly, the model assumes that self-interest is the best way to explain and influence behaviour. Thirdly, it is assumed that people make deliberate evaluations before acting.

Although these assumptions have enabled the study of economics to provide numerous insights into the collective behaviour of people, arguments are increasingly being made that they provide an incomplete picture. People ignore some of the available information, give too much weight to other information, perceive risk incorrectly, make "irrational" choices, appear to act against their own best interest, and in general behave inconsistently with the ideals of the rational actor model (Prendergrast et al, 2008).

In turn, this implies that policy approaches could be more effective if they incorporated elements from outside the traditional economic framework. That is, policy that acknowledges a more comprehensive set of behavioural drivers and barriers would be more likely to be effective than policy that is based solely on the assumptions of the rational actor model. In later sections, these additional drivers and barriers are considered, but first, we consider some research findings that relate to external drivers of behaviour, in particular information and incentives.

4.2.1 Information

The rational actor model suggests that providing relevant information is important in driving decision making and behaviour: information helps inform "rational" decisions, and if the information is readily accessible, this lowers the effort costs involved in decision making (Prendergrast et al, 2008). However, actual behavioural research has often demonstrated that the provision of information alone does little to change behaviour.

With reference to household energy consumption, the USA energy crisis of the 1970s prompted the widespread use of public information campaigns designed to reduce consumption. Extensive studies into the impact of these campaigns showed their effects were negligible, with energy savings in the range of 0-2% (McDougall et al, 1981). Similarly, awareness campaigns for water consumption have been demonstrated to have an impact on consumption of only 2-5%, and their effects are short-lived (Inman and Jeffrey, 2006). There are a number of reasons that can be suggested for this lack of impact:

- People ignore information if it is too complex, or if the suggested behaviour change is too onerous.
- People are strongly influenced by habit, and they will find reasons to keep doing what they have always done.
- People tend to ignore or downgrade information that is incompatible with their current attitudes, values and behaviour.

These drivers of behaviour are discussed below in Section 4.3.

Because of these and other findings, information is best considered a *necessary but insufficient condition* for behaviour change (Darnton, 2008). Although it is often insufficient to prompt behaviour change on its own, information is needed for people to understand the reasons for changing their behaviour and to help them identify the ways they could change, as well as simply providing knowledge about alternative products and services that are available.

For behaviour that relates to household consumption and sustainability, there is definitely a role for information provision. There is widespread misconceptions and lack of knowledge in the community about the nature, causes and consequences of climate change (McCright, 2007), and people know very little about their own energy consumption (Shipworth, 2000). In Australian households in particular, levels of knowledge about climate change and energy issues are extremely low. Although people perceived themselves to have moderate to high levels of knowledge, their perceptions are unrelated to their actual knowledge of climate change issues like sources of CO_2 emissions (IPSOS, 2007). A recent study of over 2000 householders in four states showed that average performance on a short test of this knowledge was equivalent to guessing: people tended to give an equal number of correct and incorrect answers (Gardner & Ashworth, 2007).

Other behavioural research has provided evidence about what features of information can increase the chance that it will influence behaviour. Specifically, for information to have any chance of impacting behaviour, it needs to be noticed, evaluated positively, understood and remembered. Even at this point, there remain barriers relating to capacity to act (see Section 4.3.2 on personal agency).

Giving information the best chance to impact behaviour requires the following features (Shipworth, 2000): the use of clear, concise, simple language, information that is personally relevant, provision of concrete recommendations for actions, and the use of credible and authoritative sources of information.

One widespread source of personally-relevant information is feedback. The ongoing provision of information about a person's or household's own level of consumption has repeatedly been demonstrated to be effective in promoting behaviour change. Feedback has been shown to reduce electricity consumption by up to 15-20% (Shipworth, 2000). Feedback provided via installation of water meters has been shown to reduce household water consumption by up to 20% (Inman and Jeffrey, 2006), especially in high-consumption households (Aitken, McMahon, Wearing, & Finlayson, 1994). Personalised feedback on recycling behaviour produces as much behaviour change as personalised incentives, but is more cost effective (Timlett & Williams, 2008). Feedback has also been shown to be most effective when given frequently (Abrahamse, Steg, Vlek, & Rothengatter, 2005).

Feedback itself is unlikely to directly cause behaviour change. Rather, feedback appears to operate by raising awareness of a formerly habitual behaviour, making the behaviour more susceptible to a person's internal motivation (see Section 4.3.1 on habits). The repeated reminders of consumption that are provided by feedback, along with visible impact of attempts to reduce consumption, help to encourage any efforts that are made. Thus, a person must still be motivated to change for feedback to work; in the absence of such motivation, feedback is unlikely to result in any measurable impact.

4.2.2 Incentives

Studies of interventions aimed at diverse household conservation efforts have shown that rewards do have an impact, but their effects are often short-lived (Abrahamse et al, 2005). For energy consumption in particular, providing financial incentives to motivate behaviour changes (most generally by increasing the cost of energy) have been shown to work some of the time, but not consistently and not extensively (Shipworth, 2000).

Charging a higher price for electricity at periods of peak demand (critical peak pricing) has been trialled and appears to work, with measurable reductions in consumption in reaction to prices that are three times the standard price (Herter, McAuliffe, Rosenfeld, 2007) but the long term responsiveness of consumers to such mechanisms are unknown, and they risk a negative impact on low-income consumers, whose electricity use is less discretionary (Boardman, 2004). It is also unclear whether other factors,

like raised awareness, provision of feedback, the effect of novelty and engagement with the electricity retailer might also be contributing to the response to critical peak pricing.

There are a number of potential reasons for the inconsistent impact of financial incentives. Firstly, energy is a 'low involvement' commodity (Boardman, 2004): people don't notice they are using it because they cannot see it and do not think about its source (Shipworth, 2000). Raising the price of such a product may have a reduced impact simply through people failing to notice or care about the price increase.

Relatedly, the cost of energy in Australia is amongst the lowest in the industrialised world. Expenditure on energy in Australian households represents only 2.1% of the average household budget (ABS, 2006a). In high-income households, energy expenditure is only 1.3% of the household budget; while energy in low-income households represents 6.3% of the budget. With these low levels of relative cost of energy, the added costs of additional consumption are often negligible, and are thus unlikely to provide much incentive to curtail energy use.

Note that likely future price rises for energy (see Figure 6 in Section 2) might help to raise levels of involvement about energy, and could make incentives more effective. However, energy demand has been shown to be quite inelastic: energy costs in the US quadrupled in the 1970s, but per household consumption decreased by only 1.5% (Frieden and Baker, 1983). More recent research has corroborated the finding that the demand for electricity is not very responsive to changes in price (Lijesen, 2007).

For Australia in particular, the elasticity for demand in electricity for residential consumers has been estimated at -0.25 (NIEIR, 2007), suggesting that a 10% increase in price would result in only a 2.5% reduction in demand. The price elasticity of demand for electricity can also be expected to decrease over time, as real income levels can be expected to rise more rapidly than electricity prices. If we also consider that price elasticity of demand estimates are based on data from the previous two decades then it is possible that present price elasticity estimates are already out of date in terms of reflecting household responses to price changes.

Other authors have noted that price elasticity for energy can be influenced by a number of factors, including changes in consumer preferences and perceptions (Jeroen & van den Bergh, 2008). Similarly, internal household water consumption is relatively price inelastic (Inman and Jeffrey, 2006).

Thus there are features other than price that influence consumption. Programs that offer the same financial incentive but are presented differently can have widely different effects: up to 10 times more participation in some programs than others (Shipworth, 2000). The nature of program promotion, perceived simplicity, reliability and trustworthiness are all issues that contribute to the take-up rate of incentive programs, as well as the impact of heuristics and biases discussed later in this section.

Energy consumption and other conservation behaviour can by motivated by reasons associated with altruistic or pro-environmental values or attitudes. There may be risks

involved in providing a financial incentive (an “extrinsic” motivator) to behaviour that is currently driven by internal or “intrinsic” motives (Nyborg, Howarth & Brekke, 2006). This is because intrinsic and extrinsic motivations are not additive. Rather, they can interfere with each other: adding an extrinsic reward to a behaviour that was originally motivated by intrinsic factors like altruism can actually reduce the intrinsic motivation, because adding overt extrinsic rewards might be viewed as controlling and represent a loss of autonomy, or because receiving an extrinsic reward might negate the potential for a self-image or social approval benefit from the behaviour. This “crowding out” effect occurs with financial rewards and when behaviour is enforced through regulation or the threat of sanctions, but not with non-financial rewards like positive feedback. Such effects are not easily reversed: once an extrinsic reward has been removed, the intrinsic motivation often does not re-surface. As a result, weak sanctions or small rewards may be the least useful: they are enough to remove the intrinsic motivation but insufficient to act as a motivator on their own (Reeson, 2008).

There are several implications for policy that can be drawn in relation to incentives. Firstly, financial incentives have a limited capacity to influence energy consumption, given the nature of the product involved. Secondly, there are other drivers of reduced consumption that may be more effective than incentives. Thirdly, adding incentives or regulations can reduce intrinsic motivation and result in limited improvements in the promoted behaviour.

4.3 Internal influences on behaviour

The influences discussed in this section share a common feature: recognition that people have insufficient capacity to search, identify and assess detailed information, then to weigh and calculate that information to identify their most appropriate behavioural response in every one of the thousands of decisions they make every day. Rather, people use a variety of mental short cuts which serve to reduce the complexity of decision-making. Unfortunately, such short cuts present a substantial challenge to efforts to encourage change to more sustainable actions.

4.3.1 Habits

A major short cut is habit: commonly performed behaviour that becomes routine and largely unconscious, in order to avoid the overload of effort that would be required to make a considered decision. Much of the behaviour associated with consumption of energy in households (and elsewhere) involves strong habits: energy use is often largely invisible to people. Attempts to change this behaviour are likely to be resisted simply to maintain the comfort and certainty of familiar activities, and to avoid the effort of changing to new forms of behaviour.

For example, leaving the lights on when leaving a room is habitual behaviour, and it is not very susceptible to influence from traditional policy drivers: simply providing more information about the costs of leaving lights on would be unlikely to be enough to change this behaviour. The use of public transport, recycling behaviour, and the *lack* of

recycling are all strongly influenced by habits (Carrus, Passafaro & Bonnes, 2008; Knussen & Yule, 2008).

People's habitual responses are relatively powerful: sometimes the best predictor of people's future behaviour is their past behaviour. Thus, if forces for behaviour change are not strong enough, they will be overwhelmed by the influence of past behaviour and habit, especially if the goal is long-term behaviour change (Prendergrast, Foley, Menne & Karalis Isaac, 2008).

Changing habitual behaviour requires a process of "unfreezing, shifting and refreezing" (cf. work by Lewin, 1951), in which habitual responses are raised to conscious awareness (unfreezing), new responses are developed and practiced (shifting), and eventually become habitual themselves (refreezing). Unless habits are brought to conscious awareness or otherwise disrupted, any attempt to change them is liable to fail. Thus, habitual behaviours may be easiest to break when the normal routine is disrupted: for example, household consumption patterns are most amenable to change when people move house or contemplate moving house (Throne-Holst, Strandbakken & Stø, 2008). In a study from the UK, people who installed solar panels on their houses shifted their consumption to match periods of peak solar generation, and also reduced overall electricity consumption by 6% (Keirstead, 2007). The presence of the new technology alone appears to have disrupted existing habits of energy consumption.

It is also possible to use a combination of other influences to change habits. Recycling habits have been altered successfully through a combination of public commitments (see Section 4.4) and provision of feedback (see Section 4.2.1; DeLeon & Fuqua, 1995).

Policy interventions aimed at changing habitual behaviour needs to acknowledge the powerful influence that habit represents, and the resulting strong resistance to change that is a feature of such behaviour. Interventions will be more successful if they deliberately attempt to raise habits to conscious awareness, provide repeated reminders, and take advantage of natural disruptions in activity (like interventions aimed at people building a new house, for example).

4.3.2 Personal agency

Another internal influence is personal capacity or agency, which can be further classified into capacity to act, capacity to process information and perceived capacity. The capacity to act relates to more physical elements such as having spare income to pay for something and then apply for a rebate (for example), and home ownership versus renting, since a wide array of physical changes to homes related to energy efficiency are much more likely to be performed by home owners rather than renters.

Capacity to process information operates as a barrier to behaviour change, since too much information can lead to "information overload". Providing additional complexity in available information actually makes it less likely that people will make a choice, or that they will make a good quality "rational" choice. Perceived capacity (or self-efficacy) is

also relevant: people are more likely to make a decision if they can feel comfortable that the decision they have made is sensible or justifiable (Darnton, 2008), and they are more likely to commit to a change in behaviour if they feel capable of performing that behaviour.

There are a number of implications of personal agency in terms of interventions. Firstly, identifying the group or types of people with the capacity to respond to the intervention is obviously important. More generally, tailoring a single intervention in different ways to various sub-groups of people is an excellent strategy to maximise the impact of a given policy (see Jeffrey & Gearey, 2006 for examples in water use, and DEFRA, 2008 for examples across a range of sustainable behaviours). Likewise, interventions that provide for personal choice between a few options are more likely to succeed. Further, it is important to acknowledge the messaging to provide information may actually more effective if the amount of information is limited rather than comprehensive: emphasis of a single salient element might be more influential than providing information on all attributes. For example, promoting notions of comfort is more effective in motivating homeowners to renovate homes than promoting energy efficiency (Knight, Lutzenhiser & Lutzenhiser, 2006). Finally, methods of providing information about desired behaviour changes should deliberately promote the sense of agency or self-efficacy in the target groups: showing working examples and demonstrations is a good way to do this.

4.3.3 Heuristics and biases

Heuristics are mental short-cuts used when making decisions in the presence of complex or incomplete information. The study of heuristics that people use to guide their decision-making has a long history, beginning with work by Kahneman and Tversky (1974, 1979, and 1981). When people use heuristics, they make use of only a subset of the available information, which leads to the systematic distortion or bias of decision-making away from choices that could be considered “rational”. A number of common biases have been identified, including:

- *Framing effects:* choices can be strongly influenced by how choice options are presented or framed, and in particular people are loss averse - people are less willing to risk a loss than to risk a gain of equivalent size. This means that potential negative outcomes tend to be more motivating than potential benefits: messages designed to encourage sustainable behaviour have been shown to be most effective when they clearly describe the recommended behaviour and when they portrayed the target as personally and negatively affected by continued inaction (Davis, 1995). A similar approach has been suggested to promote energy efficiency: to highlight the current losses people are experiencing in their electricity spending, rather than gains that could be made by changing behaviour (Shipworth, 2000).
- *Hyperbolic discounting*: people are less willing to wait for a larger delayed benefit than to accept a smaller, immediate benefit – this has obvious implications when considering the long term effects of our own behaviour on the environment, for example.

- *Inertia:* people tend to avoid making choices, or choose the easiest or default option amongst a series of options (Darnton, 2008). After electricity market deregulation, for example, research showed that people with a choice between different retailers resisted making any choice, and settled for the status quo, even when this resulted in higher personal costs of electricity (Brennan, 2007). On the other hand, the preference for the status quo can be also leveraged to encourage positive behaviours, for example by changing the default temperature settings on washing machines to reduce hot water use (McCalley, 2006).

For policy interventions, there are some simple but fairly profound implications of heuristics and biases. Firstly, behavioural choices can be framed to encourage a preferred choice. Secondly, focussing on short-term benefits and reduction in short-term losses will motivate more behaviour change than emphasis on long-term impacts. Thirdly, structuring systems so that the default choice is the preferred behaviour can take advantage of the preference for the status quo.

4.3.4 Attitudes

An attitude represents a tendency to react in a particular way towards a socially significant event or object, based on an organisation of beliefs and feelings (Eagly & Chaiken, 1998; Krosnick, Boninger, Chuang, Bernet & Carnot, 1993). Early research attempted to predict people's behaviour from their attitudes, but found little relationship between surveyed measures of attitude and measures of actual behaviour (Abelson, 1972; Wicker, 1969).

Subsequent research has shown that the relationship between an attitude and behaviour can vary depending on how strong the attitude is (Fazio, Blascovich & Driscoll, 1992; Fazio & Williams, 1986), how easily recalled the attitude is (Doll & Ajzen, 1992), and whether the attitude is expressed publicly or in private, individually or in a group (Smith & Stasson, 2000). In more practical terms, research has demonstrated that attitudes are able to predict intentions to change and some simple and low-cost behaviours (like setting the temperature control higher on an air conditioner), but that they are less able to predict large expenses like buying more efficient appliances, or pervasive behaviours like household energy consumption. These latter actions are better predicted by contextual factors such as income and household size (Iwata, 2001; Gatersleben, Steg & Vlek, 2002; Guerin, Yust, Coopet 2000; Black, Stern, & Elworth, 1985).

Clearly, it is possible for people to hold an attitude but to act in a way that is inconsistent with that attitude: for example, people can report themselves as strongly pro-environmental and yet litter, drive a large car and otherwise act in ways that damage the environment. This sort of internal hypocrisy is relatively common, and provides some explanation for why attitudes espoused in surveys often fail to predict actual behaviour. This state is usually below levels of conscious awareness, but if the inconsistency is brought to their attention, people can experience an unpleasant state of "cognitive dissonance".

Cognitive dissonance itself can provide a mechanism to change behaviour. If people are confronted with an overt difference between their attitudes and their behaviour, they can sometimes shift their behaviour to a more consistent state. For example, when householders were confronted with the inconsistency between their pro-environmental survey responses and their over-use of water, their levels of water consumption dropped (Aitken, McMahon, Wearing & Finlayson, 1994). However, such an approach can backfire; often it is easier for people to change their espoused attitudes than their behaviour (Shipworth, 2000).

Notwithstanding their inconsistent influence on behaviour, attitudes do have a strong influence on processing of information. New information that is inconsistent with an existing attitude is often minimised or ignored entirely, while information that is attitude-consistent is given much more attention (Darnton, 2008). In this manner, attitudes can become self-sustaining, and strongly resistant to change. In the case of climate change, accurate information about the issue may be ignored if it inconsistent with people's current attitudes, an effect which is particularly important when dealing with climate change scepticism.

Attitudes towards climate change

Concern over environmental issues and climate change in particular is high in Australia. These pro-environmental attitudes can be used to promote behaviour change to more sustainable forms, but the above limitations in the link between attitudes and behaviour all are relevant in this instance. There are also further issues that relate specifically to climate change and pro-environmental attitudes.

Firstly, climate change is often presented (in the mainstream media) as a serious threat to humanity. It also involves substantial uncertainty (Peterson, 2006), and is perceived as an environmental or "green" issue, and as a "global" problem, with negative impacts that will occur many years in the future, often in distant locations rather than locally (Leiserowitz, 2007). Secondly, there are multiple apparently credible and authoritative sources of climate change scepticism and denial, which act to weaken any message about climate change (e.g. Dyson, 2005).

These features can actually discourage behavioural changes in response to climate change (see also Hulme et al, 2007), via a number of mechanisms:

- Framing an issue as an "environmental" concern can marginalise the relevance of the appeal, making it seem important only to environmentalists. Such messaging risks excluding a large proportion of Australians who do not identify themselves as environmentalists.
- Research indicates that in general, people tend to respond irrationally to information about uncertainty and to information about potential negative outcomes (Arvai, 2008); clearly information about climate change involves both of these considerations, and people may often respond to it in maladaptive ways.

- Behaviour change in response to threat requires that people feel personally vulnerable, feel capable of responding, and feel some degree of responsibility for the problem (Moser, 2007). However:
    - people may not feel personally vulnerable to climate change, either because the effects are not well understood, are perceived to be many years away, or perceived to be global and general rather than local and specific (c.f. Weber, 2006).
    - People may not feel capable of responding to climate change, because the problem is perceived to be too big and/or because a sense of individual agency is blocked by negative emotions of fear or hopelessness. Even those people who feel capable of responding may not know what specific useful action they can take in response.
    - People may not feel personally responsible for climate change (not understanding how their individual behaviours contribute to the larger problem), and/or they may expect outside agencies (typically other countries or the government) to take responsibility for a solution.

In summary, attitudes have a complex and inconsistent relationship with behaviour, so attempts to encourage behaviour on the basis of existing attitudes, and attempts to change attitudes, often result in failure or only partial success. Attitudes to climate change in particular have features that make it difficult to motive behavioural change. One way around this issue is for policy messaging to avoid mention of climate change, and focus instead on environmental impact, resource use, or wasted money.

4.3.5 Values

Values are judgments or ideas that people hold about what is right, good or desirable and together create an individual's value system (Gutman 1982; Maniywa & Crawford, 2001; Zhao, He & Lovrich, 1998). Values tend to be inflexible, relatively stable and enduring, and can influence our attitudes and behaviour. The seminal work on values by Rokeach (1973: 5) argued that values are "an enduring belief that a specific mode of conduct or end-state of existence is personally or socially preferable to an opposite or converse mode of conduct or end-state of existence". Rokeach also proposed that values are established through culture, personality, and societal experiences, and are more enduring than their consequences: attitudes, motives, preferences and interests.

There is evidence that people's values can contribute to the success of strategies aimed to change their behaviour (Poortinga, Steg & Vlek, 2004). Values of altruism have been demonstrated to predict pro-environmental behaviour and residential energy reduction (Poortinga, Steg, & Vlek, 2004). Cultural values that are commonly held within a country have been shown to be relevant to sustainable behaviour: country-specific values successfully predict differences in pro-environmental attitudes (Oreg, & Katz-Gerro, 2006), and differences in actual behaviour (Guerin, Crete & Mercier, 2001).

However, individual and cultural values can also impede behaviour change in relation to energy consumption, if those values link success and wealth with extensive use of resources (e.g. Throne-Holst, Strandbakken & Stø, 2008). This is certainly relevant in Australia, as well as much of the western world, where there are cultural values that associate success and happiness with high levels of resource use and discretionary consumption. It has been noted that inevitably, it will be necessary to address these values in order to allow for long-term sustainable use of resources (Wilson & Dowlatabadi, 2007).

Given the stability of values, only long-term and large-scale interventions can expect to influence them (SEI, 2009). For smaller scales and shorter timeframes, it is important to acknowledge that the impacts of interventions can and will be moderated by the prevailing values of individuals, community groups, and Australian society at large.

4.4 Social influences on behaviour

Other people have a very strong influence on our behaviour as individuals. This effect can occur via observation or impressions of other people's behaviour, through our beliefs about what others expect us to do, or via the simple presence of other people. Such effects have repeatedly been demonstrated in relation to sustainable behaviours. For example, people who make public commitments to reduce energy consumption (Pallak, Cook & Sullivan, 1980) or to recycle more (Schultz, Oskamp & Mainieri, 1995) are much more likely to follow through with actual behaviour change than people who commit to the same change privately.

Social norms, the perceptions people hold of "what other people do", also can be a powerful influence on behaviour. People take behavioural cues from the visible or perceived behaviour of others (e.g. Schultz, Khazian & Zaleski, 2008) and they have difficulty maintaining an attitude that is different to the typical attitude of those around them (Ajzen & Fishbein, 2005). These "normative" influences tend to be strongest when the example behaviour is performed by someone similar to the individual. The behaviour of similar people (especially family and friends) or people in a similar circumstance has the greatest influence on people (Griskevicius, Cialdini, & Goldstein, 2008), and has been demonstrated to influence household energy consumption (Hanson, Bernstein & Hammon, 2006).

Because of the inherent link between perceptions and social influence, such effects are obviously likely to be more successful for observable behaviours than for behaviour which is less overt (Schultz, 2002). Thus, we would expect a greater social influence for behaviours like installation of solar panels than hidden changes like the addition of insulation.

Normative influence is also strengthened when the situation is uncertain: the less internal information people have, the more the influence of other's behaviour or perceived behaviour will be relevant in shaping their own behaviour. Given the historical and more recent low levels of knowledge around many issues of environment, energy and climate change (e.g. Bang, Ellinger, Hadjimarcou & Traichal,

2000; Gardner & Ashworth, 2007), this arena is clearly well-suited to normative influence.

Notably, the effect of these normative influences is often imperceptible to individuals. That is, when people's impressions of what others typically do are manipulated, their behaviour changes, but they do not attribute this behaviour change to normative influence (Nolan, Schultz, Cialdini, Goldstein & Griskevicius, 2008). The implication here is that policy-makers are unlikely to rely on a tool that they expect would have no effect on their own behaviour, so it is unsurprising that social norms historically have been underutilised as a behaviour change tool at the policy level.

Behaviour change appeals that highlight the many people who are doing the wrong thing are counter-productive, because they provide a message that the "wrong thing" is common and therefore appropriate. This can in fact promote the behaviour that the appeal is trying to reduce, known as a "boomerang effect" (Schultz, Nolan, Cialdini, Goldstein & Griskevicius, 2007). For public messaging on consumption, for example, telling Australians that their levels of consumption are amongst the highest in the world might backfire, by presenting a message that excessive consumption is normal, and therefore excusable. People with low levels of consumption can even respond to such a message with the self-talk "well, I am not using as much as some people…" and may even be motivated to increase their consumption.

At a general level, normative and other social influences can be considered as *enablers* of many other behavioural drivers. That is, the presence of social influence or social support can help to increase the impact of other drivers of behaviour. Goals that are committed to in public are more effective that privately-set goals (see above in this section). Information that is provided by a trusted or local source is more influential (e.g. Shipworth, 2000). Social influence provided alongside feedback is more effective than feedback alone (Aitken, McMahon, Wearing & Finlayson, 1994). And attitudes that are shared within a group of individuals tend to be more difficult to change (see Ajzen & Fishbein, 2005).

The strong, consistent and pervasive impacts of social influence have clear implications for policy interventions designed to promote sustainable behaviour. Positive actions taken by individuals and community groups should be widely publicised, to help promote such behaviour as "normal". Where possible, normative information should be localised, since information about what people in my own city or suburb are doing is much more influential than information about people in another city. Encouraging public commitments to change behaviour can also have a powerful influence on ensuring that people to follow through with planned behavioural changes. Finally, using existing social networks to deliver information and appeals for change increases trust and credibility, and increases the likely influence of such messages. This last approach has been used successfully in the Energymark program[7], which uses existing social networks to deliver information and promote behaviour change related to energy use and greenhouse gas emissions.

[7] http://www.csiro.au/science/EnergymarkTrial.html

4.4.1 Community-based action

Worldwide and in Australia, there are already a massive number of community-based groups involved in issues of climate change and sustainability[8]. Such community-based action groups represent a form of "social momentum" that is generated with a group of people develop a set of shared goals or values (Gardner & Stern, 2002). For actions that are pro-environmental, and those related to sustainability more generally, these shared goals or values may relate to a sense of altruism, a generalised concern about climate change or environmental degradation, a sense of responsibility for protecting the environment for future generations, a concern for local impacts of climate change, a desire to contribute positively to the community, or some combination of the above.

Research suggests that community-based action is more effective when there is: a locally controlled resource, local dependence on the resource, the presence of a strong community, and appropriate rules and procedures in place (Gardner and Stern, 2002). Although energy is almost always centrally controlled, not locally controlled, in Australia, it is possible that the wider adoption of distributed energy sources[9] will allow for a situation in which many communities, apartment buildings and groups of businesses do control their own energy generation.

It is a notable feature of such groups that they are not initially motivated by financial incentives, or by the simple provision of information. Thus, these groups are unlikely to be positively influenced by the traditional policy drivers described above. Indeed, offering financial incentives to people who have already begun to change their behaviour may sometimes discourage existing action based on a sense of altruism or community contribution (e.g. Nyborg, Howarth & Brekke, 2006). More useful influence is likely to be gained in such groups via the provision of social acknowledgement and non-financial support, and by allowing such groups to maintain their self-determination (Reeson, 2008).

It is also possible to encourage such groups y a demonstration of shared values. If a governing entity (at the local, state or federal level) itself exemplifies the desired changes in its own operations, this will help to demonstrate commitment and encourage others to follow suit. Conversely, people have been shown to mistrust and ignore policy interventions directed at environmental issues if the government's own approach to these issues is perceived to be inconsistent (see Jackson, 2005).

4.5 General conclusions on behaviour change

Without reiterating the implications for policy application that have already been identified, there are several more general conclusions that can be drawn at this point about the effective use of behavioural research findings in promoting sustainable behaviour:

[8] See, for example: http://www.cana.net.au and http://www.wiserearth.org/
[9] See http://www.csiro.au/science/Intelligent-Grid.html

1. *Recognise that behaviour is difficult to change:* There are a huge array of influences that have combined to develop peoples' current behaviour and preferences, and it is unreasonable to expect that a simple or short-term intervention can be sufficient to provoke a change in this behaviour without encountering resistance.

2. *Address gaps in knowledge:* Recognise that lack of understanding and misconceptions about environmental issues are still quite common. Information needs to be presented in a way which emphasises the immediate, specific behaviour changes which are desired, and that provides simple messages about desired behavioural outcomes. It is also important to recognise that information alone does not provide sufficient impetus to change behaviour.

3. *Target interventions to individuals:* Motivating factors can and do differ between individuals – something that encourages one person to act can discourage that action in another person. This issue leads to the recognition that no approach is likely to work all the time on all people, so different approaches may be needed for the same behaviour change in different groups (CSD, 2004). An understanding of different community sectors, and an appreciation of what changes are most likely to be achievable by them, provides the best chance for an intervention to succeed. DEFRA (2008) in the UK provide a good example of this kind of approach, using research to identify distinct segments within the population, and then targeting interventions to different segments, based on their different willingness and capacity to change.

4. *Directly address barriers to change:* Interventions need to address the specific barriers relevant to specific behavioural changes, including issues of process, infrastructure, capacity for change, access, cost, etc that may influence individual capacity to make the desired changes.

5. *Focus on incremental changes first:* Few individuals are willing to make massive shifts in their lifestyle in order to pursue more sustainable living, so the changes that are promoted need to be matched to the types of changes that people are prepared to make.

6. *Present a consistent message*: Policy interventions will achieve more impact if they form part of a coherent approach, rather than representing a whole series of unrelated interventions in different sectors. A consistent approach will allow the interventions to reinforce each other, and will maintain a high degree of awareness and momentum for behavioural change.

7. *Take care when encouraging community-based action:* interventions that offer incentives for community-based and self-motivated changes may in fact backfire, and make continued action less likely. Providing acknowledgement, support and allowing for self-determination is much more likely to foster ongoing efforts from people and groups that are self-motivated to reduce consumption and to engage in other environmentally sustainable changes.

5. OVERVIEW OF POLICY MAKING PRINCIPLES

Policy and program design and implementation are key tools for Government in shaping social, economic and environmental outcomes. In the context of driving sustainable behaviours and improving the sustainability of resource use, we consider the following tools, in no particular order, to be most relevant:

1. Education
2. Financial incentive/subsidy
3. Regulatory instrument
4. Tradeable permit
5. Voluntary agreement

These tools are preferably implemented in combination, as no single tool is likely to be effective on its own. Each tool will be considered in Section 6.

5.1 Evidence-based policy making

Policy making has been the subject of significant research and attention. In particular, the use of evidence-based policy making has gained increasing interest and momentum with the Blair Government in the UK making a commitment towards the use of evidence in policy decision making with their 1999 White Paper, Modernising Government (Cabinet Office, 1999).

Evidence-based policy making is an approach that ‘helps people make well informed decisions about policies, programmes and projects by putting the best available evidence from research at the heart of policy development and implementation' (Davies, 2004). Explicitly, it aims to avoid the use of ‘best hunches’ and ‘educated guesses’ in the policy-making process.

Evidence-based policy making includes the use of various research methods to test economic, scientific, environmental or ethical considerations that affect policy making. It is used to both identify issues to be addressed by policy makers and to guide the design of policy interventions. This approach complements a range of principles identified by the Cabinet Office in 1999 (Campbell et al, 2007). These principles include:

- forward looking
- outward looking
- innovative and creative
- using evidence
- inclusive
- joined-up
- evaluated

- reviewed
- based on ‘what works’.

Evidence-based policy development has an intuitive logic, but implementing it is not always easy. Research by Campbell et al. (2007) in the UK highlights issues such as the demands of political cycles, inadequate resources and political culture that can undermine the use of evidence-based research in policy development.

5.2 Developing policy goals and design

Influence of behaviour and decision making is often a goal of policy makers trying to improve the sustainability of resource use. Policy interventions typically occur based on evidence that markets do not accurately factor the cost of some social or environmental harm into decisions. Policy intervention to produce sustainable outcomes can address decision making in a number of ways including, but not limited to: redesigning market structures; providing better information to markets; establishing a price for the social or environmental harm; or setting performance based targets for production. Essentially, policy interventions are designed to change the way individuals or groups make decisions in order to achieve a certain outcome.

Importantly, as outlined in Section 3, research into decision making processes highlights the limitation of assuming information is processed rationally, and that decision makers will act in their best financial interest. Decision making can be affected by internal and external values, and also in more subtle ways such as the way information is presented, including the ordering of words and the choice of words with only superficial differences in meaning.

Research on decision making has challenged the legitimacy of traditional cost benefit analysis (CBA) in establishing the need for policy intervention, as well as the design of the policy intervention itself. Relying on rational CBA theory to guide environmental policy makes sense if citizens make, or act as if they make, consistent and systematic choices toward both certain and risky events (Friedman et al in Hanley et al, 2005).

As outlined in Hanley (2005), anomalies in results given by CBA challenge its legitimacy. Hanley (2005) cites an example in the UK of policy makers trying to value the cost of pollution. In theory, pollution should be valued consistently by the same person. Therefore regardless of being compensated for a level of pollution, or paying to reduce pollution by some amount, the unit value of pollution should be consistent. However individuals interviewed nominated significantly different values of pollution depending on whether they would be compensated for existing levels of pollution, or would pay to reduce pollution. Specifically, they nominated far high levels for compensation than willingness to pay, and many respondents refused to nominate a value for compensation as they saw this as an offensive request.

This type of result is subject to various explanations and intuitively is not entirely unexpected. If someone earns an income that doesn’t allow basic shelter and health costs to be met, it is unlikely they will be willing to pay much to reduce pollution they

may not know much about. In the case outlined above, high level policy advice was to seek conservative values where there are differing contingent valuations, and so the lower value, determined by willingness to pay, was selected (Hanley, 2005).

From a policy perspective, the most important lesson is that there is potential for analytical bias to influence the interpretation of results of cost benefit analysis. Consequently, there is the potential for these biases to under or over value policy intervention and so distort the efficacy of policy design.

Because of this, some policy making bodies use multi-criteria decision making analysis (MCDA) as a policy development tool. MCDA allows sharing of data, concepts and opinions across those involved in the policy making process including members of the public, consultants, policy agencies, and elected officials. Through iteration and reflection, MCDA allows sources of decision making anomalies such as incomplete information, misallocation of risk, or the framing of problems to be worked through and resolved (Kiker et al, 2005).

Essentially, this approach allows a CBA to be used, but has inbuilt processes to ensure the analysis has legitimacy from objective and subjective viewpoints. MCDA is broadly consistent with the idea of policy networks, in that a well functioning policy network can facilitate the MCDA process.

In the United States, research by Allison (2005) has highlighted the importance of policy networks in shaping public policy. Ostrom et al in Allison (2005) say:

> *"Policy networks coordinate public and private actors who are increasingly bound by shared values, common discourse and dense exchanges of information in their efforts to influence public policy. A growing number of academic studies demonstrate that successful environmental protection in the United States relies on such policy networks."*

In this way, policy networks can be used to overcome some of the difficulties of implementing evidence based policy development by ensuring policy continuity across political cycles and by encouraging sharing of resources and collaboration. However it must be recognised a policy network that doesn't use evidence based research, or doesn't represent a diversity of economic, scientific, environmental or ethical views, would have the potential to undermine effective policy making.

5.3 Managing risks to effective policy making

While behaviour change has an important role to play in achieving sustainability outcomes, the availability and cost of technology can often limit the extent to which behavioural change can bring about sustainability outcomes. Therefore it is also useful to consider risks to effective policy making specifically in the context of technology development/and or large scale structural change required to deal with environmental problems.

One risk is technology lock in. Technology lock in occurs when the dependence of a particular technology is reinforced by the market it is used in through positive feedback. Examples include standardisation of rail gauges, dominance of VHS technology over Betamax and the monopoly of the QWERTY keyboard layout. Not all technology lock in will have negative affects, but it can limit the speed and efficiency of technology change.

When trying to drive improved sustainability of resource use, a risk is that policies can inadvertently reinforce the status quo albeit with marginal efficiency improvements, or marginal pollution reductions. By reinforcing the status quo, competing technologies may be locked out and remain immature or underdeveloped, yet those technologies that are locked out may be necessary to make the transition to a desired policy objective. In this way, locking out necessary technology development may have adverse impacts in the long run and undermine the efficient transition to an economy capable of operating in a sustainable fashion.

Research by Kline (2001), details one example of technology lock in - it is worth quoting the following passage in full:

> *"… the U.S. government sponsored research and development that led to the development of light-water reactors for powering nuclear submarines. Light-water reactors were arguably the right choice for the sub-marine application, given all the technical and strategic considerations. After they were chosen for use in submarines, light-water reactor designs dominated the nuclear market for utility power generation by virtue of the experience of manufacturers in producing them for the Navy. This outcome represented the technology path of least resistance. Many have argued that other nuclear designs are better suited to the utility power market, but light-water reactors are now locked in (Cowan, 1990)."*

This is very important to consider when looking at the policy outcomes that can be achieved by mechanisms such as emissions trading where the cost of abatement is likely to move incrementally up a cost curve as the emissions cap is tightened. In theory, emissions trading may deliver least cost abatement at any given time, but it may not deliver the least cost abatement path over an extended period of time unless it complementary policies are well designed.

For instance, emissions trading may encourage marginal efficiency gains in coal and gas fired generation over the first 10-15 years at the expense of investment in renewable energy, distributed energy or energy storage technology. Hypothetically, only in 15 years time when abatement costs reach a certain threshold will these alternative technologies be cost competitive with the more efficient gas and coal technologies. However, if there has been underinvestment in skills and technology required to integrate intermittent power into the national grid, the implementation of those renewables may be slowed, and/or more costly than they would have been if developed earlier.

Another issue may be that new investment occurs with a low emissions price, but is at risk of being made prematurely redundant by a high emission price in the future as the emissions cap is tightened. This has the potential to: create policy pressure to limit the cap tightening; leave the investment stranded; and/or create a need to 'bail out' the investor. While it is beyond this paper to model such scenarios, hypothetically it can be seen that locking in a certain way of supplying and distributing energy may increase the cost of reducing emissions.

To overcome technology lock in, and maximise the potential for spill over benefits[10] that can come with diverse technology development, it is best to use a suite of complementary polices (Kline, 2001). This can help ensure a smooth, efficient transition to more sustainable resource use. For instance, in the case of stationary energy, research and development can be directed at a range of technologies that may be cost effective for niche applications such as off grid or remote energy supply. Overtime, these technologies may develop sufficiently to gain large scale market acceptance for on grid applications, or may result in technology improvements that can be applied in centralised generation.

Perhaps most importantly, when considering the impact of technology lock in, policy makers must ask, is it possible to achieve the long term sustainability objective with a certain technology or system? If there is significant risk of a technology or system being locked in, and significant risk that the technology or system can't deliver the sustainability objective required, it may be beneficial to accelerate the development of alternatives, or retire the existing technology before it has reached the end of its useful economic life. This ensures that time and money is not sunk into maintaining something which ultimately, will not be compatible with the sustainability objective.

One policy development technique that is useful for overcoming technology lock in risk is backcasting. Backcasting is the process of envisioning a desired future objective based on need, and then working out what is required to get there. Whereas forecasting attempts to determine future scenarios based on information and data analysis today, backcasting attempts to determine what change is necessary to achieve a desired future scenario (Jansen, 2001). This thinking dominated the development of the Dutch Sustainable Technology Development Programme in the 1990's and led to models for strategic planning that were applied across Government and private sectors.

Backcasting is useful for policy making in that it helps policy makers think in terms of what is necessary to fulfil essential needs, not what appears possible given today's circumstance, and so can stimulate creative new thinking and problem solving. In the Dutch context, backcasting has been coupled with interdisciplinary partnerships between Government, private enterprise, financiers, research and education institutions and end users of technology.

By involving a range of stakeholders in policy development in this way, policy becomes more than just a consultative process to determine the detail of policy delivery, it can

[10] In this case, spill over benefits are gains in one technology or application that inadvertently benefit the development of other technologies or applications.

galvanise a collective strategy based on a shared policy objective (Van de Meulen, 1999).

This collective engagement in policy objectives, as opposed to just engagement in policy design, is compatible with the creation and use of policy networks outlined previously, multi-criteria decision making analysis, and in keeping with best practice policy development principles.

Another way to avoid technology lock and its associated risks is to take a portfolio approach to technology analysis and deployment, and to overlay the prospects of a technology with its inherent risks (Awerbuch, 2005). For example, when considering stationary energy supply this approach requires consideration of current generation costs concurrently with a risk analysis as to their future costs. For renewables such as wind and solar, costs are relatively known at any given time as once they are built, they incur no variable fuel costs. With sound wind or solar radiation data, their output costs are relatively predictable. However future costs for gas, coal and nuclear are more 'at risk' because of their fuel cost component and in the case of nuclear, the unknown cost of waste disposal. In Australia, a risk analysis of future generation costs would include water availability – significant price shocks occurred in 2007 due to water shortages for critical generators, highlighting the dependence of the current supply mix on water availability[11].

Under a portfolio planning approach, the current cost of generation is considered concurrently with risks to future costs of generation. In this way, an analysis of probable future prices that factors in variables such as predicted costs of fuel types, construction materials and/or dependant resources such as water, can help determine a more accurate valuation of different generation types.

What follows is a more detailed analysis of local and international policies and programs aimed at addressing the sustainability of producing and consuming goods and services in the economy. We look at case studies of how each policy tool outlined above as relevant to this study has been applied, what has worked, what has not, and why. We also comment on the likely efficacy of replicating in Australia those overseas programs analysed, with reference to evidence based research outlined above, and the need for evidence based policy making.

[11] See NEMMCO price tables - http://www.nemmco.com.au/about/900-0001.pdf

6. ANALYSIS OF AUSTRALIAN POLICIES AND PROGRAMS

This section describes and analyses policies and programs that have been used to improve the sustainability of resource use in Australia with a focus on reducing emissions from the energy sector, the largest source of emissions in the Australian economy. However the evaluation and discussion of different case studies point to opportunities to apply learning to resolve other environmental issues, such as waste production and water scarcity.

6.1 Education/Information

Influencing consumer behaviour through education is best thought of as being part of a Government program, contributing to a Government policy objective. Education can be used to deliver a range of objectives from simply informing consumers about certain products or services, to increasing the uptake of certain products and services through affecting consumer knowledge, emotions or some other factor. Education can be critical to ensuring complementary policy objectives are achieved, and their benefits maximised. To do so, education programs must well researched, planned and executed to coincide with complementary policy interventions.

By way of example, the Federal Government recently implemented the 'think change, think climate' campaign to support the broader policy objective of emission reductions. In essence, the campaign is used to educate people about climate change, various government initiatives and their value. Implicitly, the program is used to galvanise support for action on climate change and policies being implemented.

6.1.1 Case study: "Black Balloons" campaign

One of the most high profile education campaigns to be undertaken in Australia, designed to influence behaviour specifically around energy consumption, is the 'black balloons' campaign initiated by the Victorian Government. DSE (2007) defined the programs objectives as being:

- Show the link between energy use and climate change
- Develop a tangible measure for greenhouse gas
- Develop a call to action brand to provide central theme for a long term campaign

These objectives could be thought of as influencing people's knowledge about the link between energy and climate change, affecting people's emotional response to energy and climate change issues by creating a tangible symbol for greenhouse gas, and influencing habits through a sustained messaging campaign detailing desirable and undesirable behaviours. If successful, such a campaign can create influence over individual behaviour by tapping into these internal and external drivers of behaviour as discussed in chapter 3.

6.1.2 Evaluation and analysis

The success of the campaign can be measured in a number of ways. After being launched in the summer of 2006/07, tracking by September 2007, outlined by DSE (2007) showed nearly half of Victorian households (47%) had been exposed to the campaign. 75% of respondents who saw the ad thought it was effective in motivating reduced energy use (a measure that some emotional response was triggered by the campaign). Agreement that reducing energy use would help tackle climate change went from 49% to 66% amongst Victorians after the campaign begun (a measure of the campaigns affect on knowledge). 82% who saw the ad said there was nothing they dislike about it. 40% said the ad has motivated them to take additional energy saving measures (again, a measure that the ad triggered some form of emotional response, or provided knowledge that could result in action).

Some interesting findings were that the environment as a motivation for saving energy went from 34% to 70% while saving money went from 76% to 56%. This suggests that effective education may assist in overcoming financial impediments to taking action on environmental issues and that implicitly, the prioritisation of financial savings as a driver of behaviour could be as much a conditioned value as opposed to a natural or permanent one. This would broadly corroborate research on the psychology of voluntary action, that intrinsic motivators can be used to crowd out external motivators, such as financial rewards and vice versa.

Importantly, research conducted by Bulkeley (2000) found that confusion over the facts of climate change does not prevent people linking the problem to causes within their daily lives. It was found that “people draw on sources of moral authority, to help discern what is good, right and believable. These included senses of responsibility for the global environment and future generations, which people were prepared to act upon despite a perceived lack of efficacy.” Put another way, if people feel responsible for the global environment, and know that driving their car is bad for the environment; they may take action to reduce car use. They do not necessarily have to understand the science of climate change, and the precise role their car plays in this, to reduce car use. This suggests that education campaigns do not necessarily have to engage in detailed science to be effective at some level.

However, education campaigns need to be cognisant that providing more detail on the effect of different actions people can take, may improve the ability of an individual to make informed decisions, and so potentially the efficiency with which they act. In a major review of information campaigns related to energy consumption, Henryson, Hakansson and Pyrko (2000) showed that providing information can influence consumption via a range of processes like information added to electricity bills, electricity metering, discounting and general information campaigns. However, the effects of information-induced change tend to diminish very quickly. As noted earlier, information campaigns can improve knowledge without changing behaviour (Abrahamse at al, 2005).

A more specific form of education is to provide ongoing feedback about an individual household’s consumption. Instantaneous feedback provided long-term coupled with

general information has been repeatedly demonstrated to produce more impact on consumption of household electricity than provision of general information alone (Wood & Newborough, 2003; Ueno, Sano, Saeki, & Tsuji, 2006; Darby, 2006).

For this reason, it may be best for broad based education campaigns to target global messages and awareness, while more specific information may be better conveyed through interactive tools that allow people to compare different decisions considering their specific circumstances.

Bulkeley (2000) also emphasises the importance of coupling education with measures that facilitate the desired action, citing the voluntary green power scheme, actively marketed in the Newcastle region at the time of the research, as a way of overcoming institutionalised impediments to reducing emissions from electricity consumption. Without voluntary green power, consumers would only have very limited ways to translate their beliefs and values on the environment into action that reduces emissions caused by their electricity consumption. Although it is difficult to allocate causation, it is telling that Victorian households and businesses purchasing some percentage of green power roughly doubled in the year after the black balloons campaign commenced.

Another example of coupling education with facilitation measures would be coupling education about the environmental benefits of public transport or cycling, with public transport services that are easily accessible, affordable, and safe, and/or well mapped, safe bicycle paths. Without this coupling, education is unlikely to translate into action, and may simply result in frustration and apathy.

Information can be tailored so that it is specific to the recipient in some way, by dealing with their own situation and context. This sort of information tends to be more effective than generalised information campaigns, but it is only effective at reducing direct consumption, not the indirect consumption of energy embedded in goods and services (Abrahamse, Steg, Vlek & Rothengatter, 2007; Benders, Kok, Moll, Wiersma, & Noorman, 2006).

Importantly, education may have a role to play in addressing household behaviours, beyond direct consumption of energy, that impact on global sustainability issues. This is because household behaviour and consumption decisions affect sustainability of water use, and production of waste. Further, the impact of consumption may occur overseas, and so may not be readily controllable through domestic regulation.

For instance, as outlined in chapter 2, consumption of food and generic goods and services has a significant impact on the environment in terms of emissions, water and land use. While it would be difficult, and potentially undesirable to regulate specific food choices, generic education on the importance of addressing sustainability of resource use, coupled with initiatives to improve information provision to consumers on sustainability issues, could help households select food stuffs and products while considering sustainability criteria.

Information provision could be modelled on the successful star rating program which helps consumers choose appliances based on energy efficiency criteria. A methodology for carbon labelling specifically has been developed by the Carbon Trust in the United Kingdom and has been trialled in a range of contexts, including by a major retailer, Tesco[12]. Such information can help create demand for products that are produced in a more environmentally benign way, and so can complement any supply side initiative undertaken by Governments.

In summary, while education has a powerful role to play for motivating and facilitating behaviour change, it must be coupled with programs, incentives, products or other tools that enable the target audience to implement the action which the education has been designed to motivate. This highlights the important of co-ordinated, long term strategic programs that couple education with complementary enabling policies.

As a priority, before conducting an education program, institutional and market barriers to adopting the behaviour change to be targeted by the education must be well analysed, understood and overcome. This will ensure that educated, and so motivated individuals, can translate their beliefs into effective action.

6.2 Financial incentive/subsidy

Financial incentives or subsidies can be used to overcome perceived or real financial barriers to the uptake of products or services. They can be delivered to customers at point of sale or reimbursed through some post purchase verification process. This type of control is required to ensure the product or service purchased has been effectively implemented. Financial incentives can encourage early adoption of new technologies that may not be commercially viable but have significant future potential, and so help provide commercial incentive for product or service development and subsequent realisation of a product's potential.

Financial subsidies have been used across Australia by Federal and State Governments to reduce the cost of installing solar hot water systems, and in some states, more efficient gas hot water systems.

6.2.1 Case study: Solar homes

Financial subsidies have also been used in Australia to create incentive to install small scale renewable energy technologies, primarily through what was called the solar homes and communities plan. This plan has evolved over time and was phased out in July 2009. Criteria and subsidies available under the program are detailed below:

[12] More information is available at http://www.carbon-label.com/business/forbusinesses.htm or http://www.carbon-label.com/casestudies/Tesco.pdf

Residential (Rebates)* - Household taxable family income must be less than $100,000		
New systems		
450 watts	Up to $8000 ($8/W up to 1kW)	The system must be installed at your principal place of residence. You have not previously received a rebate for a photovoltaic system from the Australian Government
Extensions to old systems		
450 watts	Up to $5000 ($5/W up to 1kW)	If you have not previously received a rebate for your system, you may be eligible for a rebate to extend your current system by 1kW. If you have previously received a rebate for systems less than 1kW you may be eligible for an extension rebate to bring the system up to a 1kW capacity
Community Use Buildings (Competitive Grants)		
450 watts	50% of the system cost up to 2kW**	Grants are available to community organisations that install photovoltaic systems where there is significant educational value.

*Conditions apply; this information is a guide only; for further information refer to the program guidelines.
**This limit refers to the grant amount only - there are no restrictions on the size of system that can be installed.

The program was complemented by the Renewable Remote Power Generation program (now phased out except in Western Australia) and the National Solar Schools Program which provide targeted incentives for investment in renewable energy technologies to remote communities and schools respectively.

6.2.2 Evaluation and analysis

Specific research and analysis on this particular program is not readily available, but in principle, the success of a cash incentive scheme can be affected by a number of factors. Firstly, future rebate values and program longevity may be unknown. In this case, a specific clause in the guideline for applicants for the rebate was that:

> "*The Australian Government reserves the right, at its sole and absolute discretion, and at any time, to change any or all of these guidelines, including to remove all or any of the guidelines or to introduce new or additional guidelines."*

Uncertainty over the longevity of a rebate may create a market perception of opportunity cost, and so if and when the rebate is ended, it can create an artificial rush of applicants to secure the rebate while it is available, creating a spike in demand. In a relatively underdeveloped industry or market, this can negate savings as manufacturers, suppliers and/or installers of the technology are affected by skill shortages. The subsequent lack of competition may erode the value of the rebate through higher prices.

Secondly, where a cash rebates for households cover one technology only, a technology winner is created for a market niche. This may weaken the signal for markets to develop alternatives to technology attracting the rebate and so exacerbate risk that one technology will become locked in as a technology of choice. In this case, technologies competing with solar PV, such as micro wind or fuel cells, could remain underdeveloped if not addressed through complementary policy.

Thirdly, in this instance, there is an upper limit on the available rebate based on system size. For solar power systems, where a large proportion of the costs are fixed (inverter costs, installation) regardless of generation capacity, this negates any economies of scale that households can achieve via the rebate system. In effect, an artificial ceiling on panel sizes is created – in this case 2kW – and may dilute the incentive for manufacturers to improve the performance of their panels over time.

The program does appear to have been helpful in driving early adoption of solar technologies and its application in niche situations. This has allowed some issues associated with rollout of solar PV to be identified and overcome, for example, issues created by connection processes and standards. Ultimately, promoting early adoption of emerging technology in this way, helps create a more efficient rollout of the technology if and when it becomes a more widely adopted choice for households.

It is instructive to evaluate the program against its objectives and to consider if the objectives were best met by the program design. The objectives have been listed by the Department of Environment, Water, Heritage and the Arts as being to:

- reduce greenhouse emissions;
- assist in the development of the Australian photovoltaic industry; and
- increase public awareness of renewable energy.

While the objectives are related, they are distinct and it could be argued that each objective could be satisfied in different ways and more efficiently. For instance, if the policy objective was to reduce greenhouse gas emissions, a subsidy for an emerging product will achieve some results, but in the case of photovoltaics, it is a high cost and probably low volume emission abatement option in the short to medium term.

If the Government objective was to increase public awareness of renewable energy, a subsidy to an emerging product may help achieve this, but a comprehensive information campaign may have done so more effectively. Again, there is a disconnect between the objective and the choice of the scheme.

Of all the objectives, the second objective - to assist in the development of the Australian photovoltaic industry - is probably best served by the rebate scheme. It has driven demand for photovoltaics allowing manufacturers and the supply chain to develop skills and technology. However again, due to uncertainty over the schemes longevity and the scheme structure, it may not have provided long term investment certainty to encourage large scale, diverse market development and encourage new market entrants that can drive competition and product improvement.

We note that revisions to the Mandatory Renewable Energy Target (MRET) may address some of these issues. This is the subject of further discussion under Section 6.3.2.

The case study highlights that in designing a financial incentive scheme for any product, it is important to ensure the scheme is effective and efficient with respect to its main policy objectives. Financial incentives are best used to encourage the uptake of pre commercial products that have promise, as a way of encouraging further market development. If this is the primary objective, the policy maker must carefully consider the implications of supporting a certain product, and the way in which the product is supported.

For instance, will the policy create a product winner to the detriment of other potentially valuable products? Will it crowd out competition in the market for that product? Does it encourage continued product innovation? Does it provide the certainty required for industry to make the investment needed to develop the product to its full potential (i.e. develop the product to the point where it doesn't need subsidisation)?

To avoid unintended or perverse outcomes when designing financial incentives, it is useful to consider policy questions relevant to technology development. For instance:

- Will supporting the product help overcome or entrench technology lock in and will the outcome be in line with the policy objective?
- Are there potential spill over benefits and how can they be enhanced?
- Is there evidence supporting the need to and benefit from subsidising the product?
- Is the product being supported compatible with the long term sustainability objective?
- Are complementary policies required to ensure the value of the incentive is maximised – for instance is specific training required for industry participants to avoid labour shortages eroding the financial incentive?

Importantly, these questions can be applied when thinking about how best to support the uptake of a diverse range of new technologies that may be necessary to achieve long term sustainability objectives.

6.3 Regulatory Instruments

Regulatory instruments are laws implemented by a Government that affect an existing market for a given product or service, or the conduct of a given economic sector. This could involve requiring mandatory information disclosure, establishing a minimum or maximum price, or quantum for a good or service to be delivered, or a performance standard that must be met. Regulatory instruments are useful at correcting markets where they fail to deliver an efficient or qualitatively desirable outcome. In the context of sustainability, this is typically caused when some social or environmental harm is not priced, or when the costs and/or benefits of a decision are not faced by the individual or group making that decision.

Examples of regulatory instruments include the mandatory renewable energy target (MRET) which requires a minimum amount of renewable energy to be generated by a certain date, and minimum energy performance standards (MEPS) which creates a minimum benchmark for energy consumed by an appliance as well as the requirement to disclose the amount of energy consumed by that appliance.

6.3.1 Case study 1: Renewable energy

A major tool used in Australia to incentivise investment in implementing alternative energy supply has been the MRET. It creates a legal obligation on energy retailers to purchase a set quantum of energy from renewable sources by 2020 with a penalty for not meeting requirements. A similar scheme has been used in the United Kingdom and other jurisdictions.

The MRET scheme creates a market and additional income for energy generated by sources defined by the scheme, the currency being Renewable Energy Certificates (RECs). REC prices are subject to a market, that is, they can be bought and sold competitively to determine their value. This approach is intended to create market discipline so that least-cost emission reductions are achieved.

The final design of the expanded MRET is still under consideration at the time of writing, but efforts appear to be made to incentivise adoption of small scale renewable energy generation technologies as well as large, centralised supply technologies.

Regulation to incentivise renewable energy is essential to ensure households and businesses transition to more sustainable energy consumption. This is because many services supplied by electricity are non-substitutable, and electricity consumption is a significant source of emissions (see Section 3).

6.3.2 Evaluation and discussion

By way of context, Sonneborn (2004) argues that an emissions trading scheme alone is unlikely to result in the development and deployment of renewable energy technologies. This is because such technologies often face market distortions, beyond the pricing of emissions that impede their development and implementation. For example, the energy supply chain in Australia was developed in an era of Government owned and operated infrastructure that used cross subsidies to prioritise, and tax benefits to encourage use of mains grid electricity. For example, rural areas were often supplied energy below the cost of service and tax benefits favour mains grid connection over stand alone energy supply (Saddler, 1995, cited in Sonneborn, 2004).

These cross subsidies enabled industry and communities to grow around a distinct energy supply paradigm resulting in positive market reinforcement such as investment in skills and education required to operate a linear, fossil fuel driven energy supply chain. Such distortions can undermine financial incentives to invest in energy efficiency or in alternative supply side options that would otherwise be efficient.

This context is important because it highlights that a centrally supplied, fossil fuel based energy system is not necessarily the most efficient or best for society, but it dominates in part by virtue of historical circumstance, and has been perpetuated by technology lock in over time, in part driven by Government policy. Therefore in developing policy to encourage the implementation of renewable energy, policy makers need to be cognisant of this history and how this affects new technology development.

When introduced in 2001, MRET sought to increase the contribution of renewable energy sources in Australia's electricity mix by 9500 GWh per year by 2010. MRET established a guaranteed market for new renewable energy by imposing penalties for non-compliance on electricity retailers. At the time of writing, the government is seeking to extend and expand MRET, by increasing the target to 45 000 GWh by 2020.

As discussed below, there is an extensive body of research emerging on the effectiveness of renewable energy targets, or quota systems. Typically, target schemes are compared to price fixing schemes, called feed-in tariffs (FiT), as both aim to accelerate the uptake of renewable energy generation.

MRET versus FiT

The relative merits of FiT and schemes such as MRET have been subject to analysis locally and abroad. Our meta-analysis (see below) has found that while both systems have their relative strengths and weaknesses, they can be used in conjunction to achieve complementary aims. It is also important to note that the merit of each policy will depend on where and how the policy is designed and implemented, as much as, if not more than, the type of policy.

A synthesised summary of relevant findings, including comments that link findings to the Australian context, from Menanteau (2002), Sonneborn (2004), Kent (2006), Toke (2006) and Kelly (2007), is presented below:

- A FiT provides investment certainty through price fixing, whereas renewable energy certificate (REC) markets are subject to fluctuations caused by changes to targets, market conditions and other factors. This means that under MRET, investors have to price in greater risk which can increase the cost of financing and negate efficiency gains of the competitive REC market to some extent.
    - The investment certainty provided by a FiT can encourage stronger investment in domestic industries, and potentially lead to the development of export capabilities, although it is important to note a FiT does not necessitate local or small scale generation, as this is dependant on other factors such as domestic industry make up, policy design and cultural norms.
- In designing a FiT, setting the price too high can create windfall gains for certain technologies.

- A competitive market for RECs is enhanced by emissions targets that are lower than what industry can achieve cost effectively - this creates a policy tension where the interests of a competitive market have to be weighed against the desire to set stretch targets for industry development.
- A target scheme such as MRET typically creates a greater incentive for reducing costs of technology deployment over time, although this can be achieved to some extent with appropriate FiT design
- MRET typically prioritises least cost renewable generation which focuses investment to one or two proven technologies. Unless MRET is complemented by other policies, this may crowd out investment in alternative technologies.
- A FiT allows any renewable energy technology investment to make guaranteed commercial return, allowing the investor to choose the most appropriate investment for their situation. This can encourage investment diversity and limit the risk of policy lock in of cheap technologies only.
    - If set too high, a FiT may lead to over-investment, and potentially inefficient investment in renewable energy technologies
    - There is a perception that FiTs are not cost effective. However studies viewed rate FiTs as either neutral, or more cost effective when compared to market based mechanisms. It is important to recognise policy success will be in part a function of where it is implemented, as much as policy design itself
    - FiTs are especially effective to encourage an initial large uptake of new technology. To ensure inefficiencies caused by price fixing don't emerge or compound over time, it is possible to transition FiT schemes to market based schemes over time.
- A FiT makes renewable energy investment viable for many investor types, whereas MRET typically favours vertically integrated retailers/generators who can leverage economies of scale and who can hedge investment risk internally.

Perhaps most importantly, findings by Haas (2004) suggest that the effectiveness of policies supporting renewable energy are less dependant on the policy chosen than on the design of the policies – citing the need for good baseline measurements, avoiding windfall profits and policy certainty amongst other factors. Haas (2004) suggests policy makers must be cognisant of many factors such as the state of the renewable energy market in a given jurisdiction, the state of technology development, the policy objective itself, complementary policy objectives and non price impediments to renewable energy generation. Importantly, Haas (2004) sees a need for policy to be flexible and adaptable to changes in market conditions over time.

The findings of Haas (2004) are broadly corroborated by Allen (2007), who cites research indicating that regardless of the policy chosen, stable, consistent, long-term framework from governments are most important.

Midttun and Gautesen (cited in Allen, 2007), argue that 'feed-in tariffs and certificate markets should not be seen as competing alternatives, but rather as complementary policy-steps in the technology development cycle'. In essence, feed in tariffs, by

providing price certainty, can be more effective at encouraging technology uptake in the early stages of development, while competitive quota systems are better at ensuring the most cost effective mature technologies are deployed on a large scale.

The impact of either a FiT or MRET scheme affects consumers through retail energy prices as costs of both are borne by energy retailers and passed through to consumers. There is no inherent reason why one scheme would impose higher costs on one class of consumer than another. This would only occur if the scheme design limited the extent to which costs could be passed through to certain consumers. Therefore the net cost on consumers is only affected by the cost of implementing the policy itself. Policy makers can choose to protect certain consumers from the price impact of these policies through other means.

Either policy will create a wealth transfer in society, as a premium will be paid to some party for renewable energy production. In the case of MRET, wealth is transferred to those that produce RECs. In the case of FiT, wealth is transferred to those that produce energy from generation systems covered by the FiT. Therefore the extent to which each policy affects the transfer of wealth is determined by the specifics of policy design, rather than the inherent characteristics of each policy.

For example, if used to encourage domestic scale renewable energy generation, there is a risk that a FiT or MRET would create a wealth transfer from households who can't afford the up front cost of renewable energy systems covered by the policy, to those that can. If policy makers wanted to ensure low income households were not excluded from the benefits of a FiT or MRET scheme, they could structure the scheme to provide higher payments to households based on means testing, or use some other payment support, such as a rebate or low/no interest loans targeted at low income households, to overcome any financing barrier.

It should be emphasised that this example only provides a very general hypothetical means by which any inequitable effects caused by renewable energy policy can be managed. Any detailed policy design would need to account for greater complexity than can be covered here. We have also commented on the potential for using MRET and FiT in Australia in a complementary way in Section 6.6.2.

6.3.3 Case study 2: Energy efficiency

Regulatory instruments can also be used to drive energy efficiency improvements. One such instrument, minimum energy performance standards (MEPS) works by setting performance standards for appliances in combination with labelling that informs consumers about appliance energy performance. In this way, MEPS creates both supply push for manufacturers to improve appliance performance and demand pull, by facilitating consideration of energy performance in customer decision making. This creates a powerful combination to drive efficiency improvements.

MMA (2004) assessed the benefits of adopting a National Energy Efficiency Target (NEET) over the period 2005 to 2014. The assessment included the economic, social and environmental benefits that might flow from avoided investment in electricity

generation plants, network upgrades for both natural gas and electricity and any benefits from reduced electricity prices. These benefits were estimated to range from $2.4 billion to $6.6 billion depending on the aggressiveness of the efficiency target.

The analysis indicated a decrease in operating costs, fuel costs, and substantial savings in capital investment in the electricity supply system mainly due to, deferral of new plants, higher levels and longer periods of mothballing, and plants operating at reduced capacity.

Further benefits, in addition to those mentioned above, included reductions in greenhouse gas emissions of up to 11% in 2014 when compared to business as usual; reductions in energy not served to end-users (less power outages); and reductions in spot market pool prices in the National Electricity Market (NEM) and the South West Interconnected System (SWIS), which, for all the efficiency scenarios, were substantially lower than those for the base scenario from 2006 until 2016.

6.3.4 Evaluation and analysis

Regulatory intervention in appliance markets is driven by the recognition that competitive markets do not provide sufficient incentive to improve efficiency of appliance performance over time. Essentially, it is a split incentive problem where action taken by one party has benefits that cannot be recovered by that party.

Achieving energy efficiency in households is also impeded by the split incentive involving landlords and tenants, where the landlord pays for appliances and the tenant pays for energy bills. Another impediment arises from the diluted incentive caused by benefits of energy efficiency accruing to multiple parties over time, without being captured by any one party at the time of appliance purchase.

For instance, choosing an energy efficient air conditioner reduces time specific peak network demand costs, and may reduce the energy retailer's exposure to peak wholesale generation costs, but the consumer only recovers operational savings over time from an imperfect tariff structure. The purchaser of an efficient appliance cannot capture all the benefits of his or her decision, as some benefits will naturally accrue to energy retailers and network companies.

In addition, the customer's savings accrue slowly over time. In strictly rational terms, this should not affect a rational purchasing decision. However insights from behavioural economics and social science indicate that decision-making is influenced not just by the quantity of gain or loss that can be made, but by the certainty of gain or loss (Kahneman and Tversky, 1981). In the case of energy efficiency, potential gains from saving operating costs over time are uncertain[13] while the cost of the more efficient appliance is certain, and so a consumer is likely to prioritise minimising the certain loss, as opposed to maximising the uncertain gain.

[13] The consumer would need to calculate the amount of energy used by the appliance over time, the price they pay for energy and any potential future change to this price, and the operating lifetime of the appliance. They still then have to weigh up the time taken to pay off their investment against any other spending they may value (i.e. opportunity cost).

The MEPS design does rectify this to an extent by providing an estimate of how much energy some appliances will use in a typical operating year. This could arguably be improved by estimating cost savings based on some average electricity price, or even administering a rebate to the customer that reflects to some degree the value of energy efficiency they can't capture through operating savings alone.

The experience of MEPS both in Australia and comparable schemes overseas has generally been very positive. MEPS have been able to drive significant cost effective improvements in energy efficiency across a diverse range of products (DEH, 2005).

In setting MEPS, Australia has taken the approach of the 'fast follower'. This means Australia seeks to adopt global best practice standards. This is in recognition that Australia's domestic manufacturing market is too small for it to lead global standards in a way which is economically efficient.

At the time of writing, we believe that a move to the 10-star standard is being considered. This would be a positive step, as it would allow consumers to differentiate between products that perform above the highest current standard (i.e. above 6 stars).

Interestingly, Nadel (2002) shows that the cost of improving efficiency of appliances has typically been less than was forecast in the United States of America. This occurs for a number of reasons including:

- Investments required in new tools or processes to improve efficiency can be coupled with investments that would have been required for normal business reasons.
- Manufacturers are sometimes forced to find business efficiencies or cut profit margins as a way of maintaining market share

Thus it appears that the MEPS concept and framework has been successful at creating incentive for improving appliance efficiency through both supply push and demand pull.

The MEPS concept and framework could also be applied to deal with other environmental issues that suffer from split incentives, such as product or packaging waste. In this case, the cost of waste disposal is not borne by the party that designs and supplies a product or its packaging, and so they don't always have an incentive to reduce waste. While consumers may have some choice as to what form of packaging they choose, they still may not be exposed directly to the cost of waste disposal and so may not choose packaging that minimises waste disposal costs.

Applying the MEPS concept, a product and/or its packaging could be judged against criteria such as use of recycled materials; ability to be reused or recycled; toxicity and so on. Minimum standards could be set and product information displayed to create supply push and demand pull for products and packaging that minimise waste. As discussed in Section 4, more specific information about consumer products is best coupled with broader education around the issue being addressed, in this case, packaging waste.

6.3.5 Case study 3: Green building design

BASIX is a “building sustainability index” introduced by the NSW State Government. The program works by prescribing a range of energy and water efficiency measures from which a home builder/designer can self-select. Each measure is weighted based on its contribution to reduction in consumption of energy and/or water. The builder/designer must select sufficient measures to meet minimum BASIX requirements. BASIX is coupled with a simple online assessment tool that allows the user to quickly determine if their design will meet BASIX requirements. For a new development to be approved, a building inspector must review measures planned for implementation in the BASIX certificate against implemented measures.

6.3.6 Evaluation and analysis

The strength of BASIX is the flexibility it allows property developers in pursuing energy and water efficiency improvements. This helps reduce costs and maximise ease of compliance. At the same time, the strength of BASIX may be a potential weakness. A developer may take a ‘tick the box’ attitude, satisfying the requirements of BASIX while ignoring potentially other beneficial, low hanging fruit. This is a potential risk of any policy that creates reward for a limited set of desired behaviours and no penalty for undesired behaviour.

For example, BASIX may encourage a developer to install solar hot water and rain tanks, and even shading measures. But the developer could still install a large number of energy intensive halogen down lights and/or inefficient air conditioning units while meeting BASIX requirements.

It is recognised that policy can be limited by industry willingness or capacity to comply, and that rewarding positive actions may be the most feasible way to begin a process of industry reform. Where this is necessary, it is important that policy makers take steps to ensure the policy progresses over time to increase performance targets and improve outcomes.

More specifically, while BASIX encourages uptake of specific products, it does not necessarily encourage improving the performance of a building as a whole, and integrating this performance with other services affected by building design, such as energy supply and/or waste disposal. This creates the potential for sub optimal building design.

For example, a significant cost of energy supply is the cost of peak demand. If peak demand can be reduced cost effectively, more scope is created for making other desirable market outcomes, such as emission reductions, more affordable. The inference is that reducing the net energy consumption of a house does not necessarily reduce the net cost of supplying energy to that house, because the cost of energy supply is largely influenced by the timing of energy demand, not just the demand quantity.

The importance and value of reforming the efficiency of building design cannot be understated. Research highlights that the most potential for cost effective emission reductions worldwide exist in the residential and commercial building industry, and that achieving these gains is best done by designing buildings as holistic systems (Levine et al, 2007).

It is also important to highlight that green building design requires a coming together of many complementary policies. Levine et al (2007) highlight that split incentives, access to finance, renewable energy policies, energy prices and the skill and industry capacity, from architects, through to builders and trades people can all impact on the level of green building design. Policy makers must address these issues simultaneously.

It is worth noting that, as highlighted in Section 3, building and renovation contributes 11.8% of household emissions based on the full lifecycle impact of products used. If the MEPS concept was used in the property industry, ratings could be applied to different building materials to help consumers make informed decisions on material selection. Minimum targets could also be set for embedded energy and water use in residential settings based on some common denominator such as usage per square meter.

For consistency with the appliance standard, best practice home design could meet anywhere up to 10 stars, with some minimum standard for new buildings. In this way, the developer or renovator would have to find the best combination of efficiency measures to meet the minimum standard and depending on market demand and cost could choose to exceed the minimum standard. Such a standard system for homes could help buyers distinguish between a home that may just have a number of visible efficiency measures (e.g. solar hot water) and a home that may have less visible efficiency measures but better performance (low flow shower heads, short runs on water pipes, insulated water pipes etc).

6.4 Tradeable Permit

Tradeable permits are typically used to create a market for a product that otherwise couldn't be traded. In this way, the product has explicit financial value. By allowing essentially undesirable products to be bought and sold, in theory, markets find an efficient price for those products.

The most obvious example of policy creating a tradeable permit is emissions trading, where emissions of some kind are assigned property rights, and the amount of emissions firms can create are limited by regulation.

6.4.1 Case study: Tradeable permits for CO_2 in NSW

New South Wales was one of the first jurisdictions in the world to create a tradeable permit scheme for carbon dioxide emissions through the NSW Greenhouse Gas

Abatement Scheme (GGAS). This scheme worked by creating a CO_2 reduction target, then requiring certain firms to purchase emission abatement in an open market in order to meet the reduction target. If firms did not purchase the amount of abatement required of them, they were penalised financially.

This type of tradeable permit scheme is referred to as a baseline and credit scheme. In such a scheme, firms that reduce their emissions relative to a hypothecated future scenario in which the trading scheme does not exist, are able to trade the value of the emissions they avoid on an open market. The quantity of abatement that must be purchased is set by Government. In this way, the firms have an incentive to reduce emissions at least cost – i.e. to compete in a limited market for abatement.

To ensure that a baseline and credit scheme is effective, it is essential to define robust methodologies for calculating the quantum of emissions a firm can legitimately trade. This is because if a firm reduces its emissions and wants to trade the value of the reduction, the viability of making the reduction must be dependant on the value gained from trading it. Without this assurance, there is no guarantee reductions are caused by the scheme.

A baseline and credit scheme is useful for encouraging activities that reduce emissions at low cost. Depending on the schemes coverage, it can do this across a range of economic activities. However a baseline and credit scheme may be less effective at limiting net emissions from an industry or activity below a certain level. This is due to the difficulty of knowing how large the abatement market needs to be to ensure a net reduction in emissions, as opposed to a slow down in emissions growth.

The NSW GGAS was reviewed by Passey et al (2007). They found the scheme lacking in effectiveness, efficiency and equity – three key objectives for any trading scheme. Specifically, they challenge the amount of reductions attributed to the scheme and state that this is corroborated by a Federal Government estimate that by 2010, GGAS will deliver 5Mt of abatement, as opposed to the 20Mt claimed by the scheme regulator in its 2006 compliance report.

Passey et al (2007) highlight a range of reasons for the scheme's shortcomings, but perhaps most importantly, they raise the issue of scheme governance. They state that "separation of powers between the 'designer', 'operator' and 'assessor' is critical to reduce conflicts of interest, especially where the assessor is publicly reporting on outcomes that are relevant to public welfare and are important to informing revision of the scheme design".

Tradeable permit schemes can affect behavioural drivers of action in a number of ways. They can help overcome financial barriers to undertaking certain behaviours by making the undesired behaviour more expensive, but they can also act as a disincentive to voluntary action, or action that is excluded from the scheme, to reduce emissions.

Under a cap and trade scheme, this perverse outcome may occur because non-financial motivators for voluntary action can be diluted. This will occur at an individual

level depending on what motivated voluntary action undertaken prior to the scheme. For instance, if voluntary action was undertaken because the individual gained satisfaction from creating emission reductions they perceived to be greater than what would have otherwise occurred, it is likely a cap and trade scheme will dilute this motivation.

This issue may not stop voluntary action occurring because there may be factors other than reducing emissions motivating the action, such as financial savings, but it is likely to cause a degree of cognitive dissonance. Again, cognitive dissonance may not stop individuals taking voluntary action, predicting how individuals will react is complex, particularly because the drivers for voluntary action and people's understanding of the cap and trade scheme may vary significantly. However the presence of cognitive dissonance is likely to result in a change in behaviour, a change in beliefs, or a combination of both.

For instance, an individual's voluntary action may have been driven by a desire to reduce emissions beyond their perception of 'normal' reductions. The individual may still decide however that even though they can't reduce aggregate emissions below the cap, they should still undertake voluntary action because other people they know and respect are doing so, and because such action supports industries that are helping to deal with climate change.

An important message for encouraging voluntary action that is not accounted for in a trading scheme is that while voluntary action may not reduce the net quantity of emissions, it still reduces the social burden of reducing emissions otherwise borne, and so still has a meaningful contribution to social welfare. This message could have appeal to external drivers of behaviour discussed above.

6.4.2 Evaluation and analysis

Designing a tradeable permit scheme entails significant complexity. Scheme integrity is essential for the public, and private enterprise, to have confidence in Government policy. Ultimately this confidence is required for the policy to have long term support, and so is essential to its effectiveness. Tight design and compliance measures are critical to ensure the scheme is effective, efficient and equitable – key measures of its integrity.

In designing and implementing the Carbon Pollution Reduction Scheme (CPRS), it is useful to consider some of the failures that have undermined the integrity of the ETS in the European Union. For instance:

- Allocation of significant volumes of free permits to polluters resulted in a wealth transfer, broadly considered inequitable and inefficient.
- Consultants E3 International identified 18 million emission permits that had been double counted under the scheme.
- Wara et al (2008) highlight that by rewarding HFC-23 destruction, the Clean Development Mechanism (CDM) actually encouraged production of the gas, as the

value of destroying it was greater than the value gained from producing refrigerant gases that lead to its production in the first instance. They also show these projects generated about EU$4.7b revenue but cost only EU$100m to implement – an expensive way to reduce emissions and not consistent with the hypothecated benefits of the trading scheme.

- Wara et al (2008) show that essentially all new hydro, wind and natural gas in China are claiming CDM credits and that they are not all likely to be 'additional'. Chinese Government policies have been directed at these technologies to ameliorate air quality issues and resource scarcity issues, with power blackouts occurring due to coal shortages. Thus it is very likely these power stations would be built without the influence of CDM.

Importantly, research by Wara et al (2008) shows that it is highly unlikely that scheme administrators will be able to verify and issue Certified Emission Reductions (CERs) at a pace required to keep up with the EU ETS, resulting in a large backlog of unissued CERs. To meet the projected issuances over the next 5 years, it is estimated the rate of issuance must increase 20-40 times. This may threaten the viability of companies that have been expecting their emission reductions to be certified for payment. Wara et al (2008) go on to hypothesize that such problems are likely to have a terminal impact on any offset scheme, because ensuring independent project approval and verification on the scale required in any scheme is likely to be made prohibitive by the need to overcome information asymmetry and distorted incentives, while minimising transaction costs.

These findings from the EU ETS highlight the practical and technical difficulties of managing an emissions trading scheme in Australia. Of critical importance to emissions trading integrity is that any wealth transfers be carefully thought through and managed to avoid inefficiencies and public disapproval, and that emission reductions be real, lasting and caused by the scheme. Primarily, this requires effective governance and oversight and a commitment to improving scheme design over time, but also careful design in the first instance so that opportunities for gaming the scheme are limited.

As noted earlier, in designing a tradeable permit scheme and complementary policies, Government should be mindful of such a scheme's potential to discourage voluntary reduction of emissions or to otherwise limit the effectiveness of complementary policies designed to reduce emissions. For example, the effectiveness of policies aimed at encouraging energy efficiency by educating consumers on climate change may be limited by an emissions trading scheme if the education focuses on the potential for emission reductions, as opposed to financial savings.

In the case of Australia, one of the most prominent voluntary action schemes that could be affected by emissions trading is Green Power, which is aimed at encouraging the uptake of renewable energy, and hence reducing emissions. There are limited tangible benefits expected from the scheme other than emission reductions and so it is likely to be adversely affected depending on CPRS design. This is because the primary rationale for purchasing Green Power is the reduction of emissions by encouraging additional renewable energy generation, and with the emission cap set by

the carbon pollution reduction scheme, Green Power customers are most unlikely to create additional emission reductions. As noted earlier, there are other voluntary actions that are unlikely to be impacted by emissions trading, and also actions which may or may not be impacted depending on ETS design.

6.5 Voluntary Agreement

Voluntary agreements can be used by Government in partnership with industries or specific firms to motivate sustainable resource use. They can also be used between firms and customers. They are non binding, but typically set an objective or target for change as agreed by the parties to the agreement. Voluntary agreements are typically used by Governments to encourage industry or firms to explore the costs and benefits of making a desired change, gather information about a particular problem, or as a precursor to more stringent requirements in the future. Voluntary agreements can also be used by Governments to encourage firms to take up 'low hanging fruit', improvements which may come at little or no cost, but which improve the sustainability of resource use.

Voluntary agreements can provide a way for Government and private firms to share resources in order to meet policy objectives. To be successful, voluntary agreements rely on an alignment of interests, the integrity of the parties to the agreement, and the discipline provided by publicity risks associated with parties to the agreement failing to meet their obligations. For instance, if a firm is required to disclose its performance publicly or to shareholders, perceptions of a firm's competence may be sufficient discipline to ensure their compliance with the agreement.

The Victorian EPA has a voluntary agreement with North East Water (NEW), a provider of water, sewerage and trade waste services, to "work together to protect the environment and to contribute to a more sustainable Victoria." The agreement outlines a number of specific actions to be undertaken and publicly reported.

6.5.1 Case study: Reducing peak energy demand

One of the more interesting voluntary programs in Australia is being carried out by ETSA utilities in South Australia on reducing peak demand energy consumption.

The program was developed in collaboration between ETSA utilities and the Essential Services Commission of South Australia (ESCOSA) as a way of testing the costs and benefits of a range of demand management options. The intent was that both the regulator and ETSA would gain valuable knowledge about efficient peak demand management options.

ESCOSA granted ETSA funding to be spent on trials and required certain conditions to be met, for instance conditions on project reporting. In this way, ESCOSA helped ETSA to develop demand management capabilities and knowledge, and also uncovered real data on the cost effectiveness of various demand management

options. Such data is essential for an energy regulator to overcome information asymmetries which may limit its ability to determine the efficiency of spending undertaken by the businesses it regulates.

Trials conducted by ETSA have targeted a mix of domestic and commercial businesses who voluntary participate, but they can receive financial benefits through participation. The trials complement work being done across other jurisdictions and businesses on the merits of 'smart meters' – commonly seen as a technology which amongst other things, will enable better peak load management.

6.5.2 Evaluation and analysis

Voluntary agreements can be an important way for policy makers or regulators to affect the behaviour of businesses, and sometimes the consumers those businesses serve. The voluntary agreements between ETSA and their customers uncovered important real data on the efficacy of various demand management measures. They also created a vehicle for ETSA to engage with customers on an important issue facing their business in a relatively benign way.

The success of any voluntary agreement hinges on the relationship between parties to the agreement – requiring mutual understanding of the importance of the issue at hand, mutual recognition of how best to address the issue, even if this involves experimentation and failure, and mutual commitment to resolving the issue. Without such an alignment of interests, a voluntary agreement is unlikely to be implemented or implemented well. Once such alignment is established, the structure of the voluntary agreement needs to be matched to the problem and on mutually satisfactory means of addressing it.

In the case of ETSA utilities, the problem to be addressed was the high cost of meeting peak demand management through building more network infrastructure. It was agreed that the primary barrier to discovering more efficient alternatives was that ETSA lacked financial incentive to invest in R&D. Together with the need for ESCOSA to be satisfied money granted was being spent appropriately, these factors largely determined the structure of the agreement with:

- Funding granted to ETSA
- ETSA given high level parameters to guide R&D but largely left to trial different technologies and solutions depending on customer type and location
- ESCOSA establishing reporting requirements that ensured it would secure the feedback on the trials conducted.

This structure gave ETSA the freedom to trial and develop a variety of technologies – allowing ETSA to find the right technology for the right circumstance. While outcomes from the trials have not been finalised, initial results are positive with ETSA confident it has uncovered and built expertise in potentially cost effective demand management options.

It is useful to consider scenarios which could have rendered the agreements between ESCOSA and ETSA, and ETSA and its customers a failure. For instance:

- If ETSA was not confident in the viability of demand management options, it may have deliberately or inadvertently undermined the success of the trials through poor project management, communication, or a general lack of management commitment.
- If ESCOSA had set up loose reporting requirements, it may not have obtained the information it needs to make meaningful judgements about the efficacy of different demand management options trialled.

Particularly when outcomes from voluntary agreements between business and Government have a high public profile, it is essential they are well thought through and structured.

6.6 International Case Studies

6.6.1 Case 1: Feed-In Tariffs for Renewable Generation in Germany

Germany is widely regarded as the global leader on Feed-In Tariffs (FIT) for renewable electricity. FiTs were first introduced in 1991 with the Electricity Feed-in Act. Germany's current FiT program was established with the Renewable Energy Act ("Erneuerbare Energien-Gesetz", EEG) in 2000, which was subsequently revised in 2004. The Act required electricity providers to pay renewable power generators a fixed tariff on gross electricity production over a 20 year period, with the tariff rate for new systems progressively reducing annually. This gradual reduction in tariffs was designed to encourage manufacturers to systematically reduce costs and offer more efficient products every year. The rate of reduction is based on the empirically derived progress ratios (from the theory of technology learning) for the different technologies. Also, the tariffs offered to different technologies vary according to yield and generation cost associated with each particular plant, so that (for example) high-yielding, low-cost generators attract lower tariffs. This system is intended to control producer profits and thus the transfer costs for consumers (Mendonca, 2007; Runci, 2005).

Part of the EEG included a review of tariffs every two years, beginning 2002. The 2002 review brought forth recommendations which were included into the updated EEG of 2004, now the current legislation. The main changes included:

- The introduction of a renewable electricity production target of 12.5% by 2010 and 20% by 2020;
- Improved integration of renewable electricity generators into the electricity system, involving regulatory change; and
- Tariff adjustment to better reflect the varying costs of different technologies (Mendonca, 2007; Runci, 2005).

Germany's renewable energy sector has flourished with the evolution of the FIT system. The solar sector has increased to employ 20,000 people achieving a turnover of €1.7 billion in 2004. Between 2000 and 2004, the turnover of the German solar power sector increased by an average of 43% annually. A turnover of €2.7 Billion was anticipated for 2005 (Friedrich Ebert Foundation, 2006, cited in Mendonca, 2007). From 2000 to 2004 the amount of energy supplied from solar installations supported by EEG increased from 13.6 TeraWatt Hours (TWh) to 34.9 TWh (BMU, 2004, cited in Mendonca, 2007). In 2006, the share of renewable energy consumption across Germany increased to 11.8%, up from 10.2% from the previous year. In 2006, companies in the sector turned over €21.6 Billion, up from €16.4 Billion in the previous year. The sector employs 214,000, which is greater than the nuclear, hard and brown coal industries in the country put together. This figure is set to grow to 500,000 by 2020 (Mendonca, 2007).

6.6.2 Relevance to Australia

As discussed in Section 6.3.2, there are subtle differences between a renewable energy target and renewable energy price fixing, but on balance, research indicates both can be used in combination in a complementary way.

At a Federal level, Australia's primary regulatory tool for incentivising the implementation of renewable energy has been the MRET, discussed earlier. However most Australian states have announced or implemented FiTs of their own, and there may be a shift to a nationally consistent FiT scheme in the future. It appears that Australia will need to find a way for FiTs and renewable energy targets to coexist and complement each other without compromising the effectiveness of either scheme.

The best way for the RET and FiT to coexist would be for one's strength to complement the others strength. The strength of a RET is that it typically encourages large scale, market proven renewable energy generation delivered in a co-ordinated way through energy market participants. On the other hand, the strength of the FiT is that it can make renewable energy investment viable for all types of investors and technologies in the early stages of technology development.

Therefore, the RET should focus on rewarding large scale renewable energy generation installations – for instance, eligibility to generate RECs could be limited to generating units, or collections of generating units above a certain size deemed 'large'. A FiT could focus on rewarding a diverse range of smaller scale renewable energy generation under that size; generation that may not be commercially attractive at a large sale, but perhaps feasible in niche applications.

In this way, a FiT would provide confidence to the market to develop technologies for smaller scale, niche applications that may have mass market potential, encouraging innovation and entrepreneurship, while the RET would ensure a minimum level of investment in proven renewable energy technologies that can be implemented at scale and minimum cost.

Policy makers and regulators must also be cognisant of the affect their action may have on the energy market. In particular, it is essential that energy market participants such as the Market Operator (NEMMCO, soon to be the AEMO), network companies, the Australian Energy Regulator (AER) and the Australian Energy Market Commission (AEMC) are aware of policy changes so they can ensure energy market frameworks can handle any major structural change to market operation.

6.6.3 Case 2: Decentralising Energy in Woking, United Kingdom

Woking Borough Council (WBC) has positioned itself as one of the leaders in decentralised energy while making significant reductions in greenhouse gas emissions. Located in the South East of England, Woking covers a geographical area of approximately 65 km^2 and services a population of approximately 90,000 (WBC, 2009).

WBC established a Corporate Energy Efficiency Strategy (CEES) in 1990/91 with the aim of achieving a 40% reduction in its own energy consumption within 10 years. In 2002, CEES was superseded by the Climate Change Strategy targeting CO_2 reduction, climate change adaptation, and promotion of sustainable development (Curran, 2005). By 2006, the Council had achieved 52% reduction in energy and 82% reduction in CO_2 emissions (Resource Smart, 2008).

The WBC mitigates CO_2 production by supplying customers on private electrical and heat networks with combined heat and power (CHP) and/or renewable energy generators. CHP facilities typically use conventional fossil fuel, such as natural gas, to produce electricity and recover heat generated in the process for practical use. Such systems return up to 90% efficiency at point of use, compared to 25% efficiency with national grid electricity. In future, renewable fuel such as biogas, biomass or hydrogen fuel cell can be used in place of natural gas (WBC, 2009).

Following success with early energy efficiency projects, WBC sought to achieve a larger impact by setting up a Special Purpose Vehicle (SPV) called Thameswey Ltd in 1999. The company's purpose was to form public/private partnerships to deliver projects targeting its broader climate change strategy, including green energy, tackling fuel poverty, water, waste and green transport. Generated revenues are then channelled back to the council to reinvest in projects, such as improvements to housing, retrofitting solar PVs and heating systems for low income families (WBC, 2009). By 2006, WBC had achieved 33% energy efficiency and 21% emissions reduction on residential property (based on 1991 figures) (Resource Smart, 2008).

6.6.4 Relevance to Australia

WBC is often cited as a case study highlighting the emission reductions and efficiency gains that can be achieved by local government bodies.

The specific technologies used in the WBC case are not necessarily transferable to all Australian conditions. For instance, cogeneration was a natural fit with WBC, due to a

combination of the heating loads imposed by British winters and by the presence of manufacturing industry: clearly these factors are not typical of Australian urban regions, other than some areas of Melbourne or Tasmania.

Perhaps the most important lesson to be learnt from the WBC case study is the innovative approach taken to delivering a range of utilities within the council area. To improve energy efficiency and reduce energy related emissions, they set up a Special Purpose Vehicle (SPV) that could deliver energy services (heating, cooling, lighting, transport), as opposed to energy products (electricity, gas). Most energy markets around the world, including Australia, are not designed to deliver energy services; rather they deliver energy products and have a natural incentive to increase product sales, rather than efficiency of energy use.

By setting up the SPV, Woking created a commercial imperative to improve efficiency of energy services and hence achieve emission reductions, without the use of complex policy interventions such as emissions trading. The SPV can engage in public/private partnerships and so is an ideal vehicle for bridging the gap between purely commercial interests and the broader social and environmental interests of the Council. WBC has applied similarly innovative thinking to housing development that ensures adequate social housing for local residents, and high quality building stock.

The other important transferable aspect of the WBC success is the long term strategic plan aimed at reducing emissions and improving energy efficiency both in Council operations and the region it governs, including the reinvestment of savings to produce more efficiency gains. Importantly, the WBC plan does not commit to a certain path for reaching their targets, rather it allowed the most effective path to be taken by integrating sustainability considerations into every aspect of the Councils function.

6.6.5 Case 3: Public Transport in Curitiba, Brazil

The rise of agricultural mechanization led to meteoric growth in Curitiba from the 1950s through 80s, with annual population growth rates in excess of 5% (Friberg, 2000). Like many cities experiencing rural urban drift, growing pressure on traffic management systems threatened the mobility of residents in and surrounding Curitiba. From a town of around 140,000 in the 1940s to a city of 1.8 million today, Curitiba has emerged as one of Brazil's most liveable cities with a world-class Bus Rapid Transit (BRT) system transporting over 70% of week day commuters and attracting an almost 90% approval rating (Roman, 2008; Friberg, 2000; and Parasram, 2003).

The key to Curitiba's success started with careful planning in the 1960s as city planners sought to manage growth through establishing a city master plan, a key feature of which involved changing the city's radial urban growth to a linear pattern through road network, land use and transport strategies. Planners recognised the critical role of transportation in forming the backbone of any city. However, instead of embarking on large scale highway constructions, like many other cities of the time, the planners sought to create major combined public-private transport arterials (structural axes), with priority given to public transport vehicles. Curitiba decided to use buses as

its primary means of public transport, not only because it was the choice of transport in the past; it was also the most cost effective means of transport. According to calculations done by Instituto de Pesquisa e Planejamento Urbano de Curitiba (IPPUC), the institution responsible for planning the implementation of Curitiba's master plan, the biarticulated bus system as it is developed in Curitiba cost 3 million USD/km to construct compared with 8–12 million for a tram system and around 50–100 million USD/km for a Subway. (Friberg, 2000)

Between 1974 and 1982, five major structural road corridors were built composed of a central 2-way express bus lane, and two local roads running in opposite directions, which allowed local through the city. Services along these five bus way corridors are fully integrated with 'feeder' and 'circular interdistrict' services. In addition, three unique innovations have increased ridership, capacity and efficiency of the system:

- Integrated fare system where long trips are subsidized by short trips, effectively making the system more affordable for people who live further from the city (in less expensive suburbs);
- Purpose built biarticulated busses with a capacity of 270 passengers (conventional bus capacity typically 80 passengers); and
- Specially designed 'tube stations', which bring passengers level with the bus floor and where fares are prepaid by tokens or in cash to a turnstile attendant. This makes boarding times comparable with subway or railway passengers (Friberg, 2000).

Curitiba's public transport system is also extremely successful from an economic perspective, with fares covering the overall costs of the system. 16 private companies operate services across the city and are managed by URBS, Urbanizao de Curitiba, a state-owned company created in 1963. The companies receive licences for specific services and are paid not per passenger but per passenger-kilometre. Fares are calculated by URBS and cover profit percentage for bus companies, personnel costs, maintenance and depreciation of the fleet. To avoid inflated fare prices, a law was established in 1990 stating that revenues could only be used to pay for the system itself. Another municipal law deemed buses must not be older than 10 years, giving the bus fleet an average age of five years. This supports bus reliability and keeps pollution levels low. URBS also monitors both mileage and passenger numbers in order to optimise bus services and frequency with demand. (Friberg, 2000) Overall, this makes Curitiba's BRT more flexible and cost effective than many rail systems (Juhel, 2008).

The key to Curitiba's success is the coordination of public transport with careful land use planning design. By identifying key corridors and structuring land use policies around these corridors, planners can ensure that more people either live close to work or nearby public transport services to work. This has made Curitiba one of the greenest cities in the world, with 30% less emissions than other comparable Brazilian cities.

Today, many cities around the world have adopted a BRT system, including Bogata in Colombia, Beijing in China, Jakarta in Indonesia, Leon in Mexico, and Seoul in South Korea. Other cities such as Cape Town in South Africa, Dar es Salaam in Tanzania,

Hanoi in Vietnam, Lima in Peru, Mexico City in Mexico, and Santiago in Chile have projects underway (Wright & Fulton, 2005).

6.6.6 Relevance to Australia

The Curitiba example shows what can be achieved when an objective of achieving a balanced and sustainable transport system is pursued through determined and well-coordinated efforts over a sustainable period. Although the elements of the Curitiba "solution" (e.g. the use of BRT) are of considerable interest, these elements are not necessarily transferable directly to an Australian setting (limitations of this kind are discussed further in the sections below devoted to transport policy). This case does however illustrate very well the importance of detailed attention to the various aspects of the transport system, notably the impacts of the system on urban land use patterns, the system in relation to the exigencies of daily travel by ordinary working people, and the incentives created for bus operators.

6.6.7 Case 4: Congestion Charges in London, UK

Before introducing the congestion charge, London was afflicted with the worst traffic congestion in the UK. The average speed in central London dropped below 10 mph during 1998-2000 for the first time since records began, indicating significant costs in time and money to businesses and individuals. Upon election, the Mayor of London promised to consider a congestion charging scheme for central London. The scheme was introduced on 17 February 2003, initially covering an area bounded by the Inner Ring Road in central London (22 sq km). On 19 February 2007, the congestion zone was expanded to double its initial size.

Congestion charging was designed to contribute to four transport priorities, as set out in the current Mayor's Transport Strategy:

- reduce congestion;
- make radical improvements to bus services;
- improve journey time reliability for car users;
- make the distribution of goods and services more efficient.

The scheme operates weekdays (bar public holidays) from 7 am to 6.30 pm; drivers entering the zone have until 10 pm on the day of travel to pay an £8 charge. Payment can be made by post, telephone, internet, SMS, at self-service machines, retail outlets and some petrol stations. Failure to pay the charge results in a £120 fine. The scheme is enforced using cameras in and around the charging zone. When drivers pay the charge, they register their individual vehicle registration number. Cameras in and around the boundary of the charge zone observe the vehicle registration numbers of vehicles entering, parked and driving around the charging zone, and check the registration against the payment database.

Some vehicles are exempt from the charge, including licensed taxis and minicabs, motorcycles and buses. Other vehicle users can register for discounts – for example residents of the congestion charging zone can register for a 90% discount, and disabled Blue Badge holders are eligible for a 100% discount.

The scheme has been undertaken as part of a wider transport strategy for London. Tackling congestion is a top priority and the congestion charge has delivered that, but a number of complimentary measures were necessary to ensure the success of the scheme. Across London, measures have been implemented to improve bus services, including increases in capacity (an extra 14,500 bus places have been provided), bus priority measures and extensive traffic management schemes around the perimeter of the zone.

The scheme appears to have reduced the volumes of private vehicles while increasing public transport use. During the first year of implementation, traffic delays in central London dropped by around 30% with 65,000-70,000 fewer car movements in the zone each day, which has been more or less maintained over the succeeding five years. Public transport use has grown significantly with record numbers of more than one billion passengers a year using the Tube, a 45 per cent increase in the use of buses and 43 per cent increase in cycling within the zone. After one year of implementation, traffic in the western extension of the Congestion Charge Zone fell by 10 to 15 per cent on 2006 levels (ManagEnergy, 2009; TfL, 2008a; TfL, 2008b).

6.6.8 Case 5: Renewable Energy Sources in Buildings across Europe

The “Renewable Energy Sources in Buildings” program, RESINBUIL, was established and financed by the European Commission’s Intelligent Energy Europe programme (IEE) to develop a strategy for increasing the uptake of renewable energy across Europe. To achieve this, a two-year plan was established across four European provinces: Burgos (Spain), Trapani (Italy), Pomurje (Slovenia) and Harghita (Romania). The project brought together local authorities, business associations, constructors, professional associations and the general public. The project partners analysed the current development rates and market barriers before implementing a strategy consisting of:

- Development of new local markets through regulatory shifts (including local tax cuts) as well as commercial agreements between installers and local banks with Energy Agencies as intermediaries.
- Promotion of energy-efficient appliances through permanent exhibits in Spain, Slovenia and Italy, and through a 4-month awareness-raising campaign using radio messages, local TV spots, posters, etc.
- Training courses on renewable energy sources in buildings at the University of Burgos (Master’s level), and online courses for architects and engineers in the other participating countries.

Project impact was assessed through initial and ongoing assessments of renewable energy source instalment rates and other market indicators. Instalment rates increased

most notably with solar thermal and biomass applications, with increases of between 50% to more than 150%. RESINBUIL also observed increases in the number of registrants in the project's Installers Network (Burgos – 113 registrations, Pomurje – 23 registrations and Harghita – 23 registrations). Overall, the project received increasing interest from the new generations of architects and engineers, as well as the general public. Response from the construction sector was more subdued, with concerns aired regarding the increases in construction costs (RESINBUIL, 2009; ManagEnergy, 2008).

7. TRANSPORTATION AND MOBILITY

This part of the Report reviews the challenges and opportunities that arise in the transition to more sustainable transport modes and usage patterns. Any strategy designed to achieve that transition is likely to involve a combination of behavioural changes, infrastructure investments and technological development.

The focus here is on travel within cities by individuals and families. Freight and commercial transport are thus excluded, along with travel outside cities; for a useful review of energy and greenhouse aspects of these sectors see Chapman (2007). Also excluded are measures aimed at improving the efficiency of conventional engines, and emerging developments in automotive technology, such as motors driven by hydrogen, biofuels or electricity (see Chapman, 2007; BTE, 2002; IEA 2001a).

By way of background, in Australia the transport sector accounts for approximately 24% of energy consumption (ABARE, 2009, p.16); while the corresponding figure for greenhouse gas emissions is 14% (BTE, 2002, p. 4). Cars and light trucks account for approximately 60% of energy used in the Australian transport sector (IEA, 2001a).

7.1 Objectives and outcomes

The concept of sustainability has been interpreted by some authors rather broadly in the context of urban transport. By contrast with this Report's focus on energy and greenhouse impacts, for example, the main indicators of sustainability identified by Richardson (2005) are safety, congestion, fuel consumption, vehicle emissions and intra-urban accessibility.

Furthermore, interventions in urban transport systems often have multiple outcomes, with side-effects that are not easily predicted in advance. It is desirable therefore to bear in mind the criteria that guide transport planning in practice, which encompass in principle all the sustainability concerns referred to above. The conventional criteria may be classified as follows:

- *Efficiency of energy consumption*: minimisation of total vehicle-kilometres travelled, total time devoted to travel, and energy cost; also safety and security criteria.
- *Equity*: distribution of transport facilities, and their costs and benefits, in space and in relation to the socio-economic composition of an urban community.
- *Environment*: impacts of transport facilities and infrastructure on natural systems (e.g. Greenhouse impacts) and on urban systems (e.g. local communities).

The multifarious nature of these objectives arises from the central place that transport systems play in the life of individuals, families and communities, and the multiple intersections (and consequent spillovers) between the activities of the various players. When formulating policy for a given urban setting or range of settings, it is therefore

often difficult to ensure that outcomes are consistently positive (see the discussion of potential conflicts in Section 7.4 below).

7.2 Dynamics of urban travel demand

Travel within cities differs in important respects from other targets of sustainability policy. Prominent among these differences is the inertia in patterns of travel demand due to the alignment of those patterns with urban settlement patterns. In particular, the locations of housing, employment, schools and retail facilities are the primary spatial determinants of most urban travel (see Anas et al, 1998 for a useful historical outline).

Furthermore, urban development in Australia – as in the U.S. and Europe – has proceeded during the past 50 years under the assumption that private cars can provide most, if not all, travel needs, leading to dispersed settlement patterns with a high level of *automobile dependence* (Kenworthy & Laube, 1999), and a corresponding "technology lock-in" to road and other infrastructure components that support the car (IEA, 2002). The result is that a shift to more sustainable transport modes in existing urban areas generally requires an accompanying shift, over time, to urban densities that can sustain those modes.

Another distinctive aspect of urban travel is the widespread commitment to private car usage, which arises from the high valuation that people place on physical mobility, on relative convenience compared to public transport options, and on the assurances of personal dignity and security which cars afford them. This commitment is expressed as a low price elasticity of the demand for petrol, and implies – like the car-dependent settlement patterns discussed above – a strong inertia with respect to mode choice. That inertia can however be averted or overcome, as shown by the London and Curitiba cases mentioned in Section 6.6.

7.3 Opinions versus behaviour

Because people's behaviour may diverge markedly from their expressed intentions and opinions, considerable care is needed when assessing the uptake, and hence the viability of new projects. This is well-illustrated by the case of EasyShare, a ride-sharing scheme developed for Sydney during the late 1990s (source for the following account is personal communication with Roslyn Trayford, December 2000).

EasyShare was in effect a do-it-yourself taxi club: a member would announce on the EasyShare website her willingness to accept passengers in her own car at a nominated time, between nominated endpoints; this would earn in return an entitlement to trips in fellow-members' cars at other times. There was a well-thought-out set of operating rules, and the website was well-designed, with a technically sophisticated back end (e.g. to estimate travel times). With State Government support, the scheme's promoters commissioned market research which indicated that

approximately 15-20% of drivers would join the scheme, and there were plans – supported by further market research – to extend it to Melbourne and to Singapore.

Yet after EasyShare was launched it never attracted more than a few thousand members – less than 1% of the original estimate. A subsequent review found that the market research had been oriented towards *opinions* rather than *intentions*. In particular, it appears that the survey participants had been allowed to focus on questions such as “Do I approve of this scheme?” rather than “Will I participate in this scheme, and to what extent?” Indeed many perceived that by reducing the number of cars on the road, the scheme would not merely have beneficial effects for the environment and transport system in general, but would yield benefits to themselves as individuals without their even being required to participate.

This case illustrates some of the difficulties that arise when estimating probable uptake of new transport services. Such difficulties can be minimised through the use of stated choice methods, in which questionnaires and surveys are structured in accordance with an extension of utility theory (Louviere et al, 2000). Stated choice methods have been applied to a wide range of technologies and products during the past 15 years, with transport applications exemplified by economic assessments of the proposals for Very Fast Train lines connecting Sydney and Melbourne, and (on a smaller scale) changes to motorway tolls.

7.4 Transport portfolio planning

Any substantial policy effort in the transport sphere involves a combination of measures. Because of the multiple interactions between objectives and outcomes (see Section 7.1 above), careful attention to planning and administrative details can be critical to the success of such efforts. We therefore consider some critical issues that arise in this regard.

7.4.1 Harmonising transport policies

We emphasise here the significance of local context and the need for effective coordination between Government agencies. Local context is important because of the substantial differences between the geography and socio-economic characteristics of urban areas, so that there can be no single set of “best practice” transport solutions. This is seen for example by comparing the geographies of Sydney and Melbourne, which make for substantial differences with respect to the potential for cycling (or ferries) in the two cities as alternatives to cars or the mainstream public transport modes.

Administrative coordination is also required, and especially a coordination of planning for all transport modes, and coordination between different levels of government and government agencies, including government departments concerned with transport and land planning, local councils, and even schools. Such coordination is desirable for example in ensuring that new residential and commercial developments are

adequately provided with bus or rail services; in ensuring that new subway stations are integrated effectively with local suburban developments; in ensuring that programs that encourage public transport use are matched by appropriate enhancements and capacity extensions in the public transport systems themselves; and in monitoring and controlling "induced traffic" arising from congestion-oriented measures, as discussed below.

7.4.2 Balance between cars and other transport modes

Attempts to make transport systems more sustainable are often focussed on efforts to reduce congestion, for example by aiding construction of urban freeways, but also promotion of ride-sharing, improving public transport services, and supporting telecommuting and staggered working hours. This seems highly desirable with respect to objectives concerned with efficiency (e.g. reducing energy cost and travel times) and the environment (reducing emissions of CO_2 and noxious pollutants). However such reductions tend to restore the attractiveness of the road system, and if not balanced by measures such as road user charges, they may bring people back to the roads as "induced traffic", bringing congestion back to its earlier levels (although perhaps redistributed in space and time), so as to nullify the benefits that had been sought (BTE, 2002).

Congestion-oriented measures may also have significant impacts on land use, as seen with telecommuting programs which, by reducing people's need to travel to CBD areas, tend to promote low-density residential development at the fringes of the metropolitan area (Muhammad et al, 2007). Such outcomes, in which dependence on the private car is intensified and distances to services are increased, must be regarded as counterproductive in relation to sustainability objectives.

The allocation of resources between the various transport modes is thus often a zero-sum game, in that further investment in freeways and other actions that favour private car usage, directly or otherwise, tends to undermine more sustainable alternatives. It follows that the concept of a "balance" between competing calls on the public purse tends to be counter-productive when it comes to policy options involving alternatives to the private car. What is desirable here is not necessarily to increase or maintain road congestion, but rather to maintain or increase the cost of road usage in order to protect the sustainable alternatives (see Section 8.2.2 below).

8. POLICY MEASURES FOR TRANSPORT AND MOBILITY

8.1 Measures targeted at transport services

In the following section we consider briefly the provision of transport services and the infrastructure that supports those services. These supply-side elements are of central importance in any effort to induce a shift towards greater sustainability in people's transport habits.

8.1.1 Transport, land use and infrastructure

It is widely recognized that an evolution towards more compact settlement patterns is required to support more sustainable modes of transport. Increased densities can reduce the average length of urban journeys; they can make market conditions far more favourable for public transport; and similarly, by placing more people on the ground they can improve the security of footpaths and other public places, thus overcoming barriers to walking and cycling (see PIA, 2003, Chapter 4).

Several strategies have been devised to achieve these outcomes. One involves an intensification of urban densities applied fairly broadly over a metropolitan area, as mandated in the Sydney region by successive NSW Governments during the past 30 years. An approach of this kind may be seen as a somewhat blunt instrument unless it can respond in detail to differences in local conditions, and includes coordination with the provision of transport and other facilities.

A more directed strategy involves a deliberate intensification of development along major new public transport corridors, and at nodes where the corridors meet, so that transport and other urban components are designed and built in tandem. This strategy, sometimes called Smart Growth, has been applied successfully in cities such as Toronto, Portland, and Curitiba (Rabinovitch, 1995), and is advocated by many urban planning theorists and practitioners. Such a strategy may require a substantial exercise of political will, but it can reduce some of the social and political difficulties often involved in planning new infrastructure, and it can establish high-volume transport facilities – such as heavy rail, busways or light rail – as essential components of the urban fabric (PIA, 2003). In addition, by providing public transport, walking and cycling facilities from the outset, the usage of these facilities is likely to be maximised (for evidence that new residents are more amenable to non-car transport options, see Fujii & Taniguchi, 2006).

8.1.2 Public transport, cycling and walking

The provision of a choice of transport options is critical in any strategy directed at sustainability: such a strategy will succeed only if the available public transport services are of adequate capacity and quality to attract and accommodate new

passengers. What is desirable here is not a single alternative mode to replace the car, but rather a real choice amongst alternatives. For example, some individuals may prefer buses for most journeys, while others may be willing to pay a premium sometimes for a multiple-hire taxi; and it is likely that most urban households will retain at least one car (e.g. for longer trips at weekends), at least in the medium-term future.

Public transport services

We emphasize that the various modes should be seen as playing complementary roles within a metropolitan region. The operating characteristics of the main modes relevant to the present report are outlined below.

- *Heavy rail* requires dedicated trackways and can carry large volumes of passengers at high speeds. Such systems form the backbones of high-density urban corridors linking major nodes within many metropolitan areas.
- *Light rail* can carry substantial volumes of passengers, and unlike heavy rail, can operate where necessary in mixed traffic.
- *Buses* can be used in mixed traffic, and this flexibility of deployment continues to be one of their main strengths. Their value however can be enhanced through the provision of bus-priority lanes, bus priority signals at traffic lights, and busways similar to grade-separated light rail lines (e.g. the O-Bahn in Adelaide); moreover, new bus models are beginning to rival light rail vehicles in size and comfort (IEA 2001b; Currie & Wallis, 2009).
- *Demand-responsive services* are exemplified by ride-sharing arrangements, multiple-hire taxis, and by hybrid services such as “roving buses” that visit major interchanges at scheduled times but can otherwise be used much like conventional taxis. These hybrid modes have antecedents elsewhere (e.g. the jeepneys of Manila), but are little used as yet in Australian cities. They hold some promise of filling a significant gap in low-density outer suburbs, which are very difficult to serve effectively via conventional buses (see “Efficiency and equity”, below).
- *Car-pooling*, also called car-sharing, has only recently seen commercial application in Melbourne and Sydney, but is well-established in the U.S. where since the oil shocks of the 1970s, many employers have provided vans or cars for employees to share when travelling to work (see 8.2.3 below). In Europe, car-pooling is being adopted in a variety of work-related and community-based contexts (Cairns et al, 2004, Chapters 8 & 9).

Attracting patronage

Much effort has been given to making public transport services more attractive to travellers. The means employed to this end include upgraded infrastructure and vehicles, smoother connections at transport interchanges, bus-priority systems, integrated and trans-modal ticketing arrangements, traveller information systems providing real time view of imminent services, improved provisions for safety and security.

Valuable guidance on passengers' responses to such improvements is provided in a recent review of efforts to expand bus patronage in a number of bus systems in Australia, the U.K. and elsewhere (Currie & Wallis, 2009). The review distinguishes the following factors influencing patronage: service quality (i.e. frequency of service and in-vehicle travel time); reliability (i.e. adherence to timetables, or presumably an assurance of high-frequency service); and "soft" attributes (cleanliness, security, and comfort). Of these factors, service quality is identified as the most important driver of major patronage increases; reliability is important in that increased patronage is difficult to achieve without it; while the soft attributes have smaller impacts.

The study also finds that bus priority systems and dedicated busways are often (with service quality) significant specific drivers of patronage increases. Related survey evidence indicates that people regard busways as almost equivalent to light rail, and the authors suggest that "upgrading a bus service to a busway is likely to be substantially more cost-effective than a rail-based solution as a means of growing the public transport market".

Efficiency and equity

Although few public transport systems anywhere operate without subsidy, economic and operational aspects are clearly important; for example, it would be very difficult to justify any service that operated with empty or near-empty vehicles most of the time.

The main differences between the modes considered earlier have to do with the densities of demand to which they are best suited in operational terms. The issue here is efficiency, which can also be critically affected by the distribution of demand over time. In particular, severe inefficiencies can arise where (as is often the case) the size and staffing of train and bus fleets are largely determined by sharply peaked usage patterns. This problem may be ameliorated through a combination of actions:

1. Behavioural measures may be used to flatten and spread peak periods (see Section 8.2).

2. Flexible working conditions (e.g. rosters involving three- or four-hour shifts corresponding with morning and afternoon peak periods) may be negotiated with drivers and other staff so as that their attendance corresponds with the times when they are really needed.

3. Smaller vehicles may be used during off-peak periods, in order to match the size of vehicles (e.g. minibuses instead of full-sized buses) better to demand. This approach will tend to involve some expansion in the numbers of vehicles in a public transport fleet, but it is likely to become increasingly attractive as fuel costs increase.

4. An extension of (3) involves replacing scheduled buses with demand-responsive services (see above under "Public transport services") during off-peak periods. The aim here is to achieve a closer match of both routing and vehicle sizes to demand.

The planning of public transport services can also involve significant tensions between efficiency and equity objectives:

- *Spatial accessibility*. Bus routes are often planned with an emphasis on accessibility, for example, subject to an upper limit on the distance from any house to the nearest bus stop. The consequence sometimes is a meandering set of routes that make travel durations unacceptably long for many potential passengers.
- *Demographic accessibility*. A desire to accommodate all but the most severely disabled people has led to major investment in accessibility features for facilities and vehicles (e.g. lifts at railway stations and kneeling buses). This development has substantially increased the cost of public transport service provision.
- *Temporal accessibility*. Similar inefficiencies arise in the case of efforts to provide comprehensive coverage at all times, even when passenger demand is very low.

Such tensions are important because if not carefully resolved they can undermine the viability – in a broad sense the sustainability – of public transport systems. In a policy context, the concern here is that with the rise of the car and the neglect of public transport services over the past 50 years, such services have come to be seen by governments as providing little more than a fallback or "safety net", relevant mainly to marginal groups such as the elderly, the young, the poor, and the disabled. To restore public transport to a mainstream position, a strong emphasis needs to be placed on frequency and speed of service, in line with the evidence discussed earlier, while developing other services (e.g. demand-responsive modes) to ensure that broad accessibility is maintained.

Cycling and walking

A shift from car use to walking and cycling will be valuable with respect to sustainability. Efforts to make walking and cycling more attractive have included the construction of footpaths and cycleways protected from other traffic (including safe road crossings), and provision of facilities for carrying bicycles on buses and rail vehicles.

The potential efficacy of such measures depends partly on the urban context (e.g. terrain, climate, urban density and average lengths of journeys), and on demographic factors (e.g. age and health of populations): subject to these conditions, the uptake of cycling or walking can be influenced by "soft" measures such as those discussed in Section 8.2.3 below. Overall, the prospects may be summarised as follows.

- There is a consensus amongst European transport experts that walking activity is unlikely to increase in the foreseeable future, apart from leisure-oriented walking and trips to school (Tolley et al, 2001). Given the generally denser urban patterns of European cities, this indicates that it would be unwise to place much emphasis on walking as an alternative mode in the Australian urban context.
- Noland and Kunreuther (1995) discuss the conditions that have made cycling a successful alternative to the private car in European countries such as Denmark

and the Netherlands, emphasising the leading role played by governments in constructing safe and convenient cycle lanes and in discouraging cars from using urban roads. They report results of a detailed microeconomic survey carried out in Philadelphia, which confirm that the key measures required to increase bicycle use are to improve cycling infrastructure and to discourage car usage (e.g. through taxation).

8.2 Measures targeted at travel behaviour

The following section reviews policy mechanisms that focus on managing demand for transport services, that is, on modifying the ways people use transport systems. The classification used here is somewhat approximate; for example, telecommuting – treated here as a substitute for travel – also has significant effects on the times when travel takes place.

8.2.1 Substitutes for travel

Telecommuting

Telecommuting, also called teleworking, typically involves employees working from home for much of the working week, while maintaining links with colleagues by telephone, broadband internet and so on: in a variant called “centre-based telecommuting”, the activities of a central workplace are decentralised to outstations located closer to employees homes (Balepur et al, 1997).

Research on transport impacts of telecommuting indicates that it can yield significant reductions in total distance travelled by individuals. The shift is towards a smaller number of commuting trips, offset by an increase in (shorter) non-commute trips; the impact however is on balance positive, in that the net number of vehicle-kilometres travelled (VKT) is reduced; furthermore, the direct impact falls mainly during peak travel periods, when congestion is highest; and the net impact on emissions (taking account length of journeys) is also positive.

The reduction in travel due to telecommuting has been estimated in one U.S. study as 77% of total VKT by telecommuting participants (Koenig et al. 1996). The reduction as a proportion of all U.S. passenger travel has been estimated as 0.8% (Choo et al, 2005); that is, without telecommuting, VKT would have been approximately 0.8% more than it actually was (the comparable “virtual reduction” for public transport was 1.8%).

The modest extent of this reduction obviously is due to the low current levels of telecommuting; in any case the cost of promoting telecommuting is also potentially small. For example, telecommuting could be implemented through tax benefits or other subsidies to employers, and such incentives need not be large, since from an employer’s point of view telecommuting may be seen as a way of shedding real estate costs. In the longer term, telecommuting probably will extend no further than the knowledge-intensive activities for which it is considered suitable; its impact is

constrained also by organisations' ability to foster or adopt forms of interaction amongst employees that differ from conventional office practice (Illegems et al, 2001).

E-shopping

Related to telecommuting are E-shopping arrangements. Under such arrangements – also called home shopping – consumers use the Internet or telephone to order deliveries of goods, instead of making purchases in retail shops. In this context Rotem-Mindali and Salomon (2007) propose a model of the decisions households make with regard to information gathering, purchase transactions and delivery mode and applied this to an E-shopping project in Tel Aviv. They conclude that E-shopping is still in an experimental phase, and that although it is likely to make some impact on traffic volumes, these impacts so far have been very limited (see also Cairns et al, 2004, Chapter 12).

8.2.2 Changing road usage patterns

Reviewed below are planning measures designed to achieve more efficient use of road systems, with a focus on reducing congestion during peak periods. This contributes to energy efficiency because it allows individual trips to be made more quickly and hence more efficiently, and also because these measures generally lead not merely to a shift of travel times away from peak periods, but also to a reduction in overall levels of road usage.

Road user charges

Road user charges have long been promoted as means towards greater economic efficiency, but have been directed in a comprehensive manner at urban congestion only in recent years, commencing in Singapore in 1975. A central principle of road user charging schemes – and a critical factor in obtaining public acceptance for them – is that the charge imposed on road users is related directly to their contribution to congestion at the time when travel occurs. Time-dependent charges can be applied quite easily to sections of motorway and to major bridges, through variations in tolls at different times of day, but the efficacy of such programs is limited both by their lack of geographical focus and by public perceptions regarding the apparent link to revenue raising (see below).

The more comprehensive "area-based" approach involves the delineation of a *cordon* around the most congested section of the city, with devices such as transponders placed around the cordon to detect vehicles entering and leaving and are integrated with tolling systems. A further step currently under investigation involves the use of GPS and distance-logging systems located on board vehicles for a more precise record of road usage in space and time, transponder linkages then being used primarily to effect payments (Blythe, 2005; Hensher & Puckett, 2005).

Area-based schemes have been introduced in Singapore (Olszewski & Xie, 2005), London (Blythe, 2005) and Stockholm (Eliasson et al, 2009), and are being planned for a number of other large cities. They have been shown to deliver major benefits in terms of reduced congestion, reductions in aggregate costs and emissions, and improved road safety, leading to substantial net economic gains (Eliasson et al, 2009; Evans 2007); and these benefits may extend over a considerably wider geographic area than the basic cordon (Eliasson, 2009).

Several authors have investigated principles that may ensure effective design of user-charging schemes. Area-based schemes are more visible to the public and more easily propounded as being of broad public value than charges on individual roads, which tend to be understood by motorists as mere extensions of existing toll-collection systems. Indeed to achieve broad public acceptance, an area-based scheme must be seen as closely integrated with the larger urban transport system, with the user charges directly linked to tangible improvements in public transport (Hensher & Puckett, 2005).

It may be noted also that the demarcation of efficient user-charge cordons, and the determination of schedules of charges, demands considerable analytical effort. Administrative effort is required also in order to ensure interoperability with other tolling systems, to ensure that adequate public transport services are provided to meet reductions in private car usage, and to design adequate mechanisms for monitoring and reviewing the system so that it can be adjusted in response to continuing experience (e.g. see TfL 2008a).

Peak avoidance

One way of spreading demand over time is to provide people with incentives to avoid travel during peak periods. A scheme of this type, called “Spitsmijden” (peak avoidance) was implemented recently in the Netherlands. A reward (3€-7€ per day) was paid to participants who avoided driving to work during the morning peak period (7:30-9:30a.m.). The success of the scheme was found to depend on the cooperation of employers in allowing staff sufficient flexibility in their working hours (Ben-Elia & Ettema, 2009).

8.2.3 Shifting travel modes

Some additional policy options for influencing the transport modes chosen by individuals and families are summarised below. Although these options are supported by only sparse evidence (BTE, 2002), they can be seen as valuable complements to the initiatives described in preceding sections.

Tax incentives

Substantial subsidies for work-related cars and parking at places of work are provided by many employers to their staff, and supported by the tax system. These subsidies

single out a single type of employee expense for special treatment (cars and parking spaces instead of business clothing or public transport fares), and the benefits that they offer to employees are not weighed against the substantial negative impacts incurred (through congestion) on urban transport systems. Such subsidies may thus be seen as entailing significant economic distortions, aside from their clear impacts on energy usage. Short of removing them altogether, a significant policy initiative would be to reduce the levels of subsidy provided by the tax system and to introduce provisions for employees to "cash-out" this type of benefit.

Workplace-oriented measures

Related to the above are incentives provided by employers to encourage the use of non-car modes amongst staff. There has been considerable experience with these measures in the U.S. and Europe, where they are sometimes bundled together in what are called "workplace travel plans" (Cairns et al, 2004, Chapter 3; TravelSmart 2005). Some of the main elements of such plans are discussed below.

- Fringe benefit programs that provide public transport season tickets or cycling equipment instead of cars and parking spaces.
- Travel-expense policies that encourage walking or public transport rather than car or taxi (where practical) when travelling on business.
- Support on the part of employers for improved transport facilities, for example by helping to lobby local governments and transport agencies for better footpaths, cycleways and public transport connections near the workplace.
- Implementation of car-pooling programs, including ownership and maintenance of car-pool vehicles, and support for car-pool logistics.

Household-oriented measures

An Australian initiative called Travel Blending® assists individuals and households in planning their travel, typically highlighting non-car alternatives to current habits. Participating households record their travel activity in a diary, after which customised alternatives such as bus or walking are suggested. Similar programs combining motivation with individualised information include Living Neighbourhoods®, IndiMark™ and TravelOptions.

Such programs have been found to be more effective than mass-market-style alternatives (e.g. Travel Wise and HeadStart), and have been applied in a number of Australian urban areas. The outcomes appear to include a reduction of total numbers of household car trips by as much as 15%, accompanied by similar increases in use of public transport (Fujii & Taniguchi, 2006). However there is some debate as to the long-term persistence of these changes; in addition, care needs to be taken when interpreting program outcomes to distinguish between changes in behaviour on the part of participants, as against the more modest changes pertaining to the population at large (Cairns et al, 2004, Chapter 5).

School-oriented measures

Trips to and from school represent a relatively small proportion of total road travel, but they do account for a significant proportion of road congestion during peak periods. Concerted plans to promote alternatives to the car for school travel have been made in many parts of the U.K., in most cases in collaborations between schools and local government authorities. The main elements of these plans are improvements to infrastructure and safety (e.g. upgrades to walking and cycling paths, and conductors at major pedestrian crossings); and “Walking School Bus” programs in which groups of children are escorted by parents to and from school. The impacts of these programs on reductions to car-based trips to and from school have been between 10% and 50% (Cairns et al, 2004, Chapter 4).

REFERENCES

ABARE, 2009. *Energy in Australia 2009*. Australian Bureau of Agricultural and Resource Economics. Canberra. Available at: http://www.ret.gov.au/energy/facts/energy_in_aust/

Abelson, R.P., 1972. Are attitudes necessary? In B.T. King (Ed.), *Attitudes, conflict and social change*: 19-32. New York: Academic Press.

Abrahamse, W., Steg, L., Vlek, C., and Rothengatter, T., 2005. A review of intervention studies aimed at household energy conservation. *Journal of Environmental Psychology*, 25(3): 273–291.

Abrahamse,W., Steg, L., Vlek, C., and Rothengatter, T., 2007. The effect of tailored information, goal setting, and tailored feedback on household energy use, energy-related behaviors, and behavioral antecedents. *Journal of Environmental Psychology*, 27: 265–276.

Aitken, C. K., McMahon, T. A., Wearing, A. J. and Finlayson, B. L., 1994. Residential water use: Predicting and reducing consumption. *Journal of Applied Social Psychology*, 24(2): 136-158.

Ajzen, I., & Fishbein, M. (2005). The influence of attitudes on behavior. In D. Albarracín, B. T. Johnson, & M. P. Zanna (Eds.), *The handbook of attitudes* (pp. 173-221). Mahwah, NJ: Erlbaum.

Allen, S.R., Hammond, G.P., and McManus, M.C., 2007. Prospects for and barriers to domestic micro-generation: A United Kingdom perspective. *Applied Energy*, 85(6): 528-544.

Allison, J.E., 2005. Distributed generation of electricity: The role of academic research and advice in California's 'Clean DG' policy network. *International Environmental Agreements: Politics, Law and Economics*, 5(4): 405-414.

Anas, A., Arnott, R., and Small, K.A., 1998. Urban spatial structure. *Journal of Economic Literature,* 36: 1426-1464.

Arvai, J., 2008. *An overview of concepts from behavioral decision research with reference to environmental management.* Report Commissioned by the Social Research Group, Exploration and Mining, CSIRO, June 2008.

Australian Bureau of Statistics, 2004. *Waste management services*, Cat No. 8698.0. Australian Government, Canberra.

Australian Bureau of Statistics, 2006a. *Household Expenditure Survey, Australia: Detailed Expenditure Items, 2003-04 (Reissue)*, Cat No. 6535.0.55.001. Australian Government: Canberra.

Australian Bureau of Statistics, 2006b. *Water Account, Australia, 2004-05*, Cat No. 4610.0. Australian Government, Canberra.

Australian Conservation Foundation, 2007. *Consuming Australia: Main Findings.* Australian Conservation Foundation: Melbourne, Australia. Available at: www.acfonline.org.au

Awerbuch, S., 2006. Portfolio-based electricity generation planning: Policy implications for renewables and energy security. *Mitigation and Adaptation Strategies for Global Change,* 11: 693–710.

Bang, H., Ellinger, A.E., Hadjimarcou, J., and Traichal, P.A., 2000. Consumer concern, knowledge, belief, and attitude toward renewable energy: An application of the reasoned action theory. *Psychology and Marketing*, 17(6): 449-468.

Baynes, T.M., Reedman, L.J. and Turner, G.M., 2007. *The impact of large scale deployment of distributed electricity generation on water resources in Australia*, in L. Oxley and D. Kulasiri (Eds.), MODSIM 2007 International Congress on Modelling and Simulation. Modelling and Simulation Society of Australia and New Zealand, 10 -13 December, pp. 1864-1870.

Beeton, R.J.S., Buckley, K.I., Jones, G.J., Morgan, D., Reichelt, R.E., and Trewin, D., 2006. *Australia State of the Environment 2006*. Independent report to the Australian Government Minister for the Environment and Heritage, Department of the Environment and Heritage: Canberra.

Benders, R.M.J., Kok, R., Moll, H.C., Wiersma, G., and Noorman, K.J., 2006. New approaches for household energy conservation—In search of personal household energy budgets and energy reduction options. *Energy Policy,* 34: 3612–3622.

Ben-Elia, E., and Ettema, D., 2009. Carrots versus sticks: rewarding commuters for avoiding the rush-hour – a study of willingness to participate. *Transport Policy* 16: 58-76.

Black J.S., Stern P.C., Elworth J.T., 1985. Personal and contextual influences on household energy adaptations. *Journal of Applied Psychology*, 70: 3–21.

Blythe, P.T., 2005. Congestion charging: Technical options for the delivery of future UK policy. *Transportation Research Part A*, 39: 571–587.

Boardman, B., 2004. New directions for household energy efficiency: evidence from the UK. *Energy Policy*, 32: 1921–1933.

Boden, T.A., Marland, G., and Andres, R.J., 2009. Global, Regional, and National Fossil-Fuel CO_2 Emissions. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn., U.S.A. doi 10.3334/CDIAC/00001. Available at: http://cdiac.ornl.gov/trends/emis/tre_tp20.html

Brennan T.J., 2007. Consumer preference not to choose: methodological and policy implications. *Energy Policy*, 35: 1616–27.

BTE, 2002. *Greenhouse policy options for transport*. BTE Report 105, Bureau of Infrastructure, Transport and Regional Economics, Australia. Available at: http://www.bitre.gov.au/info.aspx?NodeId=58

Bulkeley, H., 2000. Common knowledge? Public understanding of climate change in Newcastle, Australia. Public Understanding of Science, 9: 313–333.

Button, K.J., 1994. Alternative approaches towards containing transport externalities: an international comparison. *Transportation Research A,* 28A(4): 289-305.

Cabinet Office, 1999. Modernising Government. Presented to Parliament by the Prime Minister and the Minister for the Cabinet Office by Command of Her Majesty. UK Government Report CM4310. Available at: http://www.archive.official-documents.co.uk/document/cm43/4310/4310.htm

Cairns, S., Sloman, L., Newson, C., Anable, J., Kirkbride, A. and Goodwin, P., 2004. *Smarter Choices – Changing the Way We Travel*. Department for Transport, U.K. Available at: http://www.dft.gov.uk/pgr/sustainable/smarterchoices/ctwwt/

Campbell, S., Benita, S., Coates, E., Davies, P., Penn, G., 2007. *Analysis for policy: Evidence-based policy in practice.* Cabinet Office, Government Social Research Unit, HM Treasury, London, UK.

Carrus, G., Passafaro, P., and Bonnes, M., 2008. Emotions, habits and rational choices in ecological behaviours: The case of recycling and use of public transportation. *Journal of Environmental Psychology*, 28(1): 51-62.

Centre for Sustainable Development, 2004. *Every little bit helps…:Overcoming the challenges to researching, promoting and implementing sustainable lifestyles.* Centre for Sustainable Development, University of Westminster, UK.

Chapman, L., 2007. Transport and climate change: a review. *Journal of Transport Geography,* 15, 354–367.

CSIRO, 2006. *Energy Technology*, CSIRO, Australia. Available at: www.det.csiro.au/PDF%20files/CET_Div_Brochure.pdf

CSIRO, 2008. *EnergyMark - Session 6: Addressing energy and climate change in homes and businesses.* CSIRO, Australia.

Curran, L., 2005. *Beacon case study – sustainable energy: Woking Borough Council*. The Beacon Scheme, London. Available at: http://www.beacons.idea.gov.uk/idk/aio/650662

Currie, G., and Wallis, I., 2009. Effective ways to grow urban bus markets – a synthesis of evidence. *Journal of Transport Geography*, 16: 419-429.

Darby, S., 2006. *The Effectiveness of feedback on energy consumption: A review for DEFRA of the literature on metering, billing and direct displays.* Environmental change institute, University of Oxford.

Darnton, A., 2008. *Reference report: An overview of behaviour change models and their uses.* Government Social Research: United Kingdom. Available at: http://www.gsr.gov.uk/downloads/resources/behaviour_change_review/reference_report.pdf

Davies, P. 2004*. Is evidence-based government possible?* Presented at the 4th Annual Campbell Collaboration Colloquium, February 19th, Washington DC.

Davis, J. J., 1995. The effects of message framing on response to environmental communications. *Journalism and Mass Communication Quarterly,* 72(2): 285-299.

Department for Environment, Food and Rural Affairs, 2008. *A Framework for Pro-environmental Behaviours.* DEFRA: London, UK. Available at: http://www.defra.gov.uk/evidence/social/behaviour/pdf/behaviours-jan08-report.pdf

Department of Climate Change, 2008a. *Australian's National Greenhouse Accounts: National Inventory by Economic Sector 2006.* Department of Climate Change: Canberra.

Department of Environment and Heritage, 2005. When you keep measuring it, you know even more about it: NAEEEP: Projected impacts 2005-2020 Summary (Report 2005/05). Australian Greenhouse Office: Canberra. Available at: http://www.energyrating.gov.au/library/pubs/200505-projectimpacts-agosummary.pdf

Department of Environment, Water, Heritage and the Arts, 2008. Your home technical manual. Department of the Environment, Water, Heritage and the Arts: Canberra. Available at: http://www.yourhome.gov.au/technical/index.html

Department of the Environment and Water Resources, 2007. Global warming cool it: A home guide to reducing energy costs and greenhouse bases. DEWR: Canberra. Available at: http://www.environment.gov.au/settlements/gwci

Department of Trade and Industry, 2007. *Meeting the Energy Challenge: A White Paper on Energy,* Department of Trade and Industry, UK. Available at: http://www.dti.gov.uk/files/file39387.pdf

Dey, C., Berger, C., Foran, B., Foran, M., Joske, R., Lenzen, M., and Wood, R., 2007. An Australian environmental atlas: household environmental pressure from

consumption. In G. Birch (Ed.) *Water, wind, art and debate: How environmental concerns impact on disciplinary research*: 280-315, Sydney University Press.

Doll, J., and Ajzen, I., 1992. Accessibility and stability of predictors in the theory of planned behavior. *Journal of Personality and Social Psychology*, 63(5): 754-765.

Department of Sustainability and Environment, 2007. *Black balloon tracking*. Available at: http://www.greenhouse2007.com/downloads/papers/071005_FreemanAbstract.pdf

Dyson, T., 2005. On development, demography and climate change: The end of the world as we know it? *Population and Environment*, 27(2): 117-149.

E3 International, 2007. *Double counting of EU ETS carbon allowances on CITL records of national emissions registries,* Press Release, 22 November. Available at: http://www.e3international.com/about/Resources/071122_Doubles_Press.pdf.

Eliasson, J., 2009. A cost–benefit analysis of the Stockholm congestion charging system. *Transportation Research Part A* 43: 468–480.

Eliasson, J., Hultkrantz, L., Nerhagen, L. and Rosqvist, L.S., 2009. The Stockholm congestion-charging trial 2006: overview of effects. *Transportation Research A*, 43: 240–250.

Energy Efficiency and Greenhouse Working Group, 2003. *Towards a National Framework for Energy Efficiency – Issues and Challenges Discussion Paper.* National Framework for Energy Efficiency (NFEE). Available at: http://www.nfee.gov.au/about_nfee.jsp?xcid=64.

Evans, R., 2007. Central London Charging Scheme: ex-post evaluation of the quantified impacts of the original scheme. Available at: http://www.tfl.gov.uk

Eagly, A. H. & Chaiken, S. 1998. *Attitude structure and function*. New York: McGraw-Hill.

Fazio, R.H., Blascovich, J., and Driscoll, D.M., 1992. On the functional value of attitudes: The influence of accessible attitudes on the ease and quality of decision making. *Personality and Social Psychology Bulletin,* 18(4): 388-401.

Fazio, R. H., & Williams, C. J. 1986. Attitude accessibility as a moderator of the attitude-perception and attitude-behavior relations: An investigation of the 1984 presidential election. *Journal of Personality and Social Psychology,* 51(3): 505-514.

Friberg, L. 2000. *Innovative solutions for public transport: Curitiba, Brazil.* World Bank, Washington DC. Available at: www.worldbank.org/html/fpd/transport/urbtrans/pub_tr/curitiba_summary.pdf

Frieden, B.J. and Baker, K., 1983, The Market Needs Help: the disappointing record of home energy conservation. *Journal of Policy Analysis and Management,* 2(3): 432-448.

Friedland, A.J., Gerngross, T.U., and Howarth, R.B., 2003. Personal decisions and their impacts on energy use and the environment. *Environmental Science & Policy,* 6: 175–179.

Fujii, S., and Taniguchi, A., 2006. Determinants of the effectiveness of travel feedback programs—a review of communicative mobility management measures for changing travel behaviour in Japan. *Transport Policy*, 13, 339–348D.

Gardner J. and Ashworth P., 2007. *Public Attitudes Towards Electricity Alternatives: Results from a Survey of Australian Households,* Report No. P2008/944. Canberra, Australia: CSIRO.

Gardner, G., and Stern, P., 2002. *Environmental Problems and Human Behaviour* (2nd edition). Boston, MA: Pearson.

Garnaut, R. 2008. *The Garnaut climate change review: Final report.* Commonwealth of Australia: Canberra. Available at: http://www.garnautreview.org.au

Gatersleben, B., Steg, L., & Vlek, C., 2002. Measurement and determinants of environmentally significant consumer behavior. *Environment and Behavior*, 34(3): 335-362.

George Wilkenfeld & Associates, 2003. *Australia's National Greenhouse Gas Inventory 1990, 1995 and 1999, End Use Allocation of Emissions*. Commonwealth Department of Climate Change, Canberra. Available at: http://www.climatechange.gov.au/inventory/enduse/index.html

Global Footprint Network, 2008. *The Ecological Footprint Atlas 2008.* Oakland: Global Footprint Network.

Griskevicius,V., Cialdini, R.B., and Goldstein, N.J., 2008. Social norms: An underestimated and underemployed lever for managing climate change. *International Journal of Sustainability Communication*, 3: 5-13.

Guerin G.A., Yust, B.L., Coopet J.G., 2000. Occupant predictors of household energy behaviour and consumption change as found in energy studies since 1975. *Family and Consumer Sciences Research Journal,* 29:48–80

Guerin, D., Crete, J., Mercier, J., 2001. A multilevel analysis of the determinants of recycling behavior in European countries. *Social Science Research,* 30(2): 195-218.

Gutman, J. 1982. Means-end chain model based on consumer categorisation process. *Journal of Marketing*, 46(Spring 1983): 60-72.

Haas, R et al., 2004. How to promote renewable energy systems successfully and effectively. Energy Policy, 32(6): 833-839.

Hanley, N., and Shogren, J.F., 2005. Is Cost–Benefit analysis anomaly-proof? *Environmental & Resource Economics*, 32: 13–34.

Hanson, M., Bernstein, M., Hammon R., 2006. The role of energy efficiency in homebuying decisions: results of initial focus group discussions. Presented at *ACEEE Summer Study on Energy Efficiency in Buildings*, Asilomar, CA, USA.

Henryson, J., Hakansson, T., Pyrko, J., 2000. Energy efficiency in buildings through information – Swedish perspective. *Energy Policy*, 28: 169-180.

Hensher, D., and Puckett, S.M., 2005. Road user charging: The global relevance of recent developments in the United Kingdom. *Transport Policy,* 12: 377–383.

Herter, K., McAuliffe, P., Rosenfeld, A., 2007. An exploratory analysis of California residential customer response to critical peak pricing of electricity. *Energy,* 32: 25–34.

Hulme, M., Adger, W.N., Dessai, S., Goulden, M., Lorenzoni, I., Nelson, D., Naess, L.-O., Wolf, J. and Wreford, A., 2007. *Limits and Barriers to Adaptation: Four Propositions.* Tyndall Briefing Note No. 20, Tyndall Centre for Climate Change Research, University of East Anglia: Norwich, UK.

IEA, 2001a. *Saving oil and reducing CO_2 emissions in transport: options and strategies.* International Energy Agency 2001. Available at: http://www.iea.org/Textbase/publications/index.asp

IEA, 2001b. *Sustainable transport: new insights from the IEA's worldwide transport study.* International Energy Agency. Available at: http://www.iea.org/Textbase/publications/index.asp

IEA, 2002. *Transportation & energy.* International Energy Agency. Available at: http://www.iea.org/Textbase/publications/index.asp

IEA, 2005. *World Energy Outlook 2005*, Press Release, IEA, UK. Available at: http://www.iea.org/Textbase/press/pressdetail.asp?PRESS_REL_ID=163.

Illegems, V., Verbeke, A., and S'Jegers, R., 2001. The organizational context of teleworking implementation. *Technological Forecasting & Social Change,* 68: 275–291

Inman, D., and Jeffrey, P., 2006. A review of residential water conservation tool performance and influences on implementation effectiveness. *Urban Water Journal,* 3(3): 127-143.

IPSOS, 2007. *Climate change report: The Ipsos omnibus tracking survey.* Available at: www.ipsos.com.au.

Iwata, O., 2001. Attitudinal determinants of environmentally responsible behavior. *Social Behavior & Personality*, 29(2): 183-190.

Jackson, T., 2005. *Motivating Sustainable Consumption: A Review Of Evidence On Consumer Behaviour And Behavioural Change.* A report to the Sustainable Development Research Network. London: SDRN.

Jansen, L., 2001. The challenge of sustainable development. *Journal of Cleaner Production*, 11(3): 231-245.

Jeffrey, P and Gearey, M. 2006. Consumer reactions to water conservation policy instruments. In D. Butler and F.A. Memon (Eds.), *Water Demand Management*: 305-330. IWA Publishing: London, UK.

Jeroen C.J.M. van den Bergh, 2008. Environmental regulation of households: An empirical review of economic and psychological factors. *Ecological Economics*, 66: 559-574.

Juhel, M., 2008. *Conclusions and key findings: Transport CO_2 emissions in emerging economies.* Organisation for Economic Cooperation and Development: Paris. Available at: http://www.internationaltransportforum.org/Topics/Workshops/Workshop4.html

Kahneman, D. and Tversky, A., 1981. The framing of decisions and the psychology of choice. *Science*, 211(4481): 453-458.

Kahneman, D., and Tversky, A., 1979. Prospect Theory: Decision-making under risk. *Econometrica,* 47(2): 263–91.

Keirstead, J., 2007. Behavioural responses to photovoltaic systems in the UK domestic sector. *Energy Policy*, 35(2007): 4128–4141.

Kelly, G., 2007. Renewable energy strategies in England, Australia and New Zealand. *Geoforum,* 38(2): 326-338.

Kent, A. and Mercer, D., 2006. Australia's mandatory renewable energy target (MRET): an assessment. *Energy Policy*, 34(9): 1046-1062.

Kenworthy, J.R. and Laube, F.B., 1999. Patterns of automobile dependence in cities: an international overview of key physical and economic dimensions with some implications for urban policy. *Transportation Research Part A*, 33: 691-723.

Kiker, G.A., Bridges, T.S., Varghese, A., Seager, T.P., and Linkovjj, I., 2005. Application of multicriteria decision analysis in environmental decision making. *Integrated Environmental Assessment and Management,* 1(2): 95–108.

Kline, D., 2001. Positive feedback, lock-in, and environmental policy. *Policy Sciences,* 34(1): 95-107.

Knight R.L., Lutzenhiser, L., and Lutzenhiser, S., 2006. Why comprehensive residential energy efficiency retrofits are undervalued. Presented at *ACEEE Summer Study on Energy Efficiency in Buildings*, Asilomar, CA, USA.

Knussen, C., and Yule, F., 2008. 'I'm not in the habit of recycling': The role of habitual behavior in the disposal of household waste. *Environment and Behavior,* 40(5): 683-702.

Koenig, B.E., Henderson, D.K., and Mokhtarian, P.L., 1996. The travel and emissions impacts of telecommunications for the state of California Telecommuting Pilot Project. *Transportation Research A,* 4(1), 13-32.

Krosnick, J.A., Boninger, D.S., Chuang, Y.C., Berent, M.K. and Carnot, C.C., 1993. Attitude strength: One construct or many related constructs? *Journal of Personality and Social Psychology,* 65(6): 1132-1151.

Leiserowitz, A., 2007. Communicating the risks of global warming: American risk perceptions, affective images and interpretive communities. In S. C. Moser and L. Dilling (Eds.), *Creating a Climate for Change: Communicating Climate Change and Facilitating Social Change*: 44-63.Cambridge: Cambridge University Press.

Levine, M., Ürge-Vorsatz, D., Blok, K., Geng, L., Harvey, D., Lang, S., Levermore, G., Mongameli Mehlwana, A., Mirasgedis, S., Novikova, A., Rilling, J., and Yoshino, H., 2007. Residential and commercial buildings. In B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (Eds.), *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge University Press: Cambridge, United Kingdom and New York, NY, USA.

Lewin, K., 1951. *Field Theory in Social Science*. In D Cartwright (Ed.), Selected Theoretical Papers. New York, NY: Harper & Row.

Lijesen, M.G., 2007. The real-time price elasticity of electricity. *Energy Economics,* 29: 249–258.

Louviere, J.L., Hensher, D.A., and Swait, J.D., 2000. *Stated Choice Methods.* Cambridge: Cambridge University Press.

ManagEnergy, 2008. *EU local energy action: Good practices 2008.* European Commission, Directorate-General for Energy and Transport: Brussels. Available at: http://www.managenergy.net/download/GoodPractice2008.pdf

ManagEnergy, 2009. *Congestion charging scheme: London, UK.* European Commission, Directorate-General for Energy and Transport: Brussels. Available at: http://www.managenergy.net/products/R1147.htm

Manyiwa, S. and Crawford, I., 2001. Determining linkages between consumer choices in a social context and the consumer's values: A means-end approach. *Journal of Consumer Behaviour,* 2 (1): 54-70.

McCalley, L.T., 2006. From motivation and cognition theories to everyday applications and back again: the case of product-integrated information and feedback. *Energy Policy*, 34:129–37

McCright, A.M., 2007. Dealing with climate change contrarians. In S.C. Moser and L. Dilling (Eds.), *Creating a climate for change: Communicating climate change and facilitating social change*: 200–212. Cambridge, UK: Cambridge University Press.

McDougall, G.H.G., Claxton, J.D., Ritchie, J.R.B. and Anderson, C.D., 1981. Consumer Energy Research: A Review. *Journal of Consumer Research,* 8(December): 343-354.

McKinsey & Co, 2007. *Reducing U.S. greenhouse gas emissions: How much at what cost?* U.S. Greenhouse Gas Abatement Mapping Initiative Executive Report. Available at: http://www.mckinsey.com/clientservice/ccsi/greenhousegas.asp

McLennan Magasanik Associates, 2004. *National Energy Efficiency Target*. Report prepared for Sustainable Energy Authority: Victoria, August.

Menanteau, P., Finon, D., and Lamy, M.L., 2002. Prices versus quantities: choosing policies for promoting the development of renewable energy. *Energy Policy,* 31(8): 799–812.

Mendonca, M., 2007. *Feed-in tariffs: Accelerating the deployment of renewable energy.* Earthscan: London.

Moser, S. C., 2007. More bad news: The risk of neglecting emotional responses to climate change information. In S.C. Moser and L. Dilling (Eds.), *Creating a Climate for Change: Communicating Climate Change and Facilitating Social Change:* 64-80. Cambridge: Cambridge University Press.

Muhammad, S., Ottens, H.F.L., Ettema, D. and de Jong, T., 2007. Telecommuting and residential locational preferences: a case study of the Netherlands. *Journal of Housing and the Built Environment,* 22: 339–358.

Nadel, S., 2002. Appliance and equipment efficiency standards. Annual Review of Energy and the Environment, 27: 159–192.

National Institute of Economic and Industry Research (2007). *The own price elasticity of demand for electricity in NEM regions*. Tech. rep. National Electricity Market Management Company.

NEMMCO, 2009. *NEMMCO price table.* Available at: http://www.nemmco.com.au/about/900-0001.pdf

Nolan, J. M., Schultz, P. W., Cialdini, R. B., Goldstein, N. J., and Griskevicius V. 2008. *Personality and Social Psychology Bulletin,* 34 (7): 913-923.

Noland, R.B. and Kunreuther, H., 1995. Short-run and long-run policies for increasing bicycle transportation for daily commuter trips. *Transport Policy*, 2(1): 67-79.

NWC, 2009. *National Performance Report 2007–08: Urban water utilities*. National Water Commission: Australia.

Nyborg, K., Howarth, R.B., and Brekke, K.A., 2006. Green consumers and public policy: on socially contingent moral motivation. *Resource and Energy Economics* 28(4): 351–366.

Olszewski, P. and Xie, L., 2005. Modelling the effects of road pricing on traffic in Singapore. *Transportation Research Part A*, 39: 755–772.

Oreg, S., and Katz-Gerro, T., 2006. Predicting proenvironmental behavior cross-nationally: Values, the theory of planned behavior, and value-belief-norm theory. *Environment and Behavior,* 38(4): 462-483.

Pallak, M.S., Cook, D.A., and Sullivan, J.J., 1980. Commitment and Energy Conservation. In L. Bickman (Ed.), *Applied Social Psychology Annual*: 235-253. Beverley Hills, CA: Sage.

Parasram, V., 2003. *Efficient transportation for successful urban planning in Curitiba.* Horizon International, Yale University, New Haven CT. Available at: http://www.solutions-site.org/artman/publish/article_62.shtml

Passey, R. Macgill, I. and Outhred, H., 2008. *The NSW Greenhouse Gas Reduction Scheme: An analysis of the NGAC Registry for the 2003, 2004 and 2005 Compliance Periods.* CEEM discussion paper, DP_070822. Available at: http://www.ceem.unsw.edu.au/content/userDocs/CEEM_DP_070827_000.pdf

Peterson, S., 2006. Uncertainty and economic analysis of climate change: A survey of approaches and findings. *Environmental Modelling and Assessment,* 11(1): 1-17.

PIA, 2003. *Sustainable cities 2025, Submission to House of Representatives Standing Committee on Environment and Heritage by the Planning Institute of Australia.* Available at: http://www.planning.org.au/

Poortinga, W., Steg, L., Vlek, C., 2004. Values, environmental concern, and environmental behavior: a study into household energy use. *Environmental Behavior,* 36: 70-93.

Prendergrast, J., Foley, B., Menne, V., and Karalis Isaac, A., 2008. *Creatures of Habit? The art of behaviour change.* London, UK: The Social Market Foundation.

Rabinovitch, J., 1995. A sustainable urban transportation system. *Energy for Sustainable Development* 2(2): 11-18.

Reeson, A., 2008. *Institutions, motivations and public goods: Theory, evidence and implications for environmental policy. Socio-economics and the Environment in Discussion:* CSIRO Working Paper Series 2008-01. Canberra: CSIRO Sustainable Ecosystems.

RESINBUIL, 2009. *Intelligent Energy Europe.* European Commission. Available at: http://www.resinbuil.com

Resource Smart, 2008. *Smart energy zones case study: Woking, UK.* Sustainability Victoria, Melbourne. Available at: www.resourcesmart.vic.gov.au/documents/SEZ_Case_Study_Woking.pdf

Richardson, B.C., 2005. Sustainable transport: analysis frameworks. *Journal of Transport Geography*, 13: 29–39.

Rokeach, M., 1973. *The nature of human values.* New York: The Free press.

Roman, A., 2008. *Curitiba, Brazil.* National Council for Science and the Environment, Washington DC. Available at: http://www.eoearth.org/article/Curitiba,_Brazil

Rotem-Mindali, O., and Salomon, I., 2007. The impacts of E-retail on the choice of shopping trips and delivery: Some preliminary findings. *Transportation Research A,* 41: 176-189.

Runci, P., 2005. *Renewable energy policy in Germany: An overview and assessment.* The Joint Global Change Research Institute, University of Maryland. Available at: http://www.globalchange.umd.edu/energytrends/germany

Schultz P. W., Nolan J. M., Cialdini R. B., Goldstein N. J., and Vladas, G., 2007. The Constructive, Destructive, and Reconstructive Power of Social Norms. *Psychological Science,* 18(5), 429-434.

Schultz P.W., 2002. Knowledge, information, and household recycling: examining the knowledge-deficit model of behavior change. In Dietz T, Stern P.C. (Eds.), *New Tools for Environmental Protection: Education, Information and Voluntary Measures:* 67-82. Washington, DC: Natl. Acad.

Schultz, P. W., Khazian, A., Zaleski, A., 2008. Using normative social influence to promote conservation among hotel guests. *Social Influence,* 3(1): 4-23.

Schultz, P.W., Oskamp, S., and Mainieri, T., 1995. Who Recycles and When? A review of personal and situational factors. *Journal of Environmental Psychology,* 15: 105-121.

Shipworth, M., 2000. *Motivating home energy action: A handbook of what works.* Report to the Australian Greenhouse Office: Canberra.

Smith, B.N., and Stasson, M.F., 2000. A comparison of health behaviour constructs: Social psychological predictors of AIDS-preventive behavioural intentions. *Journal of Applied Social Psychology,* 30(3): 443-462.

Sonneborn, C.L., 2004. Renewable energy and market-based approaches to greenhouse gas reduction—opportunity or obstacle? *Energy Policy,* 32(16): 1799-1805.

Stern, P., 2000. Towards a Coherent Theory of Environmentally Significant Behaviour. *Journal of Social Issues,* 56(3): 407-424.

Stockholm Environment Institute, 2009. *A Literature Review on Sustainable Lifestyles and Recommendations for Further Research.* Stockholm Environment Institute: Sweden. Available at: www.sei.se

Throne-Holst, H., Strandbakken, P., and Stø, E., 2008. Identification of households' barriers to energy saving solutions. *Management of Environmental Quality,* 19(1): 54-66.

Timlett, R.E. and Williams, I.D., 2008. Public participation and recycling performance in England: A comparison of tools for behaviour change. *Resources, Conservation and Recycling* 52: 622–634.

Toke, D., 2006. Renewable financial support systems and cost-effectiveness. *Journal of Cleaner Production,* 15(3): 280-287.

Tolley, R., Lumsdon, L. and Bickerstaff, K., 2001. The future of walking in Europe: a Delphi project to identify expert opinion on future walking scenarios. *Transport Policy,* 8: 307-315.

Transport for London, 2008a. *Central London Congestion Charging Impacts Monitoring: Sixth Annual Report.* Available at: http://www.tfl.gov.uk

Transport for London, 2008b. *Congestion charging scheme five years on.* Transport for London: London. Available at: http://www.tfl.gov.uk/corporate/media/newscentre/7527.aspx

TravelSmart, 2005. *Evaluation of Australian TravelSmart projects in the ACT, South Australia, Queensland, Victoria and Western Australia 2001-2005.* TravelSmart Australia. Available at: http://www.travelsmart.gov.au/publications/evaluation-2005.html

Turton, H., 2004. *Greenhouse gas emissions in industrialised countries: Where does Australia stand?* Australia Institute discussion paper No: 66. Canberra: The Australia Institute. Available: https://www.tai.org.au/

Tversky, A., and Kahneman, D., 1974. Judgment under Uncertainty: Heuristics and Biases. *Science,* 185 (4157): 1124-1131.

Ueno, T., Sano, F., Saeki, O., and Tsuji, K., 2006. Effectiveness of an energy-consumption information system on energy savings in residential houses based on monitored data. *Applied Energy*, 83: 166–183.

UNEP/GRID-Arendal, 2005. *National carbon dioxide (CO_2) emissions per capita. (2005).* In Maps and Graphics Library. Available at: http://maps.grida.no/go/graphic/national_carbon_dioxide_co2_emissions_per_capita.

Van de Meulen, B., 1999. The impact of foresight on environmental science and technology policy in the Netherlands. *Futures,* 31(1): 7-23.

Wara, M.W. and Victor, D.G., 2008. A realistic policy on international carbon offsets. Working Paper #74. Available at: http://iis-db.stanford.edu/pubs/22157/WP74_final_final.pdf

Weber, E. U., 2006. Experience-based and description-based perceptions of long-term risk: Why global warming does not scare us (yet). *Climatic Change,* 77: 103–120.

Wicker, A. W., 1969. Attitudes versus actions: The relationship of verbal and overt behavioral responses to attitude objects. *Journal of Social Issues,* 25(4): 41-78.

Wilson, C., and Dowlatabadi, H., 2007. Models of Decision Making and Residential Energy Use. *Annual Review Environmental Resources,* 32:169–203.

Woking Borough Council, 2009. Available at: http://www.woking.gov.uk

Wood, G., and Newborough, M., 2003. Dynamic energy-consumption indicators for domestic appliances: environment, behaviour and design. *Energy and Buildings,* 35: 821–841.

World Business Council for Sustainable Development, 2004. *The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard (Revised Edition).* WBCSD: Geneva, Switzerland.

World Commission on Environment and Development (WCED), 1987. *Our common future.* Oxford: Oxford University Press.

Wright, L and Fulton, L., 2005. Climate change mitigation and transport in developing nations. *Transport Review,* 25(6): 691-717.

Zhao, J., He, N. and Lovrich, N.P., 1998. Individual value preferences among American police officers: The Rokeach theory of human values revisited. *An International Journal of Police Strategies and Management,* 21(1): 22-37.

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