

CSIRO Submission 08/281

Garnaut Review – Issues Paper 5 – Transport,
Planning and the Built Environment

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1. Introduction

In making this submission, CSIRO notes that the Garnaut Climate Change Review Issues Paper 5 (Transport, Planning and the Built Environment) focuses on barriers to the adoption of existing low-emission technologies and practices, and policies to address and overcome such barriers.

CSIRO has contributed the findings of its research to the Garnaut Review through a variety of means, including:

- Direct provision of research results as to the review by a team of CSIRO scientists,
- Peer review of the scientific chapter of the Garnaut Review,
- Collaboration with ABARE in scenario development for the review.

In addition to the contributions already made, this submission provides CSIRO's general response to the issues paper (section 2), as well as comments on some of the specific questions raised (section 3). Comments are not provided on those questions where CSIRO does not have relevant research findings to contribute. An overview of the research being conducted by CSIRO that can help inform policy development in this domain is also provided in an appendix.

2. General response

CSIRO supports the paper's observation that improving vehicle efficiency has an important contribution to reducing transport emissions and can be implemented relatively quickly through turnover of the vehicle stock, whereas changes to urban layout and transport infrastructure will take several decades to be fully implemented.

It is important to note that the term "low-emissions" in the passenger transport sector can encompass both low greenhouse gas emissions and low air pollutant emissions. In general, measures to reduce greenhouse gases will reduce air pollution (and vice versa), but this is not always the case. Any examination of possible policy options, therefore, would benefit from identifying whether the total outcomes are positive (they reduce both greenhouse gases and air pollution) or whether they increase one or both of greenhouse gases or air pollutants.

For example, it was shown in ethanol trials run in New South Wales in 1997 that 10% ethanol in petrol leads to a 7% decrease in tailpipe greenhouse gases. When the whole life cycle is taken into account (Beer et al., 2003) then the greenhouse gas savings from renewable fuels range from 1.7% (from wheat) to 5.1% (from molasses, using co-generated power). However, adding 10% ethanol to petrol increases will increase the volatile organic compounds being evaporated and those being emitted from the tailpipe, by 45% and 7% respectively. This has implications for potentially increased smog formation. CSIRO is currently undertaking a study in partnership with the Department of Environment, Water, Heritage and the Arts to examine this issue.

Similarly, the use of hydrogen-powered buses and cars is likely to have good outcomes for air quality, as the combustion of hydrogen produces only water vapour as its emission. The situation in terms of greenhouse gas emissions is more complicated. If the hydrogen supply is from natural gas reformulation then, on a life-cycle basis, there is no greenhouse gas advantage to using hydrogen fuel (Beer et al., 2001). However, if hydrogen is produced from renewable sources such as wind, solar or tidal power, then there could be both reduced urban pollution and greenhouse benefits. The same would be true of the carbon dioxide emissions if they could be sequestered.

Additionally, a changing context causes complication. For example, it may be true to say that today a particular biofuel causes less greenhouse gas emissions or air pollutants than the fossil oil equivalent, but as new fuel standards are applied or new emission control technologies (such as Euro 4) are introduced, this may no longer be the case.

Most reports dealing with greenhouse gas emissions do not explicitly deal with embodied carbon. For example, the 2007 IPCC Mitigation Reports (Bernstein et al. 2007, Levine et al. 2007) cites its importance but does not elaborate much further. It would be prudent to discuss this issue however as, for example, the use of products or technologies that will provide a 5% **operational** carbon reduction but have an additional 50% **embodied** carbon in their manufacture (e.g. from raw material extraction to a store shelf) will not lead to an overall reduction in emissions.

3. Comment on some questions proposed by the Issues Paper

Transport

CSIRO research indicates that attention to different disciplinary perspectives to human behaviour and motivation (Gintis, 2000; Frey, 2001) and a systems perspective on social framing and feedbacks (Ostrom et al., 1999; Lebel et al., 2006; Hatfield-Dodds et al., 2008) can yield useful insights for addressing barriers and policy issues associated with greenhouse gas emissions from the transport sector. Based on this, the following are general points that would be of benefit to consider in answering the following questions posed in the Transport and Planning section of the Issues Paper (p7 and 8).

Q. What are the key barriers to the adoption of cost-effective and low-emissions mode use in the passenger transport sector? How might these be addressed effectively and efficiently by government policy?

- The evaluation of public transport would benefit from careful attention to a range of attributes including frequency and reliability, perceived safety, and peer use or acceptance. A bus service that is shiny and new and arrives after five minutes is almost a completely different good, in marketing terms, to a bus that arrives irregularly.
- Ownership and use of private vehicles have important identity and status dimensions. This implies that there would be benefit in evaluating policy options from a social system perspective, as the welfare impact will relate to how changes impact on relative position in the future. Individually based evaluations that reflect current status or social position values (as if the change only applies to one individual) are unlikely to provide an accurate guide to the welfare impact on individuals of changing the set of vehicles available to all individuals. For example, bright red cars may currently denote certain personality traits or identity signals. Introduction of a substantial red car tax may see lime green cars taking on these social functions. Evaluating the impact of this tax against the current social reference point would overstate the social impacts of the tax
- Provision of credible and accessible information about the social and economic impacts of different transport choices and policies could be expected to have significant impacts on attitudes and behaviour. But many of the behaviours that would reduce greenhouse emissions, such as shifts from private vehicles to public or self-powered transport, are likely to be strongly influenced by evolving norms, group behaviour (where individuals are happy to act if others are also acting), burden sharing and perceived fairness, and clear public signals about the importance of the change (reflected, for example, in new expenditure on public transport to improve service and lifestyle fit).

Q. What policies would be suitable to address barriers to the uptake of more fuel efficient passenger vehicles?

- It would be advantageous to consider the incentive effect or behavioural impact of adding a carbon price to transport fuels in terms of both price and income elasticity. It is quite possible that rising income may more than outweigh carbon price induced increases in price. There would be benefit in analysis paying particular attention to the impact of fuel costs on asset choice (such as size and type of car), and exploring the advantages and disadvantages of more targeted regulations or incentives influencing vehicle choice.
- The economic costs associated with congestion are so large that introducing congestion charging on top of existing vehicle and fuel taxes would be likely to result in very significant changes in road use over time. Such a significant change would require very careful management to explain the benefits, address legitimate concerns, and establish a mandate for action.

Q. What policies could support cost-effective emissions reductions in the freight sector?

Evaluation of options could consider Intelligent Transport Systems (ITS) options, which could provide a means to effectively and efficiently support the management of both demand and supply in a given transport system.

- Evidence obtained both locally and from overseas indicates that Intelligent Transport Systems options improve traffic flow, drive-time efficiency, and safety, and can reduce fuel use and emissions. In Europe it has been estimated that 5-10% fleet-wide reductions in fuel consumption and CO₂ emissions are possible with the appropriate driver training, support and feedback instruments.
- New integrated logistics systems, including freight interchanges, are likely to be important for road-rail shipment integration, as will inter-modal interchanges at road-rail and sea-rail terminals.

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Appendix. CSIRO research in greenhouse gas emissions from the transport sector and the built environment

CSIRO is carrying out research in a range of areas pertinent to greenhouse gas emissions from the transport sector and the built environment. A brief overview of this research is given below.

Social and economic research into incentives, governance and behaviour

CSIRO is researching incentive effects and behavioural change for greenhouse gas emissions reductions at both the individual/enterprise level and at the level of regional social systems (including collective decisions to modify institutional arrangements). It is also conducting research on evaluating the size and significance of various environmental externalities (especially where these involve threshold effects) relative to the impacts of potential policy responses; how institutional framing effects choices by influencing the criteria used to evaluate options; and how the framing of information on the advantages and disadvantages of different policy options influences attitudes towards them. This research has a number of implications for transport and urban planning, although most of it has not been directly applied to transport issues.

Greenhouse gas emissions reduction research

CSIRO's research into greenhouse gas (GHG) emissions reduction in transport and the built environment is centred on two major topics:

- 'Embodied' carbon – aiming to develop a data-driven, rigorous process of estimating the 'carbon footprint' of any manufactured product or service – not just in transport and the built environment – in Australia; and
- 'Operational' carbon – aiming to reduce the energy used in transport and in the operation of buildings.

Most reports dealing with GHG emissions do not explicitly deal with embodied carbon. For example, the 2007 IPCC Mitigation Reports (Bernstein et al. 2007, Levine et al. 2007) cites its importance but does not elaborate much further. It would be prudent to discuss this issue however as, for example, the use of products or technologies that will provide a 5% operational carbon reduction but have an additional 50% embodied carbon in their manufacture (e.g. from raw material extraction to a store shelf) will not lead to an overall reduction in emissions.

Embodied Carbon

Critical decisions with potentially significant environmental, social and economic implications should be made based on carbon footprint information, the calculation of which should be data-driven and based on standard or widely accepted methodologies, such as the life cycle analysis (LCA) method in the ISO 14000 series of standards.

CSIRO, together with the Australian Life Cycle Assessment Society (ALCAS), has initiated and led the development of the Australian Life Cycle Inventory (AusLCI) Database Initiative. With further support from industry, professional groups and state and federal government bodies, the infrastructure and platform required to provide a publicly available database containing product Life Cycle Inventory (LCI) information are now being developed. Several projects aimed at collecting and processing LCI data for major materials have been undertaken and work is being extended to other products and materials for a range of industry sectors.

Specific CSIRO projects (recently completed, on-going and planned) include:

1. Development of a national LCI database – AusLCI (including both business development and associated technical developments)
2. Establishment of LCI datasets for, amongst others, forest and timber products, light metals, and cementitious products.
3. Development of decision-support tools for LCA-based product/material selection and specification (e.g. LCADesign software for CAD and LCA-based design of commercial office buildings)

4. Comparisons of environmental (and carbon) footprint of different housing construction in different climatic regions (and comparing to operational carbon).

Operational Carbon

Transport

There are many possible control strategies to minimise GHG emissions generated by the transport sector. These include demand control, supply control and new technologies. CSIRO research has identified a number of possible strategy options from demand, supply and new technologies. A number of research projects have been carried out to review the effectiveness and efficiency of these strategies in reducing GHG emissions.

Demand and supply control related projects

Whilst demand control focuses on developing a number of mobility programs to change travel behaviour and thereby reduce private vehicle use, supply control strategies are gradually changing the overall structure of transport networks to reflect changes in land use arising from increasing rates of residential development in many urban areas in Australia.

CSIRO's Sustainable Communities Initiative (SCI) is engaging business, government and non-government organisations in pioneering new collaborative approaches addressing complex urban development challenges, including the impact of urban development and land-use planning on transport requirements, and therefore GHG emissions. Several 'action research' projects are underway, including:

1. East Lake Urban Renewable project with ACT Planning and Land Authority (ACTPLA).
2. Delfin Lend Lease's Metro Melbourne urban development project

In these projects, CSIRO facilitates and leads the development of urban sustainable development frameworks and indicators, which can be used for planning/goal-setting, development and assessment of solution options, monitoring and management of actual transport 'performance' (or associated energy/carbon impacts) after completion and during occupancy stage, and benchmarking (e.g. with other developments).

The Energy Transformed Flagship Program has set up a Future Fuels Forum to develop a range of plausible transport fuel scenarios for Australia out to 2050. The Forum is considering the current and potential use of a wide spectrum of conventional and alternative fuels, their availability, cost, and environmental implications. The Forum will release a public report on the findings by mid 2008.

New Technology in transport related projects (Intelligent Transport Systems)

Intelligent Transport Systems (ITS) options could provide a means to effectively and efficiently support the management of both demand and supply in a given transport system.

- Evidence obtained both locally and from overseas indicates that Intelligent Transport Systems options improve traffic flow, drive-time efficiency, and safety, and can reduce fuel use and emissions. In Europe it has been estimated that 5-10% fleet-wide reductions in fuel consumption and CO₂ emissions are possible with the appropriate driver training, support and feedback instruments.
- New integrated logistics systems, including freight interchanges, are likely to be important for road-rail shipment integration, as will inter-modal interchanges at road-rail and sea-rail terminals.

Previous CSIRO research has addressed three levels of urban transport planning, development and management via local and international linkages:

1. **Strategic level.** The aim of activity at this level was to develop methodology and decision support tools to serve two major tasks. First, it was important to measure user acceptance and consequence of new Intelligent Transport Systems products. Second, the challenge was to measure the impact of Intelligent Transport Systems in the

evaluation of policy pathways toward sustainability for urban transport subject to social, economic, environmental constraints. Example projects include:

- Development of a Prototype “Design to Market” Tool for Intelligent Transport Systems Products. This tool helps to measure user acceptance for different combination of Intelligent Transport Systems services (CSIRO Internal Report Transport Futures 2004).
- Development of Intelligent Transport Systems Greenhouse Gas Impact Evaluation Tool for Policy Makers and Planners. This tool assists in quantifying the potential impact of Intelligent Transport Systems in reducing traffic congestion and greenhouse gas emissions (CSIRO Internal Report Transport Futures 2004).

2. **Tactical/Network Level.** The aim of this activity was to develop methodologies and tools for optimising road traffic conditions by integrating information and control strategies. Example projects include:

- Review of international experience on the use of en-route dynamic Information systems to influence driver behaviour. This research report to VicRoads provided a detailed review of all of the techniques trialled in many developed countries that incorporated the use of dynamic information to influence driver behaviour response as a means to minimising traffic congestion (Ton 2005).
- The use of Probe Vehicle in network traffic collection. This collaborative research project with the Institute of Transport Studies at Monash University developed a new methodology for implementing a low cost instrument car for classifying and predicting traffic and driver behaviour (Ton et al. 2006).

3. **Operational Level.** This level was aimed at measuring the vehicle and driver performance before and after the introduction of Intelligent Transport Systems products in terms of safety, fuel economy and route guidance. Example projects include.

- Development of Eco-Drive Agent concept, which was aimed at developing an electronic personal assistant for real drivers to enable more efficient and safer driving by using sensors to observe traffic data and learn, predict and advise driver responses. The concept was developed in 2005 (Ton et al. 2005) and has received immediate interest from both local (Institute of Transport Studies and Accident Research Centre at Monash University) and overseas institutions.
- Development of real time in-vehicle laser-based sensing model for capturing surrounding traffic. This collaborative research project with the National Taiwan University developed a supporting component for the Eco-Drive Agent concept. Its aim was to automate the task of classifying surrounding traffic of a test car (Ton et al. 2006).
- Integrating CSIRO’s fuel consumption and vehicle emission models with traffic simulators. Work has been completed in collaboration with the Intelligent Transport Systems Research Laboratory at the University of Queensland. This work is part of the Eco-Drive proof-of-concept where the local traffic impact upon the performance of a particular vehicle/driver can be measured and monitored (Ton et al. 2006).
- Development of the Ultrabattery for hybrid vehicle use. The Ultrabattery is a high power storage system that has recently successfully completed a 160,000 km trial in a Honda Insight vehicle at the Millbrook testing circuit in the UK. The trial, sponsored by the ALABC, achieved similar performance to the Ni-MH batteries the Ultrabattery replaced at less than One third of the battery pack cost. The Ultrabattery is now being manufactured by Furukawa in Japan and contractual relationships being developed with the US and Europe interests.

Buildings

CSIRO has a long history of researching the energy consumption in buildings, in particular in developing decision-support tools during building design and when considering refurbishment options, viz:

1. We developed the *Energy Express* software package to calculate the operational energy consumption of commercial buildings.
2. We developed *AccuRate* software to calculate the heating and cooling energy loads for residential buildings. This program is the reference tool for the Nationwide House Energy Rating Scheme and can be used to satisfy the Building Code of Australia (BCA) requirements for the energy efficiency of residential building envelopes.
3. We are currently enhancing *AccuRate* to include calculations of the energy consumption and CO₂ emissions associated with heating and cooling systems, hot water, and lighting (and also water use).

And as mentioned earlier, CSIRO facilitates and leads the development of urban sustainability frameworks and indicators, which can be used for planning and goal-setting, development and assessment of solution options, monitoring and management of actual housing and subdivision energy/carbon performance both after completion and during occupancy, and benchmarking (e.g. with other developments).

After reviewing the R&D impact potential on reducing GHG emissions from different building types (residential, commercial or industrial), we have recently initiated a large, focused project to facilitate the transition of Australian housing towards a zero emission capability (Foliente et al. 2008). The Australian zero emissions household (Aus-ZEH) research, development and demonstration (RD&D) program plans to deliver:

1. an integrated technology testing and demonstration platform for achieving a zero emissions household (ZEH) culminating in the design and construction of full-scale demonstration ZEH(s) in different climate regions;
2. a best-practice technical *Guide for Low Carbon Housing* as a possible companion/supplement to the BCA;
3. a decision support tool (DST1) for house-level *what-if* analyses; and
4. a decision support tool (DST2) for housing stock *what-if* analyses.

The latter is envisaged to assist in assessing the potential contributions of different policy and regulatory options [such as those investigated by UNEP around the world (CEU 2007)] to GHG emissions reduction in residential buildings in Australia.