Lessons Learned from Australian Infrastructure Upgrades

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Lessons Learned from Prior Infrastructure Upgrades in Australia

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Research Provider	RMIT University
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EXECUTIVE SUMMARY

This report fulfils ***Deliverable Five*** for Research Project 2.1-01 (RP2.1.01) of the Future Fuels CRC. The aims of this project, *Crystallising lessons learned from major infrastructure upgrades*, are to (1) provide a report on *lessons learned* from earlier infrastructure upgrades and fuel transitions, and (2) identify *tools* that can be used to develop consistent messaging around the proposed transition to hydrogen and/or other low-carbon fuels. In both the report and the toolkit, there are recommendations on how to apply lessons learned and shape messaging, throughout the value chain, based on prior infrastructure upgrades.

This report presents three Australian case studies that that are relevant to the development of future fuels: (1) the transition from town gas to natural gas, (2) the use of ethanol and LPG as motor fuels, and (3) the development of coal seam gas resources. Drawing on published information, each case study provides an account of the issues that arose during the upgrade or transition, and of the approaches through which industry and government stakeholders managed these issues. From these accounts, lessons are identified that can guide stakeholder engagement in future infrastructure upgrades and fuel transitions. The findings from the case studies and academic literature have been used to develop an accompanying draft toolkit for use by FFCRC stakeholders.

The report also distils applicable lessons and frameworks from academic literature about stakeholder analysis, megaprojects, and the social acceptance of industries and technologies. This report is meant to be used in conjunction with a companion toolkit that provides a framework for making coordinated decisions across the fuel value chain.

Summary of lessons learned from the case studies and academic literature

Although each of the case studies is defined by different events, technologies, and incentive schemes, there are similarities and overlaps in the lessons that they contain. First and foremost, each case study illustrates the importance of gaining and maintaining the public's trust in a new industry or fuel.

The first case is the towns gas conversion. In the late 1960s, many gas consumers in Australia were presented with a new fuel, natural gas, that was not only cheaper but also cleaner and more reliable than the coal gas that it replaced. Nonetheless, gas companies had to invest considerable effort to ensure that customers accepted the so-called "lazy blue flame". Thanks in part to those efforts, the conversion to natural gas was widely considered successful.

The second case is the introduction of ethanol and LPG as motor fuels. When petrol stations in New South Wales started blending ethanol into petrol in the 1990s to produce a cheaper fuel, motorists were initially happy to use it. Ethanol was only ever competitive with petrol because it was not taxed as heavily. But by the early 2000s, concerns about engine damage and poor governance caused a consumer backlash which no amount of government subsidies, consumption mandates and

awareness campaigns was able to fix. The LPG industry managed to recover from a safety scare in the late 1970s and had a boom in the years around 2005 on the back of generous government subsidies; but the popularity of LPG plummeted when subsidies were removed, falling even further with the emergence of new diesel and hybrid technologies.

The third case is the rapid expansion of the coal seam gas (CSG) industry across a broad geographic area. The CSG industry initially began to develop in the 1990s without issue but became increasingly controversial from the mid-2000s. Communities were not prepared for the impacts that occurred when a vast network of infrastructure expanded onto high-value agricultural and rural residential areas. The initial failure of the industry to build productive relationships with landholders and communities contributed to the ongoing trust problems and widespread public opposition that ultimately ensued.

The case studies also illustrate that earning public trust is not a simple matter of selling a reliable product while minimising social, financial, and environmental impacts. Trust has many drivers, and chief among them are perceptions of fairness, integrity and good governance. Australians' trust in government was much higher in 1969 than it is today, a factor that may have contributed to the successful transition from towns gas to natural gas. In contrast, a lack of confidence in both the capability and integrity of state and federal governments has subsequently contributed to the public's reluctance to accept ethanol and coal seam gas. Compounding these problems, there have been perceptions that the benefits of these industries have flowed disproportionately to private interests at the expense of the public. In addition to the distribution of benefits, the processes through which benefits have been allocated have also been criticised. In the case of ethanol, the largest beneficiary of government policies also happened to be a generous political donor. In the case of coal seam gas, gas companies had both financial and legal advantages over the landholders with whom they negotiated.

Another broad lesson that can be learned from all three case studies is that public reactions to new fuels and infrastructure are highly context-dependent. For example, the experiences with gas conversion were markedly different in Sydney compared to Melbourne. Consumers' responses to ethanol have been different in Queensland compared with New South Wales, as have the reactions of rural and urban communities and governments to coal seam gas in Queensland, Victoria, and New South Wales.

In addition to these overarching lessons, the case studies also provide lessons that are more particular. The case study on ethanol, for instance, illustrates the limitations of mandates as a policy mechanism to increase the production or consumption of a fuel. It also shows that while lower prices can make an alternative fuel more popular, many consumers will pay more to avoid a fuel that they do not trust. In contrast, the experience with LPG shows that subsidies and rebates can be hugely successful in driving demand if consumers already trust a fuel. Equally, however, the fate of LPG

demonstrates what can happen when there are no prospects for a fuel to become competitive without ongoing subsidisation.

The academic literature on social acceptance and participation theory reinforces many of the themes identified in the case studies. The centrality of trust to social acceptance, highlighting the roles of procedural fairness and good governance in earning trust, have been demonstrated in numerous studies. So too has the observation that social acceptance and successful engagement are contingent on contextual and dynamic factors. More generally, there is a wide body of literature demonstrating the benefits of meaningful community participation throughout project lifecycles. At the same time, however, the literature shows that care must be taken to select appropriate engagement methods for different situations and types of stakeholders.

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1 INTRODUCTION

This introductory Chapter provides background to the "Lessons Learned" project including the original project objectives. The evolution of the project towards meeting those objectives is described below.

1.1 Purpose

This report fulfils ***Deliverable Five*** for Research Project 2.1-01 (RP2.1.01) of the Future Fuels CRC. The aims of this project, *Crystallising lessons learned from major infrastructure upgrades*, are to (1) provide a report on *lessons learned* from earlier infrastructure upgrades and fuel transitions, and (2) identify *tools* that can be used to develop consistent messaging around the proposed transition to hydrogen and/or other low-carbon fuels. In both the report and the toolkit, there are recommendations on how to apply lessons learned and shape messaging, throughout the value chain, based on prior infrastructure upgrades.

This report presents three Australian case studies: (1) the transition from town gas to natural gas, (2) the use of alternative motor fuels, and (3) the development of coal seam gas resources. This retrospective review is designed to provide strategic advice concerning stakeholder engagement in the development and deployment of infrastructure upgrades and fuel transitions. Ultimately, this project aims to assist FFCRC members in the energy sector to craft and use evidence-based, comprehensive, and coherent messages to key external and internal stakeholders in the gas, hydrogen, electricity, and biogas sectors. A companion Toolkit has been prepared to assist FFCRC members in designing coherent engagement strategies in the rapidly evolving energy sector.

This project was the first to launch from RP2 of the FFCRC and sits within in a broader program of work intended to assist industry stakeholders in the energy sector towards gaining social acceptance of hydrogen and/or other low-carbon fuels and fuel mixes. This report lays a foundation for this broader program of work by distilling applicable lessons and knowledge from previous infrastructure upgrades and fuel transitions. Drawing on these lessons, this report also takes the first steps towards identifying which stakeholders may be relevant to any future deployment of low-carbon fuels, and towards understanding how these stakeholders might best be engaged.

1.2 Background

This section highlights some of the value the FFCRC is poised to bring the Australian energy sector in addressing rapidly emerging developments in the current and future operating environments. In particular, the need to invest in decarbonised fuels and electricity products has become clearer in order to meet international as well as local expectations.

1.2.1 The need to decarbonise

To avoid unacceptable levels of global warming, as benchmarked in the COP21 and the Paris Agreement, Australia and other developed nations will need programs of

rapid decarbonisation over the coming decades. Modelling done by the Intergovernmental Panel on Climate Change (IPCC) in 2018 explains that to limit global warming to an average of 1.5°C above pre-industrial levels will require carbon dioxide emissions to fall by 45% from 2010 levels by 2030, and to reach net zero levels by 2050.[1] Limiting warming to 2°C (a scenario likely to cause more significant impacts than 1.5°C) would require CO^2 levels to fall by 25% by 2030 and 100% by 2070. Achieving such reductions will require major changes across a wide range of economic activities. Among other things, it will require a transition from the use of carbon-intensive fossil fuels such as coal, natural gas, and oil, to sources of energy that are renewable and carbon-neutral.

Australia is a signatory to the 21st Conference of the Parties (COP21) Paris Agreement (2015). Consequently, the Australian Government has committed to carbon emissions reduction targets, which will be revised every five years starting in 2020. Australia's current target is to reduce emissions to 26% to 28% below 2005 levels by 2030. Future revisions of this target are likely to be more ambitious, both because of the expectation under the Paris Agreement that each revision be more ambitious than the last, and because Australia's current targets are well below what is required to limit temperature rises to even 2°C.[2]

Among Australia's state governments, New South Wales, Victoria, and Queensland have adopted (but not legislated) a goal of achieving net-zero emissions by 2050. A significant strategy for achieving this goal is the wide-scale adoption of renewable energy targets. Queensland, Victoria, and the Northern Territory are aiming for 50% of all electricity to be sourced from renewables by 2030. South Australia has adopted—and is on track to achieve—the more ambitious target of 50% by 2025. New South Wales and the federal government are aiming for 20% by 2020.

Currently, the federal government has stated no plans to introduce a new target after 2020. However, a recent analysis by RepuTex (2019) suggests that even in the absence of new federal government intervention, renewables will supply 52% of electricity in Australia by 2030, thanks largely to state-level renewable energy targets. Furthermore, with the recent bushfire crisis of 2019-2020, demands for climate action from the general public are likely to increase.

1.2.2 The role of gas networks in the decarbonisation journey

Gas networks, as carriers of low-carbon or zero-carbon 'future fuels', can potentially play a vital role in decarbonising Australia's energy mix. Future fuels may not only reduce the need to electrify gas-based processes and appliances but could also help to solve grid-level storage challenges associated with renewable electricity. In addition, renewable gas technologies present new export opportunities for countries that have extensive renewable energy resources, such as Australia.

In modern economies, renewable energy is consumed almost exclusively in the form of electricity. However, electricity presently accounts for only one fifth of all energy consumed in Australia. Roughly half of all energy is consumed in the form of petroleum

products, while a further fifth is consumed as gas.[3] Comprehensive decarbonisation will require that these fuel-based energy uses are either electrified or converted to use low-carbon or zero-carbon fuels such as hydrogen, synthetic methane, and bio-methane.

The scope for electrification is considerable, but there are limitations. For example, some industrial processes, such as the manufacturing of steel, require heat intensities that are difficult to achieve with electricity. In the transport sector, battery-powered electric vehicles are becoming popular for everyday use. Hydrogen fuel cells are only beginning to be used to meet the demands of long-distance and high horse-power transportation (e.g., shipping, freight trains, and long-haul trucks). In domestic settings, although electricity is available for certain appliances, gas remains the preferred fuel especially or cooking due to its precision in achieving specific food preparations, although there has been an increase in the uptake of electric induction cooktops that ensure precise temperature control as they use electromagnetic energy to directly heat pots and pans.[4] However, they do require cookware made of magnetic-based materials, such as cast iron or magnetic stainless steel, which could add to 'upgrade' expenses.

Furthermore, the widespread adoption of renewable electricity presents challenges relating to energy storage and grid management. Electricity generation from wind and solar energy is subject to both daily and seasonal variation, which can lead to surpluses and shortfalls. At present, the energy grid is struggling to balance existing disparities especially with growing use of solar panels and electric vehicles.[5] Batteries will remain an important technology for mitigating these disparities but may not be suitable for storing large volumes of energy over long periods. In addition, electricity is difficult to distribute efficiently over vast distances. To address this issue, a useful approach may be to convert surplus electricity into hydrogen or methane storage solutions. Compared with electricity, these gases can be stored over long periods and moved efficiently over large distances, especially in places already serviced by pipeline networks.

The Australian gas industry's vision for decarbonisation has been articulated in Gas Vision 2050, which identifies three key transformational technologies through which gaseous fuels may be transitioned: biogas production, carbon capture and storage (CCS), and hydrogen. Presently, Energy Networks Australia (ENA), the Australian Gas Infrastructure Group (AGIG), Bioenergy Australia (BA), and the Council of Australian Governments (COAG) Energy Council are investing in hydrogen and biofuels as a priority. Furthermore, the Energy Charter provides a platform for industry and government to work directly with consumers. The goal is to meet a range of energy needs across the value chain within a changing energy environment. The Energy Charter signatories focus on five principles:

1. We will put customers at the centre of our business and the energy system
2. We will improve energy affordability for customers
3. We will provide energy safely, sustainably and reliably

4. We will improve the customer experience
5. We will support customers facing vulnerable circumstances

1.2.3 Social acceptance of future fuels

Incorporating gas networks and renewable fuels into a decarbonised energy network in Australia will present challenges relating not only to the technical and economic feasibility of future fuels, but also their social acceptability. Put simply, the deployment of new fuels and associated technologies could be jeopardised if affected communities, end-users, and the public at large do not support the new fuels and the technology required to distribute them.

At present, most members of the Australian public feel that they have a fairly good understanding of the role of solar and wind energy for electricity needs, but have little knowledge about renewable gas products (e.g., some of the proposed future fuels) and technologies, let alone the role they could play in a decarbonised economy.[6] While there is no indication so far that the public or their political representatives will oppose new fuel products and technologies, there is no guarantee that they will be supportive either. The willingness of consumers to adopt and pay for new fuel products in light of possible concerns about safety, performance, cost, and environmental impacts is also something that cannot be taken for granted. As recent experiences with the development of coal seam gas in Australia demonstrate, there is also a risk that industry proponents or their contractors could face on-ground conflict or reputational damage, which in turn could affect support for the technology. If not managed strategically, these and other potential obstacles to social acceptance could hinder and potentially derail the adoption of renewable gas technologies.

1.3 Research approach

This research is undertaken with qualitative methods relevant specifically to *stakeholder engagement theory*. The approach is described in more detail in this section.

1.3.1 Components

This project includes four streams of work:

- A *desktop review* and presentation of *three case studies* that are in some way analogous to the potential introduction of low-carbon fuels in Australia. These case studies and their relevance to the present study are outlined below.
- *A desktop review of academic literature* relating to social acceptance and stakeholder participation in comparable technology transitions and energy projects.
- Analysis of data from *semi-structured interviews with key informants* who have a lived memory of, or expert insights into, the three case studies.
- Development of a *stakeholder analysis toolkit* incorporating interview data to assist with community engagement and messaging about the coming infrastructure upgrade.

1.3.2 Research questions

This report addresses a series of inter-related research questions, stated below. These questions relate specifically to the two broad objectives stated in Section 1.1, namely (1) provide a report on *lessons learned* from earlier infrastructure upgrades and fuel transitions, and (2) identify *tools* that can be used to develop consistent messaging around the proposed transition to hydrogen and/or other low-carbon fuels.

The four primary research questions are:

1. What were the drivers of earlier infrastructure upgrades and in what way were community stakeholders engaged from supply chain to whole-of-industry?

2. What factors influence the strategies industry uses to earn community trust as an important aspect of social license

3. Which combination of methods is most effective in communicating key messages to primary community and government stakeholders?

4. What were the downfalls of infrastructure upgrade programs that were not successful and what strategies could be adopted to prevent this?

1.3.3 Future Fuels & Case Studies

Australia's energy sector continues to develop and innovate within a dynamic energy marketplace. In response to domestic and international energy consumers, Australia's energy sector is actively exploring the use of hydrogen and other low-carbon fuels in a variety of forms. One fuel that has captivated the attention of many in the energy sector is hydrogen that potentially can be used domestically for manufacturing, transport, heating, and energy storage, as well as being exported to other countries. Other fuels, such as biomethane or synthetic methane, may also become part of the mix. As yet, there is no certainty about which future fuels opportunities will be realised, or on what scale.

Widescale uptake of future fuels within Australia would involve at least two kinds of major change: (1) consumers switching to a new fuel and new appliance configurations, and (2) the construction, modification and replacement of infrastructure, including pipeline networks, the electricity grid, and related equipment. These kinds of changes, broadly understood, have occurred before in Australia. Although circumstances and specifics may differ, there is value in understanding how comparable transitions have unfolded in the past so that transferrable lessons might be learned from and applied to future fuels developments.

The primary goal of this report is to identify and reflect on these lessons. Rather than attempting to be exhaustive of nationally relevant transition projects, this report concentrates on the three most salient Australian case studies pertaining to future fuels developments. The report is meant to provide insight on how to anticipate social risks and opportunities specifically within the Australian context. Much is still unknown about the dynamic nature of public sentiment and behaviour to as-yet-developing

fuel mixes and related infrastructure. However, there are broad aspects of social engagement that warrant consideration, even at this early stage. Learning from the engagement strategies reflected in these cases may provide a firmer foundation for anticipating how Australian consumers will respond to the development of future fuels within a decarbonising energy mix.

The first case study is the transition from 'town gas' to natural gas that took place in the 1960s and 1970s, following similar transitions in the UK and other parts of the world. This case sets a clear precedent for any future transition to using hydrogen or other low-carbon gases in domestic networks. Indeed, at a technical level it is almost a mirror image of such a transition, as town gas consisted of about 50 per cent hydrogen. While Australia is a different country culturally and socially than it was 50 years ago, there are also lessons to be learned in how governments and gas companies went about engaging their customers, as well as the wider public, through this formidable logistical and technical challenge.

The second case study is on the use of alternative motor fuels, specifically ethanol and LPG. After being used in Queensland in the 1930s, ethanol came back into vogue as a motor fuel additive in the 1990s, whereas the use of LPG was first encouraged by the Australian Government in the late 1970s. Both fuels have been promoted in various ways by both state and federal governments with mixed success. Despite hundreds of millions of dollars of government subsidies over several decades, along with encouragement in the form of targets, mandates and education campaigns, ethanol and LPG remain marginal components of Australia's motor fuel mix.

The third case study is the development of the coal seam gas (CSG) industry in Australia. Although a component of the domestic fuel mix since the mid-1990s, CSG—a natural gas primarily comprising methane (CH4) sourced from coal seams—became a subject of public controversy in the late 2000s when the industry experienced exponential growth to take advantage of new export opportunities. Conflicts around land access, environmental impacts, and socio-economic disruption had a cumulative effect greater than the sum of their parts. The industry became a major political issue and altered the public's perceptions of, and trust towards, the gas industry. For this reason alone, CSG development is impossible to ignore in the context of future fuel developments. Beyond its political import, CSG development also contains more practical lessons, and indeed cautionary tales, that may guide the development and deployment of future fuels.

This research project was initially scoped to reveal lessons that may inform stakeholder engagement strategies in future fuels developments. While this primary focus remains, the limits of the analysis have been loosened to incorporate other applicable lessons as well, such as insights relating to government policy. The reason for this inclusion is two-fold. Firstly, as the analysis will make clear, public trust and government oversight become entwined whenever there are considerations about environmental impacts, public safety, and government support for an industry or product. Secondly, the research that was conducted for these case studies included reviews of historical

records in addition to reports prepared for and by government agencies. The full suite of documents available presented a valuable opportunity to identify policy issues and precedents that may warrant further consideration in anticipation of future fuels developments. Note, however, that the consideration of policy matters in this report is only preliminary.

1.4 How to read this report and use the toolkit

This report contains six chapters:

Chapter 1 – Introduction summarises the purpose, background and approach of the investigation.

Chapter 2 – The transition from town gas to natural gas

Chapter 3 - The use of ethanol and LPG as motor fuels

Chapter 4 – Coal seam gas development

Chapter 5 – Review of academic literature (the theory behind the toolkit)

Chapter 6 – Implications and recommendations for industry

For those who want a quick reference to the cases in Chapters 2, 3, and 4, each chapter begins with a summary of the key elements of the case, a timeline, and the major lessons learned. We have organised each chapter on the cases to be 'rippable' – so you can share the cases one by one with your teams, based on their relevance to your work.

The toolkit is a separate document that is designed to help the sector approach the coming energy transition from a position of insight and strength, based on past learnings. Industry interviewees contributed content to the toolkit by sharing their direct experience with one or more of the cases in this report. We have not used direct quotes, to protect the anonymity of our generous interviewees. However, we have synthesised their recommendations and embedded those in the toolkit.

The toolkit is designed to assist the energy sector answer RQ3 as the technical, social, economic, and environmental space in the energy sector rapidly changes. The suite of tools in the toolkit can be used together or as a supplement to existing stakeholder engagement strategies. We hope the toolkit will assist the sector in communicating their evolving position on the energy transformation in an unambiguous and inclusive manner throughout their value chains. The toolkit is a 'living' document meaning that it will be updated regularly to incorporate lessons learned from both historical and current examples

With the insights presented in this report in combination with the toolkit, we hope to make a contribution towards consistency of messaging at each stage of the energy transformation. With clear, transparent, and forthright relationship-building between the different stakeholders to Australia's energy infrastructure, there is an opportunity to build a genuine level of trust between the general public and the energy sector.

[1] IPCC. (2018). *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*.
[2] Climate Action Tracker. (2020). Australia. Retrieved from https://climateactiontracker.org/countries/australia/.
[3] Department of the Environment and Energy. (2018). *Australian Energy Statistics, Table H, August 2018*.
[4] Allied Market Research. (2020). Household induction cooktops market. Retrieved from https://www.alliedmarketresearch.com/household-induction-cooktops-market.
[5] AEMO and Energy Networks Australia. (2018). *Open Energy Networks, consulation paper*.
[6] Lambert and Ashworth. (2018). *The Australian public's perception of hydrogen for energy*.

2 THE TRANSITION FROM TOWN GAS TO NATURAL GAS

Case study 1 – The transition from town gas to natural gas

How and when was the fuel introduced?

In the 1960s and 1970s, many Australian towns and cities transitioned from using 'town gas', which was manufactured from coal, to natural gas, which is obtained from underground reservoirs. Consisting mostly of methane, natural gas was cleaner, cheaper and more reliable than town gas, which consisted of hydrogen, methane, carbon monoxide, and other components.

The introduction of natural gas began with the construction of gas transmission pipelines from the gas fields to major cities. These pipelines were built mostly by state governments. Gas companies then visited every customer's household to modify their appliances so that they would work with natural gas. Gas companies also visited houses before and after the conversions to survey appliances, to fix conversion faults, and to help customers adjust to the new fuel.

What were the challenges and how were they addressed?

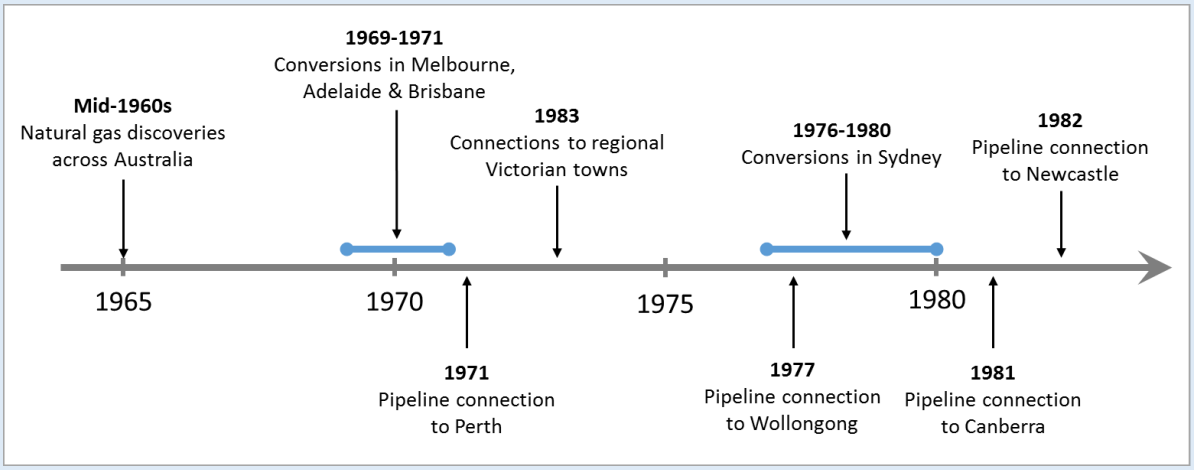
Converting appliances was a huge logistical and technical undertaking. In Melbourne, for instance, the Gas and Fuel Corporation deployed a team of 800 workers to visit 435,000 households and convert 1.25 million appliances. The process took 18 months and cost around $350 million in today's terms. Despite extensive preparatory work, things still went wrong. In the early days, the corporation's targets were too ambitious, resulting in hundreds of call-backs to fix faulty conversions. Some converted appliances did not behave as expected, and few mechanics had much experience with conversions. One poorly converted room heater left two people in a coma (one of whom eventually died) due to carbon monoxide poisoning. The only fallout from the incident was the banning of unflued gas heaters in Victoria.

Gas companies also had to contend with apprehension or disinterest from their customers. In Adelaide, for example, the South Australian Gas Company surveyed 300 housewives before the conversion process and discovered that natural gas had a serious image problem. In response, the company invested more than $100,000 ($1.2 million in today's terms) in a publicity campaign to inform customers about what to expect from the conversion. In Sydney, delays in pipeline construction meant that natural gas did not arrive until 1976, much later than anticipated. Faced with ambivalence and even cynicism from its customers, AGL reinvented itself through a massive and highly successful marketing campaign dedicated to 'the living flame'.

What are the lessons for future fuels?

- *Expect the unexpected*. No amount of laboratory testing or planning can prevent unexpected problems from emerging when a new fuel is deployed at scale. Delays result.
- *Conversion requires communication*. Proactively engaging customers before, during and after a major conversion process will help to ensure that issues are identify and addressed quickly and effectively.

- *Times have changed*. Managing a large-scale conversion program is likely to be more difficult today than 50 years ago. Trust in government is at an all-time low, and gas companies are not highly trusted either. Gaining access to households will also be more difficult now that fewer people stay home on a full-time basis. And finally, safety incidents and installation problems could be broadcast via social media, potentially becoming a series of public relations crises.



Key events in the transition from towns gas to natural gas in Australia.

2.1 Approach to the case

In the 1960s and 1970s, many Australian towns and cities transitioned from using 'town gas', usually manufactured from coal, to natural gas obtained from underground reservoirs. This case study examines various events and processes through which these transitions occurred. It is presented in five sections. Following an overview of the conversions that took place in Australia, separate sections provide further details relating to three aspects of the conversions. Section 2.1.2 examines public attitudes to natural gas prior to the conversions, and the approaches that gas companies took in gauging and influencing those attitudes. Section 2.1.3 covers the building of pipelines to connect gas fields to population centres; and Section 2.2 examines the appliance conversion process.

First and foremost, this case study provides an understanding of the social dimensions of the conversions, such as how the public was informed about and engaged during the process, and how positively or negatively the public responded. In addition, the case study has taken opportunities to explore technical, logistic and governmental aspects of the conversions. This case study does not directly examine the similar conversion process that occurred in Britain (UK) between 1967 and 1977. However, it does discuss how experiences from Britain and elsewhere helped to inform the conversions in Australia.

The specific times, places and issues covered in this case study were driven to a large extent by the availability of information. The primary source material for this case study

was historical newspaper articles available through the online collections of *Trove*, which is a public resource run by the National Library of Australia, and *Newspapers.com*, a commercial service with a global market. Most of the relevant articles from *Trove* come from *The Canberra Times*, as few other newspaper titles from the case study period were available. While Canberra itself does not feature heavily in the case study, *The Canberra Times* does provide reasonable coverage of events in Sydney and Melbourne. The only Australian newspapers available on *Newspapers.com* for the relevant period are *The Age* and the *Sydney Morning Herald*, the daily newspapers of Melbourne and Sydney.

This case study also draws on two published histories of Australian gas companies: Rosemary Broomham's (1987) *First Light: 150 Years of Gas*, which tells the history of AGL, and Peter Donovan and Noreen Kirkman's (1986) *The Unquenchable Flame: The South Australian Gas Company, 1861-1986*. Given the sources used, this case study necessarily focuses on natural gas conversions in Melbourne, Sydney and Adelaide. Conversions in other towns and cities are covered in less detail.

2.1.1 Overview of gas conversions in Australia

Until the late 1960s, most of the gas used for heating and cooking in Australian cities and towns was manufactured from coal or oil products. This 'town gas'—so called because it was manufactured in local plants—was variable in its composition, but typically comprised about 50 per cent hydrogen, 35 per cent methane, 10 per cent carbon monoxide, and 5 per cent ethylene.

During the 1960s, discoveries of large reserves of natural gas, which consists primarily of methane, in several parts of Australia opened up a new pathway for supplying gas to industrial and domestic customers. State governments and gas providers (which in some cases were state-owned) quickly embraced natural gas as a replacement for manufactured gas and set about transitioning their customers to the new fuel.

Natural gas for capitals

MELBOURNE, Thursday.—Natural gas will come to all mainland capital cities soon, according to the chairman of directors of the Associated Oil Group, Mr. E. N. Avery, today. Mr. Avery, who was addressing the annual meeting of Associated Freney Oil Fields, N.L., said experts from the Canadian Western Natural Gas Company had visited Queensland investigating the feasibility of a 300 mile pipeline from Roma to Brisbane. Their findings were awaited.

Figure 1 The Canberra Times, 2 October 1964, p. 15.

The first step in bringing about this transition was to construct pipelines from the gas fields to the existing capital city distribution networks. Pipelines from Roma to Brisbane, Gippsland to Melbourne, and Moomba to Adelaide were completed in 1969, while Perth received its first gas from Dongara in 1971.[1] Sydney did not receive natural gas until the Christmas of 1976, when the pipeline from Moomba was finally completed.

Lateral connections to regional centres followed the completion of the main lines to capital cities. In Victoria, natural gas reached Ballarat, Bendigo, Castlemaine, and Bacchus Marsh in 1973, and Albury/Wodonga in 1977.[2] In New South Wales, Wollongong was connected in 1977, while Goulburn became the

first inland city in the state to receive natural gas in May 1980.[3] A connection to Newcastle was not completed until 1982. Canberra, which never had a gasworks but embraced liquefied petroleum gas (LPG) in the 1960s, first received natural gas in 1981.[4]

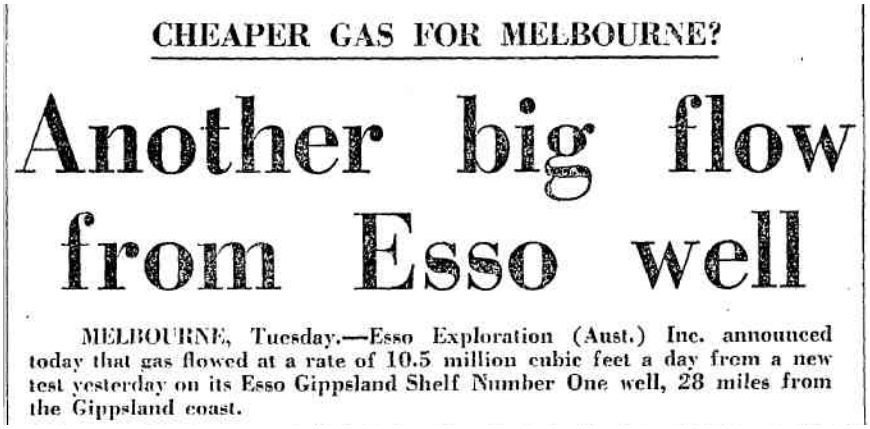
The second phase of the transition was to adjust or replace household appliances to make them compatible with natural gas. The conversion process in Melbourne was completed by the end of 1970, making Melbourne the first city in Australia to be supplied entirely by natural gas. Brisbane and Adelaide converted in a similar timeframe.[5]

2.1.2 Natural gas: an easy sell?

Although the source material reviewed for this study does not provide a comprehensive picture of public attitudes ahead of the conversion to natural gas, it suggests that the arrival of natural gas was widely considered to be a good and uncontroversial thing. An article published in Western Australia's *Beverley Times* in January 1969, when Brisbane, Adelaide and Melbourne were poised to start receiving natural gas, is typical of how natural gas was discussed in newspapers at the time:

> *Natural gas is a clean, efficient source of industrial and domestic energy and a valuable raw material for petrochemicals and fertilisers. It has won ready acceptance in many other countries…In Australia, the advent of natural gas will mean new industries, the economic development of many existing ones, and cheaper gas in tens of thousands of homes, factories.*[6]

As the headline from 1965 in Figure 19 shows, newspapers were speculating about cheaper gas even as the major natural gas discoveries were still being made.



CHEAPER GAS FOR MELBOURNE?

Another big flow from Esso well

MELBOURNE, Tuesday.—Esso Exploration (Aust.) Inc. announced today that gas flowed at a rate of 10.5 million cubic feet a day from a new test yesterday on its Esso Gippsland Shelf Number One well, 28 miles from the Gippsland coast.

Figure 2 The Canberra Times, 14 April 1965. The first gas would flow to Melbourne customers just four years later, in April 1969.

Price remained a major selling point for natural gas in the lead-up to conversion. In April 1968, about a year before natural gas arrived in Melbourne, the Chairman of the Gas and Fuel Corporation of Victoria announced that "price cuts for natural gas compared with coal gas could be expected to range from 25 to 50 per cent."[7] A year later, on the eve of the arrival of natural gas in Melbourne, the promised savings had

been revised down, but would still be substantial for customers who relied heavily on gas:

> *In comparison with town gas, which natural gas will replace for the corporation's 420,000 customers, a householder using only a cooker and a sink heater can expect a reduction of almost 10 per cent a year on present rates, or about $5. For domestic consumers who use gas for everything except heating the house, the cut in rates would be about 14 per cent. The all-gas house would enjoy a cut in rates of some 20 per cent.*[8]

In any case, the financial savings for customers, which were even greater in Brisbane and Adelaide,[9] did not need to be huge for the new product to be appealing. Natural gas performed its duties just as effectively as town gas but had the advantage of being cleaner, benefitting not only consumers and their appliances, but also the wider network infrastructure. According to an in-depth article published in *The Canberra Times* in March 1969 on the economic benefits of natural gas for the Australian economy, natural gas offered a "preponderance of beneficial features":

> *The natural gas flame looks and behaves much the same as the flame from coal gas though it is lazier and takes a wink of an eyelid longer to ignite. Space heaters using natural gas may look less bright but the amount of heat given out will be the same.*
>
> *The advantages of natural gas over coal gas are that it is non-toxic and has about twice the heating value, volume for volume. The higher heating value of natural gas reduces the cost of distribution compared with coal gas but its different combustion behaviour requires modifications to appliances.*
>
> *Natural gas is also cleaner in that the relative absence of impurities reduces the tendency to form soot. More, the absence of oxygen reduces corrosion in supply mains.*[10]

Natural gas much cheaper

MELBOURNE, Friday. — Price cuts for natural gas compared with coal gas could be expected to range from 25 to 50 per cent, the chairman of the Victorian Gas and Fuel Corporation, Mr A. E. Chadwick, said today.

Conversion of the corporation's Melbourne area and Gippsland towns is expected in 19 months from next March.

Mr Chadwick said, "We will be competing with other fuels. Price reductions will have to be made if we hope to sell the volume of gas we have agreed to buy from BHP and Esso".

Mr Chadwick said the corporation believed it should not be prevented from selling natural gas anywhere in Victoria outside the areas supplied by other gas utilities.

Figure 3 The Canberra Times, 20 April 1968, p. 3.

A further expected benefit of natural gas over town gas was its reliability. Being dependent on coal or oil, the supply of town gas was sensitive to the availability of those resources. A national strike by oil refinery workers in 1970, for example, left Brisbane temporarily without gas, and forced the Victorian Gas and Fuel Corporation to consider rationing supplies.[11] Sydney's gas supplies were similarly threatened in July 1974 when a strike of marine engineers stalled shipments of oil from the Bass Strait.[12]

For the most part, then, natural gas was an easy sell, as it promised to be cheaper, cleaner, and more reliable than town gas. Nonetheless, the public was not entirely at ease with the prospect of switching to a new fuel. For a start, there were stories about things going wrong in similar conversions overseas, especially in Britain, where the conversion to natural gas had started in 1967. An article titled "Britain fumes over sea

gas" published in *The Age* in December 1968[13] informed readers about some of the issues experienced in Britain, Holland and Germany. The complaints ranged from burnt roast dinners to families being left without gas for days or weeks as faults were resolved – the implication being that Melbourne consumers could expect the same when the conversion began. The same article did, however, address many of the misconceptions surrounding the same alarming stories, painting natural gas in an overall positive light.

The traditional gendered division of labour, whereby women did the majority of cooking and other housework, was strongly entrenched in Australia in the 1960s and 1970s. Accordingly, gas companies focussed many of their communication efforts on one consumer group – housewives. In engaging this group, gas companies were especially keen to allay concerns about how the lazier yet hotter flame of natural gas would behave in cooking. In April 1966, a full three years before natural gas reached Melbourne, Victoria's Gas and Fuel Commission invited Margaret Fulton, then the cookery editor of *Woman's Day* magazine, to cook a three-course dinner on a stove connected to a cylinder of natural gas.

> *The meal (onion soup, roast chicken and peaches flambe, as Miss Fulton recalls it) turned out very well. "Of course, housewives will have to adapt to natural gas," she [said], "but I have no doubt the oven manufacturers will produce equipment making allowances for its extra heat content."*[14]

Later, when the conversion in Melbourne was underway, the Gas and Fuel Commission maintained its focus on engaging with housewives, even employing a special team of women as the primary point of contact for issues that arose during the conversion, as is discussed in more detail in Section 2.2.4.

In preparing to bring natural gas to Adelaide, the South Australian Gas Company (SAGASCO) also targeted housewives in its engagement efforts. A survey of 300 housewives undertaken three months prior to the conversion revealed that the company "had a major problem with the image of natural gas," noting that "a very serious state of apprehension exists with respect to the changeover".[15] Media coverage of the changeover did not help their cause, as it focussed mainly on negative aspects. SAGASCO resorted to legal action on at least two occasions to prevent the airing of what it deemed to be misleading coverage about the safety of natural gas.[16]

Recognising the importance of gaining public support, SAGASCO invested more than $100,000 ($1.2 million in today's terms) in a publicity campaign "to sell the benefits of natural gas, to explain its characteristics and to forewarn consumers of the necessary, but temporary, inconvenience which would accompany the conversion."[17]

> *A key to this promotion was the production of a twenty-minute film on conversion and a campaign to take this to influential groups ranging from SAGASCO staff to Members of Parliament, the Housewives Association, the Country Women's Association, groups of builders and architects and*

schools. At the same time copy was prepared for the print and electronic media.[18]

SAGASCO did not limit its communication efforts to outside stakeholders. Recognising the importance of consistent knowledge and messaging within the company, SAGASCO started an in-house Natural Gas Newsletter.

Despite the cleaner image of natural gas, some people worried about its environmental impacts. A letter to the editor of the Sydney Morning Herald published in January 1971 (five years before Sydney would eventually have natural gas, but more than a year after it had been available in Melbourne, Brisbane and Adelaide) asked "Do we really need natural gas in NSW?" As well as doubting the reality of the modest cost savings promised to Sydney customers ("up to 10 per cent for domestic cooking"), the writer expressed concerns about the safety not only of consumers but also of trees, citing reports from Holland that "hundreds of thousands of trees and plants have been killed by gas leaking from the 7,500 miles of pipeline which criss-crosses the country".[19]

2.1.3 Connection

Getting natural gas to customers from its point of origin was no simple matter. The construction of transmission pipelines to capital cities were major engineering projects. Pipelines of this length had not been constructed in Australia before. Distance, however, was but one of many challenges that these projects faced. There were difficulties also in procuring the necessary skills and equipment, in negotiating construction contracts and gas supply agreements, and in navigating shifting political sands.

Year's delay in gas use

Victoria will not be using natural gas before January, 1969—12 months later than originally announced.

The delay follows the long negotiations over the price of natural gas between the Gas and Fuel Corporation and Esso-BHP.

pected an agreement before the end of the year.

The development and marketing of the gas will involve big capital expendi-

Figure 4 The Canberra Times, 5 October 1966, p. 22.

Yet, with the notable exception of Sydney (discussed in further detail below), the process of getting natural gas to Australian capital cities proceeded fairly quickly. Some early pronouncements proved to be optimistic for example, the Brisbane gas companies predicted in 1965 that, "natural gas would be used in Brisbane by Christmas next year at the latest"[20]. Nevertheless, once construction commenced, the pipelines to Melbourne, Perth, Adelaide and Brisbane were all completed within about a year. The pipeline from Moomba to Adelaide was completed in just nine months, which was two months ahead of schedule.[21] In most states, the natural gas industry went from discovery to delivery within the space of a decade. In Victoria, the timeline was closer to five years.[22]

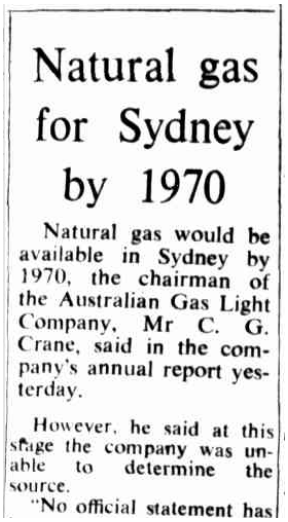
Although completed more or less on schedule, the planning and construction of these pipelines were far from uncomplicated. For example, the pipeline to Melbourne from the Gippsland coast was beset by political debate before construction even began. In March 1966, the Victorian branch of the Australia Labour Party argued that the

state-owned Gas and Fuel Corporation should assume ownership of all-natural gas deposits.[23] Instead, the Gas and Fuel Corporation ended up negotiating a price—itself a subject of criticism—with Esso and BHP. The role of government was also central to debates about where pipelines would be built and who would benefit. In April 1966, the leader of the Victorian Country Party expressed the view that natural gas "should be used to build a balanced state" instead of flowing only to metropolitan areas.[24] Trade-offs between communal benefit and economic expedience would also feature in debates about delivering gas to Sydney, as discussed below.

2.1.4 The Moomba-to-Sydney pipeline

> *"The story of the pipeline is one of facts and figures, stops and starts, strikes and disagreements and above all the weather."*[25]

Unlike the other states, New South Wales did not have its own reserves of natural gas, and so would have to source it from elsewhere. By 1967, discussion was well underway about the possible route of a pipeline from Gippsland to Sydney. The most direct route would take it through the Snowy Mountains, from Sale straight to Canberra and Goulbourn. The councils of towns along the Hume Highway argued against the proposed "pipeline through the scrub"[26] and advocated for an alternative route that went via Yass and would require a separate connection to Canberra.[27] The federal government was sympathetic to the Hume Highway route, and amenable to subsidising it.[28] Meanwhile, the Managing Director of AGL, William Pettingell, backed the more direct route, announcing in December 1968 that "A natural gas pipeline to service Sydney and Newcastle would be routed through the Cooma, Queanbeyan and Goulburn areas", while "Branch lines would carry gas to Canberra and Wollongong." Pettingell further proclaimed that "gas for domestic purposes in Sydney, Newcastle and Wollongong would cost about 25 per cent less from 1970."[29]



Natural gas for Sydney by 1970

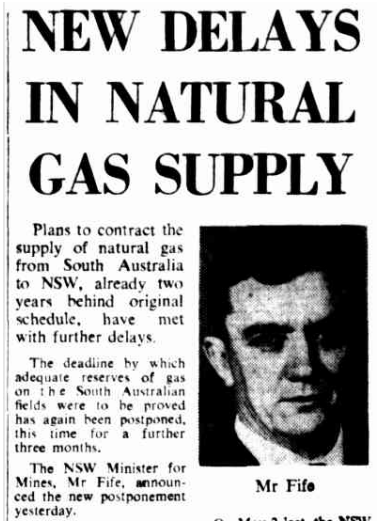
Natural gas would be available in Sydney by 1970, the chairman of the Australian Gas Light Company, Mr C. G. Crane, said in the company's annual report yesterday.

However, he said at this stage the company was unable to determine the source.

"No official statement has

Figure 5 The Canberra Times, 14 March 1967, p. 15.

At the end of 1969, the pipeline became the subject of a deep internal rift within the federal government. The former Minister for National Development, David Fairbairn, accused the Prime Minister, John Gorton, of secretly agreeing to provide funds for the shorter pipeline route, even while negotiations between the states continued.[30] Between the states there was also disagreement. Eager to minimise any costs that a longer pipeline would create for end-customers, the New South Wales Government favoured the direct route through the Snowy Mountains, while Victoria was keen to maximise opportunities for towns along the Hume Highway.[31] At the same time, Victoria was also weighing up the option of supplying inland towns with LPG instead.[32]



NEW DELAYS IN NATURAL GAS SUPPLY

Plans to contract the supply of natural gas from South Australia to NSW, already two years behind original schedule, have met with further delays.

The deadline by which adequate reserves of gas on the South Australian fields were to be proved has again been postponed, this time for a further three months.

The NSW Minister for Mines, Mr Fife, announced the new postponement yesterday.

Mr Fife

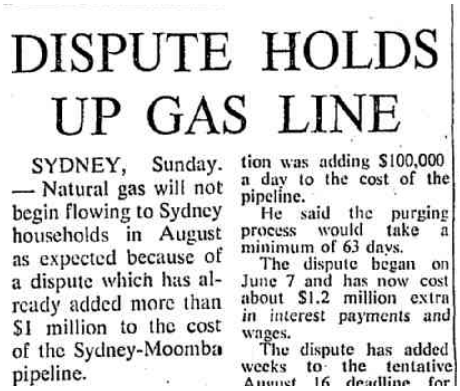
Figure 6 The Canberra Times, 10 June 1972, p. 19.

Negotiations around the pipeline from Bass Strait ended only in December 1970 when AGL reached an agreement with South Australian producers to secure gas from the Gidgealpa fields instead, even though the necessary reserves for long-term supply had yet to be proven.[33] Confirmation of those reserves took until September 1972.[34] With the gas secured, AGL applied for a permit to build the pipeline in December 1972, and public submissions were invited for the environmental impact assessment.[35]

Meanwhile, the political landscape was undergoing a dramatic change, as the first Labour government in 23 years came to power following the election on 2 December 1972. In January 1973, the Whitlam government informed AGL of its plans to build a national gas grid which would incorporate the Moomba-to-Sydney pipeline.[36] After initially resisting,[37] AGL acquiesced to the new arrangements in March 1973.[38] Construction of the pipeline would now be overseen by the new National Pipeline Authority.

By this time, however, the seeds of yet another delay were already germinating. Environmentalists opposed the most direct route of the proposed pipeline because it cut through the Blue Mountains National Park.[39] A public inquiry on the matter led to the adoption of a southern route through Yass and Goulburn.[40]

With the route agreed, construction of the pipeline finally began in June 1974.[41] The projected cost was $186 million, and the target completion date mid-1975. These aspirations were dashed by a series of industrial disputes and bad weather events, which by June 1976 had each added about three months to the timeline.[42] There were also ongoing negotiations around price, with Delhi and Santos wanting higher prices than originally agreed. Feeling pinched financially, AGL deferred commitments to construct lateral lines to country towns such as Wagga and Bathurst, causing further tensions with the federal government.[43]



DISPUTE HOLDS UP GAS LINE

SYDNEY, Sunday. — Natural gas will not begin flowing to Sydney households in August as expected because of a dispute which has already added more than $1 million to the cost of the Sydney-Moomba pipeline.

tion was adding $100,000 a day to the cost of the pipeline.

He said the purging process would take a minimum of 63 days.

The dispute began on June 7 and has now cost about $1.2 million extra in interest payments and wages.

The dispute has added weeks to the tentative August 16 deadline for

Figure 7 The Canberra Times, 21 June 1976, p. 9.

The pipeline was finally completed in time to deliver natural gas to Sydney for Christmas 1976. Described at the time as "the biggest government engineering project in Australia since the Snowy Mountains Scheme",[44] the project cost an estimated $230 million, or $1.4 billion in present-day terms.

During the saga, AGL's general manager of 21 years, Sir William Pettingell, retired on 15 February 1974. Among his parting words was a parting shot at what he believed had been direct political interference by the federal government in the pipeline project: "Political ideologies come and go", he said, "but gas companies go on forever."[45]

2.2 Conversion

2.2.1 Best laid plans

As detailed in Section 2.1.2, gas companies in Australia took various proactive measures to prepare the community for natural gas. Alongside this work, they also undertook detailed planning and preparation for the more technical and logistic aspects of the conversion.

Victoria's Gas and Fuel Corporation, which serviced the majority of Melbourne customers, engaged an American consulting firm called International Gas and Power Engineers to oversee the conversion process. The Corporation was eager to benefit from lessons learned in transitions to natural gas that had already occurred in other countries, including the United States, Canada, and Britain. There seemed to be no shortage of advice on offer. The newspaper article discussed in Section 2.1.2 titled "Britain fumes over sea gas" (published in *The Age* in December 1968) concluded by saying that "the lesson of the British and Dutch experience would seem to be this: *Make sure your technical staff know what they are doing, make sure the public understands what is happening and avoid making promises you cannot fulfil.*"[46]

In a separate article on the same page, readers were assured that the Gas and Fuel Corporation "knows what it is doing with natural gas in Victoria."[47] Indeed, by this point in time the Corporation's American contractors had already "prepared detailed conversion instructions for each of the 650 types of gas appliance installed in Melbourne". To work under the supervision of the sixteen American experts, the Corporation had assembled a workforce of 400 Australians, who included "70 fully qualified plumbers and gas fitters, who act as supervisors for the other converters, who are given a week's classroom instruction, and complete their training in the field." Following a household survey to determine which specific appliances would need to be modified, the Corporation's team prepared conversion kits containing the parts needed to convert each individual household's appliances.

Although Sydney was the last capital city to receive natural gas, AGL was highly proactive in their planning. Indeed, even before AGL had secured a source of gas, they had a timeline and a strategy for transition. In March 1967, the chairman, Mr G.C. Crane, announced that Sydney would have natural gas by 1970, and outlined the three-stage programme through which transition would be achieved. Crane explained that the first stage was already underway: "We are now supplying newly developed areas from simulated natural gas plants so that when natural gas becomes available, the changeover in these areas can be made directly."[48] In the second stage, he said, "natural gas would be used three ways": converted into town gas so that it could be used with existing appliances; supplied directly to areas that were using simulated natural gas; and supplied as-is to large industrial customers. The third stage of the transition "would cover the systematic conversion of the appliances and burners in the company's areas of supply." Meanwhile, gas stove manufacturers had already set themselves a deadline of July 1 to have all outgoing appliances ready for natural gas.[49]

Conversion date set for gas appliances

Gas stove manufacturers have set July 1, 1967 as a deadline in which to have all outgoing appliances ready for both natural and manufactured gas.

A manufacturing company spokesman said this in Sydney yesterday.

Natural gas which will be piped on a 535-mile route from fields off the Gippsland Coast, is scheduled for completion by 1970 at the latest.

The biggest problem posed by the changeover is the conversion of appliances used by 425,000 consumers.

The Australian Gas Light Company, supplier to 80 per cent of the city consumers, has already indicated that it will meet all conversion costs.

A spokesman for the company said yesterday conversions to existing appliances "won't cost the consumer a penny".

He said it was difficult to estimate how long all conversions would take, but admitted it would be "a fairly long job".

The spokesman said so far no negotiations had been made on a suggested consortium of big companies to handle the Gippsland gas. It was still at the "suggestion stage".

Figure 8 The Canberra Times, 14 December 1966, p. 33.

When 1970 came, Sydney was a still long way from having natural gas, but AGL's preparations continued unabated. In December 1970, anticipating that gas from Moomba would reach Sydney by Christmas 1972, AGL's marketing service manager was overseeing an ambitious program to test the full gamut of stoves that their technicians would encounter:

> *In a special workshop in the AGL's complex near Railway Square, two home economists who are also housewives are steadily working their way through all 850 brands and types of cooking stoves ancient and modern to be found in the Sydney area. Technicians convert a stove, hook it up to a bottle of natural gas from Roma and the good ladies cook something on it to see that the conversion works properly.*[50]

In December 1973, AGL had their eyes on mid-1975 as the date when conversions would begin. Their "plan for the lazy flame" (to use the words of a report in the *Sydney Morning Herald*) by now involved converting 1,260,000 appliances using a labour force of 600 over four years at an expected cost of $30 million ($188 million in present-day terms). The former naval captain in charge of conversions described the process as

> *. . . not technically difficult, but logistically complex. The 390,000 gas-using homes in Sydney contain 1,200 different types of cooker, 500 different*

> *water heaters, 550 fires and room heaters, and 140 different washers, boilers and refrigerators. Within each there are also differences of parts. … Each job is a different permutation.*[51]

Captain J.P Stevenson expected that "On average, the conversion force will visit each gas-using house nine or ten times. The actual conversion will require four of five separate visits spread over five days…It will be largely a problem of communication."

2.2.2 Tools rush in

Natural gas was first delivered to Melbourne in April 1969, and the conversion of household appliances was completed about 18 months later. The two gas distribution companies in Melbourne—the Gas and Fuel Corporation and Colonial Gas Company—budgeted $23 million and $5 million respectively (a total of $336 million in present terms) for the conversion process.[52] In Victoria, as elsewhere, the conversion costs were borne by the gas suppliers.

The scheduled date of 31 March 1969 for conversion day, or C-Day, was delayed until 14 April due to the late arrival of parts from England.[53] In the days leading up to the revised date, the Gas and Fuel Corporation was reportedly "working against the clock to prepare kits and parts for the first conversions." Their aim was to convert sections of 3,000 households at a time, each section taking up to three days, during which time householders would only be able to use a single hotplate burner.

115th year of publication 24 Pages Melbourne, Monday, April 14, 1969 5c (Inc. Tas. & A.C.T.)

Natural gas gets the big 'turn-on' this morning

Natural gas comes to Melbourne at 7.30 this morning.

"It's just like waiting for the start of a grand final," Mr. Norman Armstrong said last night.

"There is a tremendous air of expectancy about the whole operation.

"A lot of people have been working and waiting for this for three years," he said.

Mr. Armstrong, 38, is the chief conversion engineer of the Gas and Fuel Corporation.

He is in charge of the operation that will bring natural gas to the first 2200 Melbourne homes in the Carrum area at 7.30.

"We are quite pleased with the preparation so far.

"All the parts necessary for conversion have gone into the field and all the conversion crews are ready," he said.

The first home to be switched to natural gas will be that of Mrs. Joy Westmore, at 707 Nepean Highway, Carrum.

But the actual operation started at 2 a.m. when conversion teams assembled near Carrum railway station.

At 3 a.m. the crews started letting natural gas into the mains while burning off the town gas as it was forced out.

At 7.30 a.m. the gas fitters will begin a make-safe operation of visiting each of the 2200 houses to ensure that all gas appliances have been turned off.

They will return later to convert one hot plate boiler of gas stoves for immediate use and start conversion of other appliances.

However, no appliances, other than the single burner may be turned on until approval is given by the gas fitter. This is expected to take two and a half to three days.

All people in the conversion area have been asked to make arrangements to let the conversion engineers in but the corporation has a special team of officers to track down people who forget.

If they cannot be located and their gas meter is outside the house, gas will be turned off at the meter. If the meter is inside, the corporation has authority for an officer to enter with a policeman to turn off the gas.

Melbourne householders so far have had few problems with preconversion, according to a survey by "Age" reporters yesterday in five suburbs which have been visited by conversion fitters.

Many said gas pressure had increased after the preliminary adjustments had been made.

A man at Hampton and a woman at Brighton said they were forced to go without hot water when their gas hot water services broke down after fitters visited their homes.

But these were the only complaints to the "Age" team who visited almost 100 homes.

Conversion is in two stages. The first involves the fitting of a regulator to the gas meter, some adjustment to stoves and taking a list of other appliances which need converting.

The second is when the fitters return to complete the conversion of the stove and other appliances and turn on the new fuel.

Figure 9 The arrival of natural gas in Melbourne on 14 April 1969 was announced on the front page of The Age.

When C-Day arrived, an article on the front page of *The Age* provided the public with detail about the process, including the arrangements through which the Gas and Fuel Corporation would "track down people who forget" to let in the conversion engineers:

> *If they cannot be located and their gas meter is outside the house, gas will be turned off at the meter. If the meter is inside, the corporation has authority for an officer to enter with a policeman to turn off the gas.*[54]

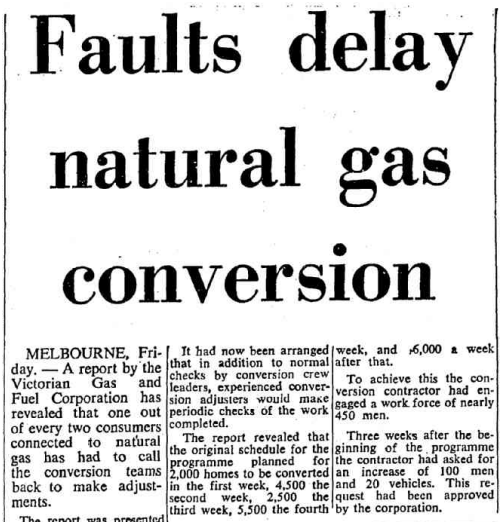
The following day's front page reported that 18 of 2,200 houses had received a visit from the CGI ("can't get in") Squad, who entered with a police officer and locksmith. Readers were assured that the Gas and Fuel Corporation would pay for any damaged caused.[55]

Figure 10 This picture from the front page of The Age on 15 April 1969 shows a policeman accompanying a locksmith picking a front-door lock to enable Gas Corporation officials to turn off the gas meter.

About two months into the process, the chairman of the Victorian Gas and Fuel Corporation, Mr A.E. Chadwick, was forced to admit that the conversion was not "all that the corporation had wanted."[56] On 12 June 1969, the front page of *The Age* revealed that:

> *More than half of the 28,000 houses already converted have been revisited by corporation workmen. Some of the houses have been visited more than six times before conversion has been completed.*[57]

Mr Chadwick said that the high number of call-backs was in part a result of a "lack of practical experience in the early days of conversion," but noted, "in addition, we have found that some makes of gas appliances do not always have standard parts, even for the same model range." The General Manager, Mr N.A. Smith, offered a different take, suggesting that the deficiency lay more with the pre-conversion household survey than with manufacturers' standards.[58]



Faults delay natural gas conversion

MELBOURNE, Friday. — A report by the Victorian Gas and Fuel Corporation has revealed that one out of every two consumers connected to natural gas has had to call the conversion teams back to make adjustments.

It had now been arranged that in addition to normal checks by conversion crew leaders, experienced conversion adjusters would make periodic checks of the work completed.

The report revealed that the original schedule for the programme planned for 2,000 homes to be converted in the first week, 4,500 the second week, 2,500 the third week, 5,500 the fourth week, and 6,000 a week after that.

To achieve this the conversion contractor had engaged a work force of nearly 450 men.

Three weeks after the beginning of the programme the contractor had asked for an increase of 100 men and 20 vehicles. This request had been approved by the corporation.

Figure 11 The Canberra Times, 28 June 1969, p. 3.

The limitations of the preparatory survey became particularly apparent when the gas companies started encountering problems with wall ovens, which on occasion were reported to explode in people's faces. In an article published in *The Age* on 3 July 1969, the Gas and Fuel Corporation's conversion engineer, Mr N.W. Armstrong, explained the problem and the difficulties in anticipating it:

> *Converted wall ovens could be explosive when both griller and oven were burning. The circulation of gases and air in the oven could cause one of the burners to go out. Gas would flow through the burner until it was ignited by the other flame. Mr. Armstrong said that when the first tests were made on wall ovens it was not possible to simulate all conditions. Neither was it possible to draw on overseas experience because the wall ovens were manufactured in Australia.*[59]

After weeks of tests conducted in cooperation with the manufacturers, the Corporation arrived at a solution, which was to "enlarge the air vents behind the stove to let in the greater amount of air needed by natural gas."[60] The solution, which required the ovens to be removed and modified at the corporation's workshop,[61] cost around ten times more than the original adjustment method.

To reduce the rate of call-backs more generally, the Corporation slowed down the rate at which conversions were performed, while beefing up the workforce by a further 100 men and 20 vehicles.[62] Meanwhile, the general manager of the Colonial Gas Association, Mr R.C. Arnold, boasted that their conversion process had gone smoothly because they had taken a more steady approach, explaining that the company had "started off at a very modest 500 [households] a week and have now built up gradually to our optimum rate of 3000 a week."[63] Mr Arnold judged the conversion process in Melbourne to be more successful than those undertaken by countries in Europe and North America, observing that "our problems have been fewer because we have gained the advantage of their experience".

By October 1969, the Gas and Fuel Corporation was converting 6,000 households per week.[64] Perhaps unsurprisingly, the corporation's original budget of $23 million proved

to be optimistic. A retrospective account published in the Canberra Times in 1979 described the process by which the program was achieved: "Working in sections, a specially-trained team of 800 men converted one and a quarter million appliances of 722 different types, in a mammoth program that cost $30 million.[65]" In present-day terms, this price tag amounts to almost $350 million.

Adelaide's conversion to natural gas begun on 19 November 1969, about seven months later than C-Day in Melbourne. The conversion in Adelaide ran smoothly overall, a success attributable in part to lessons learned from the Melbourne and overseas experiences. As Peter Donovan and Noreen Kirkman (1986) observed in their history of SAGASCO,

> *There were problems encountered in the conversion, but despite the magnitude of the task these were minor and the whole operation proceeded like clockwork. By mid-1970, more than 100,000 consumers had had their appliances converted and the project was well on schedule. The smoothness of the operation was certainly facilitated by lessons learnt from the Victorian experience, but it was due primarily to the detailed preparatory work of the Company and the consultants, and the willingness of the men and union to work extra time.[66]*

Following the lead of Victoria's Gas and Fuel Corporation, SAGASCO hired American contractors to oversee the conversion program. Working under the team of eight American supervisors was a local squadron of 240 adjusters. Before the gas arrived, SAGASCO surveyed all industrial and commercial establishments and up to 10 per cent of domestic customers to establish the material requirements of the conversion. However, consistent with the experience in Melbourne, the preparatory work was not enough to prevent unexpected problems from arising. Where Melbourne converters had to contend with poorly vented wall ovens, their counterparts in Adelaide encountered widespread gas leaks. As Donovan and Kirkman explain,

> *Natural gas is a petroleum-based product and characteristically absorbs oils and greases. In a very short time it absorbed the oily deposits from the mains which had been deposited by the coal gas, much of which had acted as a sealant at joints and earlier leaks. In particular it dried out the leather seals in meters which were impregnated with grease and in many instances these washers shrank in thickness from about 3 mm to that of a piece of paper, with the result that leaks were common. Many bills skyrocketed, much to the consternation of consumers who had been assured that the cost of the new fuel would be cheaper than the town gas.[67]*

While SAGASCO was able to follow spikes in bills find gas leaks on properties, they adopted other methods to find leaks in the broader distribution network, including the use of a 'sniffer car' fitted with gas-sensing equipment.[68]

Like the Victorian Gas and Fuel Commission, the South Australian Gas Company also underestimated the costs of converting to natural gas. Its forward estimate of $8.7 million ($104 million in present terms) represented a 45% increase over the estimate

from just a year earlier. The additional costs covered "the cost of linking up of mains and the provision of a valving system to facilitate the change-over from manufactured to natural gas."[69]

2.2.2.1 A fatal conversion

> *He found the television set on, the newly converted natural gas fire burning, and the remains of a chicken dinner on the table.*[70]

Faulty conversions in Melbourne resulted in more than just delays and finger-pointing. Barely a month after C-day, a young married couple living in the suburb of Doncaster were found unconscious in their living room. The couple had succumbed to carbon monoxide produced by a recently converted space heater. Janice Toll died after being in a coma for 37 days, while her husband, Ivan, regained consciousness after two months.

Control screw wrong for natural gas

MELBOURNE, Monday. — An air-control screw in a space heater was not of an appropriate design for natural gas, a gas expert told the coroner's court yesterday.

Maxwell Alexander Watt, officer in charge of the utilisation laboratories of the Gas and Fuel Corporation, was giving evidence at the third day of the inquest on Mrs Janice Toll, who with her husband, Ivan, was found unconscious in the lounge of their Doncaster flat on May 17 last year.

Toll tragedy would not have happened if the converted gas heater's air-control screw had not had a blade on the end.

He agreed the position of the blade did not matter as much with town gas.

Tests because of tragedy

Watt said the tests on the Toll's spaceheater, a flueless type, had been carried out because of the tragedy.

The findings from the tests had led to modifications of the conversion technique.

Figure 12 The Canberra Times, 4 August 1970, p. 7.

In response to the tragedy, the Gas and Fuel Corporation not only amended its conversion manual,[71] but also moved to ban the sale and installation of flueless gas heaters in Victoria.[72]

The newspaper records examined for this study include no mention of public anger around the incident or any pursuit of punishment or compensation through legal proceedings. The fitter who converted the heater signed a statement saying that he "neglected to bore holes down the heater's ceramics, as specified in the manual," but he also explained that the heater was of an unfamiliar design:

> *Mr Page stated he was employed by the International Gas and Power Engineering Pty Ltd to do conversion work on heaters. He had been an electrician, but when he went to work for the International Gas Company, he attended a school in Port Melbourne for a week and then spent a week in the field "with an experienced man". He said he had been doing conversion work for a month before he went to the Toll's flat. The heater was new to him in that it was the type that did not have a flue. Following the manual he dismantled it, adjusted it, put it together and tested it.*[73]

The coroner was sympathetic to the fitter, saying that "having regard to his qualifications, training and experience, little, if any, blame can be attached to him personally."[74]

2.2.3 The blame game

The coroner presiding over Janice Toll's death may have been forgiving towards the fitter who adjusted the heater, but others were quick to blame conversion faults on

those who did the work. A pair of articles published in Australia's communist newspaper, *The Tribune*, in July 1969 offered a different perspective. "While poor workmanship may cause trouble in individual cases," the *Tribune*'s Victorian correspondent explained, "the fact is that gasfitters, adjusters, and technical personnel are coping with problems created by far more important factors".[75] Amid speculation about undisclosed details of the contract between Esso-BHP and the Gas and Fuel Corporation, one of these factors concerned the quality and consistency of the gas supplied:

> *One of the causes of the conversion difficulties, in which some appliances have become dangerous after the change-over to the natural gas, is the latitude allowed to Esso-BHP in the characteristics of the gas supplied. These can, according to stories about the secret contract, vary widely from day to day. So that an appliance adjusted on one day may not be suited to the gas supply a few days later. This is a possible cause of flames going out, and explosions.*

Another alleged factor was the pressure to perform the work as quickly as possible:

> *Men employed on the conversion say that the two firms under contract to the GFC are technically competent and experienced. But they are up against the fact that Esso-BHP have all along been anxious to get their hands on the big profits as soon as possible.*

Further blame was laid at the lack of standards from manufactures:

> *Appliances are not always standard. Manufacturers often use parts intended for future models in their current production, with the result that many appliances are 'bitzas'.*

Meanwhile, the Plumbers Union emphasised the need for proper training, given the lack of experience with appliance conversions:

> *Union officials point out that — unlike USA, where natural gas conversions have been in progress in various cities for at least 20 years and there is a pool of workers with experience — Melbourne is the first city to undertake the job in Australia, and training must start from scratch.*[76]

IT'S NOT PLUMBERS WHO ARE TO BLAME

By our Victorian correspondent

MELBOURNE: Plumbers and gasfitters are angry at allegations that "shoddy workmanship" is the cause of difficulty in converting household appliances to natural gas.

Figure 13 The Tribune, 9 July 1969.

2.2.4 The domestic touch

The success of the conversion processes in Melbourne and Adelaide can be attributed in part to the gas companies' recognition that the challenge was not just one of engineering. The Victorian Gas and Fuel Corporation and SAGASCO were keenly aware that the transition was not just about modifying appliances, but also ensuring the satisfaction of end users, which at that time was primarily housewives. As mentioned in Section 2.1.2, the gas companies' efforts to engage this group of customers began well before the conversion itself. The Gas and Fuel Corporation enlisted Margaret Fulton as a champion for the new fuel, while SAGASCO gauged consumer sentiment through a survey of 300 housewives.

Mrs. Joy Westmore, of Carrum, whose home was the first in Victorian connected to natural gas, examines the identification pass of Mr. S. Stratford, a conversion engineer.

Figure 14 A clipping from The Age on 2 January 1969 shows a visit made by the Gas and Fuel Corporation in preparation for the appliance conversion process, which began in April 1969.[77]

As C-Day in Melbourne approached, the Gas and Fuel Corporation reached out to household cooks by mailing a list of menus that could be cooked on a single hotplate during the two to three days in which gas supplies might be restricted.[78] Once conversions had been completed, many housewives encountered difficulties with their appliances, whether due to poor conversions or to unfamiliarity with the new fuel. To address these difficulties, the Gas and Fuel Corporation deployed a special team of women to act as customer advisers, as an article published in *The Age* on 24 June 1969 explained:

> *A new type of doorknock project started in Melbourne yesterday. The door-knockers are supervisor Mrs. Joan Ulbrick and her team of nine mature women—in the 40 to 50-age group. They are the Gas and Fuel Corporation's new customer advisors, who will cover areas converted to natural gas. Each day they will go along one converted street after another, asking housewives if they have any problems caused by the conversion. The corporation's home economist, Mrs. Joan Barbour, said the women were chosen because of their common sense and their proficiency as cooks.*[79]

Newspapers were also an important medium through which consumers' apprehensions about the unfamiliar blue flame could be allayed. In the abovementioned article in *The Age*, the reporter wrote of her experience testing natural gas on a friend's newly converted stove:

> *I had a gay old time trying all sorts of cooking…boiling frozen peas and milk on top of the stove successful when I found out I had to turn the flame down to the merest peep, (which didn't blow out even when fanned); toasting bread under the griller (burnt, because the flame was too fierce and being long and wobbly, met overhead); heating frozen pies and cooking pastry in the oven (which wouldn't light as it should have done from the front, but otherwise was successful). A pav came out like a dream.*
>
> *Yes, there was a paler flame. Yes, it was tall and wobbly, it flicked off before the control knob went back to the Off sign. But so what, she'd get used to it, my friend said.*

Melbourne residents would have been well and truly used to natural gas by the time it reached Sydney six and a half years later. Sydney customers, however, reacted to natural gas with a mixture of cynicism and indifference. As discussed in the next section, AGL's efforts to win them over ultimately would transform both the company and its fortunes.

2.2.5 AGL's Operation Lazarus

As noted earlier, AGL were well and truly prepared for conversion by the time natural gas arrived from Moomba in December 1976. They were so well prepared, in fact, that the arrival of natural gas in Sydney was something of an anti-climax. Whereas Melbourne residents had been primed to accept plumbers into their homes and to adjust their cooking techniques, Sydney residents were told that they could continue

using their appliances as if nothing had changed. This is because the gas, despite having been piped all the way from South Australia, would be processed at AGL's Mortlake plant to assume the properties of town gas before being distributed to most customers.[80] Only in the southern suburb of Sutherland, which hosted several industrial customers, were houses converted straight away to receive pure natural gas. Next in line were domestic customers in Wollongong, where there was no plant available to produce simulated town gas.[81]

Natural gas starts today

By our Civic Reporter

Hundreds of thousands of Sydney consumers will begin using natural gas in their appliances from today.

The general manager of the Australian Gas Light Company, Mr John Robinson, said yesterday all technical checks before the gas was fed into the Sydney system had gone "according to plan."

The AGL has been testing the gas since it arrived at Wilton, near Picton, last Thursday — carried in the 1,300 km pipeline from Moomba, South Australia.

Mr Robinson said AGL had decided to process the gas at its Mortlake plant.

This would make no difference to the operation of appliances, which up to now have been running on town gas.

The processed gas would be available to 400,000 homes.

Mr Robinson said conversions would not be necessary except in areas where consumers had been informed.

The AGL would announce new tariffs next year.

These are expected to be marginally less than the 75c-78c per therm now charged for coal or oil gas.

Mr Robinson said AGL's decision to process the gas itself, instead of undertaking the "lengthy and tedious operation" of changing over 1½ million appliances, would help keep the cost of the gas down.

"A number of large industrial organisations are already changing over their operational plant from fuel oil to natural gas and they will be accelerating this in the coming weeks," he said.

Figure 15 The arrival of natural gas in Sydney was reported on page 15 of the Sydney Morning Herald, 24 December 1976.

Despite its anti-climactic nature, AGL promoted the arrival of natural gas in Sydney with great fanfare, featuring it in New Year's Eve celebrations and lighting a flame on the steps of the Sydney Opera House as part of the first Festival of Sydney, of which AGL was the principal commercial sponsor. The event is recalled by Rosemary Broomham in her history of the first 150 years of AGL:

> *There it burned, accompanied by rock music and all the trappings of modern promotional activity heralding the new era, and reminiscent of the illuminations which had announced the arrival of Sydney's gas supply on the birthday of Queen Victoria almost 136 years earlier.*[82]

Just as gaslights had been embraced as cleaner than the oil and tallow lamps that they replaced, natural gas was hailed as cleaner than coal and manufactured gas, a matter of no small importance in the environmentally aware 1970s. Nonetheless, Broomham notes the following:

> *Despite the Company's enthusiasm, the public was unmoved by the revolution that had been accomplished. Few industrial consumers immediately responded with orders and, as the General Manager M.J. Williams recalled, 'people in the domestic market didn't see any change. Sydney was still the same old place'.*[83]
>
> *Natural gas was not absorbed into Sydney's life as readily as coal gas had been; electricity and oil, both of which had a better image and widespread acceptance, were strongly entrenched alternatives…in the early years of natural gas victory was very much in doubt. Delays had made potential consumers cynical about its eventual arrival.*[84]
>
> *Natural gas offered the domestic consumer the same advantages of efficiency and economy appreciated by industry, but research carried out in 1978 revealed that in general the Company's policies had failed to*

> *remove the prejudice under which it had laboured since the 1950s. 'People didn't like us very much', observed T.G. O'Maelly. 'They thought of our product as old-fashioned, still expensive, dirty, smelly, dangerous.'*[85]

A likely factor contributing to the lukewarm reception of natural gas in Sydney was that its arrival was not accompanied by a decrease in price, as it had been in other capital cities. Residential gas prices in Sydney remained unchanged until they fell by between 5 and 16 per cent in March 1979.[86]

This drop in price coincided with AGL's launch of its ambitious and widely successful 'Living Flame' advertising campaign, the centrepiece of which was a group of blue-suited ballet dancers dancing around a giant stove. Around this time, AGL also created a New Homes Division, which "worked to encourage builders, who had largely dismissed gas, to connect it to the new estates".[87] These initiatives heralded a turn-around in fortunes for AGL. As Broomham writes,

> *In 1980 the prolonged trend for domestic disconnection of gas in favour of other fuels was at last reversed and the largest increase in this market for more than 40 years occurred in 1984. The full significance of the Australian Gas Light Company's transformation became apparent in 1981 after the first five years of natural gas. By this time sales of gas had increased by 700 per cent and the number of appliances sold by the Company had increased by 230 per cent.*[88]

Speaking in 1979, T.G. O'Meally, the Group Manager General Sales, likened natural gas to a miracle that had brought the company back from the brink of a "terminal illness" that had begun in the 1950s. In reference to a biblical account of miraculous resuscitation, he used the term "Operation Lazarus" to describe the strategies employed to revive the company. In a speech in 1986, Maurice Williams use the same imagery to describe the plight of AGL prior to the arrival of natural gas:

> *He had been rejected in the market place as being too expensive and too old fashioned. He was further weighed down by poor public image; his customers regarded him as the organisation that would not, or could not, change to meet their needs and those of the community. Governments regarded him as the purveyor of an irrelevant form of energy … Financial markets regarded him as reliable and responsible – but of little consequence.*[89]

By Williams' account, natural gas had been the saviour of the company, and indeed the state's gas industry more broadly. For AGL, the arrival of natural gas had been no mere matter of conversion, but rather one of resurrection and transformation.

2.3 Lessons for future fuels

2.3.1 Every transition is different

The experience of the transition to natural gas was different in different states, and different in capital cities as compared with country areas. In Brisbane, Melbourne, and Adelaide, the transition to natural gas occurred without serious delays or controversies, even if some effort was required to bring customers along for the

journey. An important sweetener for customers in these cities is that they saw immediate reductions in their gas prices. The experience in Sydney was very different. Early expectations that Sydney would have natural gas by 1970 were dashed as political machinations, industrial disputes and bad weather conspired to delay the arrival of natural gas until the end of 1976. Sydney customers had to wait a full seven years longer for natural gas than consumers in Melbourne, Brisbane and Adelaide, and had to wait longer still to see their gas bills fall. On the other hand, the protracted timeframe, in combination with AGL's use of simulated forms of natural gas and town gas at strategic times and places, probably helped to make the appliance conversion process smoother and less traumatic for everyone involved.

To the extent that the natural gas transition in Australia has a legacy in the form of memories and attitudes, this legacy could well be different in New South Wales as compared with other states. People who remember (or who have been told about) the transition in Sydney could be more cynical about the idea of another transition. On the other hand, the same people may have positive memories of The Living Flame campaign, which did much to turn around the image of natural gas in New South Wales.

Also, worth noting, is that in Canberra and some other inland centres, natural gas arrived more recently than 1976. Canberra did not receive a reticulated gas supply until the early 1980s. Memories of the arrival of natural gas might be more vivid and widespread in these populations.

2.3.2 Expect the unexpected

Leaving aside the ordeal of supplying natural gas to Sydney, the conversions in Australian cities went fairly smoothly, due in no small part to the intensive preparations undertaken and the lessons learnt from both overseas and local experiences. However, the experiences reviewed in this case study demonstrate how local conditions can produce unexpected complications even after extensive preparation. Melbourne's locally made wall ovens, for example, exploded only under a specific set of conditions that technicians had not thought to test.

There appears to have been differing views in Victoria's Gas and Fuel Corporation about whether better surveying and testing prior to the conversion was to blame for the exploding ovens and other technical issues that resulted in a flurry of call-backs in the early weeks. Whatever the case, it seems likely that the troubles would have been fewer, or would have at least been easier to manage, had the corporation been less ambitious in its initial conversion schedule. The pressure to convert 3,000 homes a week from the outset likely led to jobs being rushed and mistakes made. Efforts to rush delivery ended up having the opposite effect: delays.

2.3.3 Those were simpler times

The complicating factors that caused problems in the 1960s and 1970s—such as the diversity in appliances and the settings in which they were installed—are likely to be even more complicated today. Meanwhile, other changes may have made

overcoming these problems more difficult. For example, fewer houses now would be occupied during the day, and there might be less tolerance for repeat visits by service people. Also, the consumers who would need to be engaged are more diverse today than 50 years ago. Whereas gas companies in the 1960s and 1970s could target most of their communication efforts at housewives, domestic responsibilities today are not so rigidly divided. Ethnic and cultural diversity has also increased many urban populations, raising a suite of culturally appropriate engagement issues.

There is also likely to be less tolerance now for serious mistakes, or even less serious incidents that could generate offense or concern. In an era in which issues of all kinds can be amplified and politicised by social media, it is hard to imagine an incident such as the death of Janice Toll leading to nothing more than matter-of-fact reporting about how conversion practices would be changed. By way of contrast, the deaths of four tradespeople involved in the Australian Government's 'Pink Batts' home insulation scheme of 2009-10 resulted in widespread controversy and ultimately a royal commission.[90]

The gas supply chain and marketplace were also simpler at the time of the conversions than it is today. In each Australian city, there were generally only one or two domestic gas suppliers, some of which were government-owned. Where there were two, each serviced a different area instead of competing for customers. Even suppliers that were privately owned operated more or less like public utilities. In the deregulated energy markets of today, distributors and retailers may not be the same company, and many customers are likely to know more about their retailer than about their network operator. Consumers have also become accustomed to a degree of choice in their energy products, such as the ability to pay for varying amounts of renewable electricity. The public's trust in governments to act in consumers' interests, and to do so competently, has also fallen significantly since the 1970s.[91] The lack of trust is exemplified in the subsequent case studies on ethanol-blended fuels and coal seam gas development, Each provides examples of how a lack of faith in government can reduce public trust in a new product or industry.

2.3.4 Gas is political

One thing that the smoother transitions to natural gas had in common is that the gas did not cross state borders. Only in New South Wales and the ACT, where there were no gas reserves within the state, did the transition run into serious delays and complications. Difficult and lengthy negotiations ensued between various parties in New South Wales and Victoria about supply agreements, prices, and pipeline routes. Complications also arose when the federal government became involved, not only in 1973 when it assumed responsibility for the Moomba pipeline, but also in1969 when it was alleged to have meddled in the decision-making around the route of the pipeline that was originally to have delivered gas from the Bass Strait. Also, in the mix were local governments wanting to ensure that large cities were not the only beneficiaries of the new fuel.

In other words, gas is a politically charged substance, and should be handled accordingly. Debates about who does or does not get access to a new fuel, and when, and for what price, will be unavoidable. So too will be debates about who owns and controls it, and who benefits from its wider adoption. Such is the political and economic importance of gas that it may even induce decision-makers to engage in questionable conduct. In 1969, accusations of secret deals in the deliberations around the planned pipeline from Gippsland to Sydney opened up an internal rift in the federal government. The wider fallout of this rift for the natural gas industry is hard to gauge from the materials reviewed for this study, but as the accompanying case studies on ethanol and coal seam gas show, perceptions of secrecy, cronyism or conflicting interests within government ranks can be toxic for the public acceptance of a new fuel.

To observe that gas is politically charged may seem trite in the wake of recent controversies around coal seam gas and the broader debate about climate change. However, the present case study is a reminder that the political dimensions of gas go beyond highly visible environmental and identity politics that dominated some aspects of the CSG debate. Equally important are the politics of distributive and procedural fairness. These themes will be examined further in the next two case studies.

2.3.5 Communication is key

As discussed earlier, the former navy captain in charge of AGL's conversion program in 1973 described the operation as, "largely a problem of communication". Likewise, the advice offered in *The Age* newspaper in 1968 in light of overseas experiences—*Make sure your technical staff know what they are doing, make sure the public understands what is happening and avoid making promises you cannot fulfil*—essentially boils down the challenge of gas conversion to a formula that is one part technical and two parts communication.

It goes without saying that technical preparation and competence are essential components of a successful conversion program. Clearly though, the challenges of conversion go well beyond engineering. The conversion programs reviewed in this case study include examples of communication and engagement initiatives undertaken before, during and after the appliance conversion process. These initiatives—which included SAGASCO's survey of housewives' attitudes, the Gas and Fuel Corporation's all-women team of customer advisors, and AGL's 'Living Flame' advertising campaign—were integral to these companies' efforts to understand, assist and convince their customers, and thus to the ultimate success of their conversion programs.

The communication environment in which any future gas conversion takes place will be far more complex and fraught with risks than that of the 1960s and 1970s. Successfully navigating this environment will be one of the biggest challenges to overcome in any future fuels development.

2.3.6 Gas conversion is expensive…

The Gas and Fuel Corporation of Victoria spent close to $350 million in present-day terms on its conversion of 435,000 households and 1.25 million appliances. This amounts to about $800 per household, or $280 per appliance. The relative expenditure by the Colonial Gas Association is likely to have been similar. While the final spend was not reported in the newspapers examined, Colonial Gas budgeted about $58 million in present-day terms to convert its 80,000 households, amounting to $725 per household.[92] AGL's projections in 1973 of converting 390,000 households containing 1,260,000 appliances for $188 million equates to the considerably lower price of $482 per household and $149 per appliance. The decision to spread the process over four years rather than the 18 months it took to convert Melbourne, Brisbane and Adelaide, could have been a factor in the lower projected expense.

2.3.7 …but it can be transformative

The transition from town gas to natural gas was much more than a change of fuels. It fundamentally changed the nature of the gas industry, shifting the central task from manufacturing to distribution. In the wake of the change, whole workforces were restructured, and a whole line of gas manufacturing plants closed down. In New South Wales, the new fuel not only changed the industry, but by some accounts, more or less saved it. The opportunities presented by natural gas, and the efforts to promote it, were central to AGL's return from the brink under Operation Lazarus.

The challenge facing the gas industry today is not unlike the challenges described in Broomham's (1987) account of AGL in the 1960s and 1970s. Natural gas, a product once hailed as cleaner than and superior to the product it replaced, is now coming to be viewed alongside coal and oil as a fossil fuel in the fullest sense—that is, a fuel that represents the past and has no place in a decarbonised future. To remain relevant, the gas industry today may need to embark on its own Operation Lazarus, using one or more future fuels as the catalyst.

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3 THE USE OF ETHANOL AND LPG AS MOTOR FUELS

Case study 2 – Ethanol and LPG as motor fuels

How and when were the fuels introduced?

Petrol has long been the dominant motor fuel in Australia, but alternatives have occasionally been promoted by governments and fuel suppliers. Notable examples are ethanol—a biofuel often made from grains or sugarcane—and liquid petroleum (or propane) gas, otherwise known as LPG. Proponents of these fuels argue that they produce fewer greenhouse emissions and other pollutants, while governments have supported them to boost fuel security and local industry.

For a brief period in Queensland in the 1930s, Shell sold a petrol-ethanol blend under the name of Shellkol. Ethanol blends (typically 10 per cent ethanol, or E10) resurfaced at independent petrol stations in northern Queensland the late 1980s and in New South Wales in the early 1990s. Assistance from state and federal governments at this time helped the industry to grow, while favourable tax treatment kept the price of ethanol below that of petrol. LPG became widely available in the late 1970s, also helped by government support and tax exemptions.

What issues and challenges emerged?

As petrol prices rose in 1999 and 2000, some independent 'cowboy' retailers took advantage of loose regulations by pushing their ethanol blends to as high as 20 per cent. Concerns about engine damage caused a backlash among consumers. The federal government, however, was slow to tighten regulations and to seek clarity from vehicle manufacturers about engine compatibility. Making matters worse, perceptions arose that the federal government was pandering to the country's main ethanol producer, who also happened to be a major political donor.

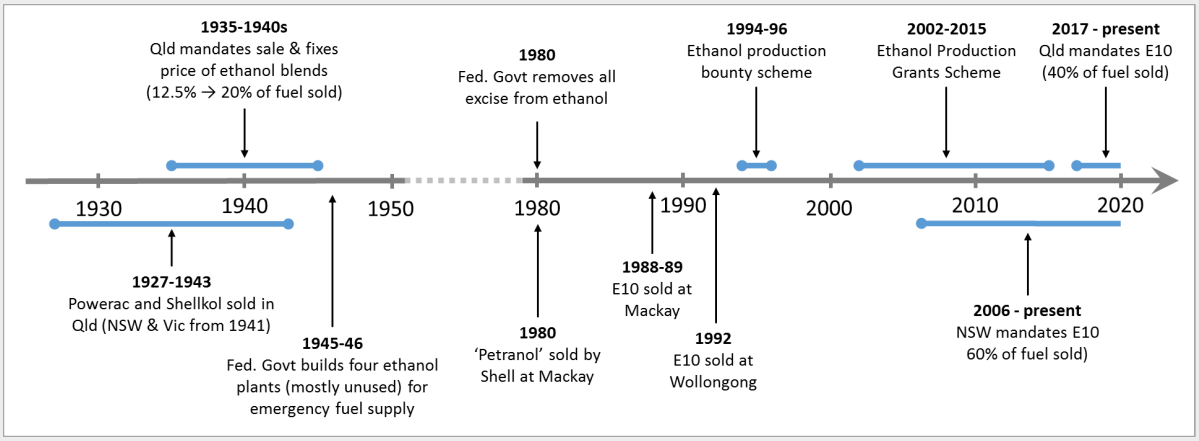
Consumer demand for ethanol rebounded the mid-2000s on the back of surging petrol prices. Eager to promote their local sugar and grain industries, the Queensland and New South Wales governments introduced mandates to enforce the sale of E10 at service stations. By and large, these mandates failed. Ethanol production has been constrained by feedstock availability, while consumer demand has remained low due to ongoing distrust and marginal price differences. When regular unleaded 91 octane petrol (ULP 91) was removed from petrol stations in New South Wales, many motorists switched to expensive premium fuels to avoid using ethanol blends.

LPG survived a safety scare in 1979 to become a trusted fuel, especially among taxi drivers and fleet operators who could quickly recover the upfront costs of engine conversion. Generous rebate schemes in the mid-2000s made LPG popular even among regular drivers. However, demand for LPG collapsed when the rebate and tax exemptions were phased out. Also contributing to LPG's demise was the emergence of new diesel and hybrid electric technologies, as well as a shift towards smaller cars.

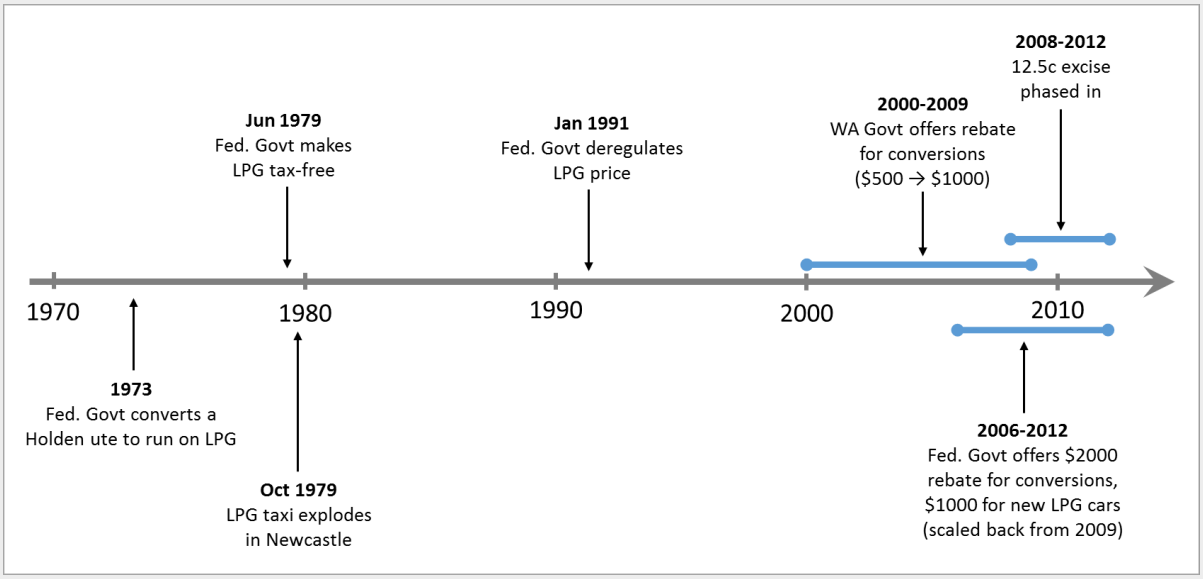
What are the lessons for future fuels?

- *Trust requires good governance as well as good behaviour.* The ethanol industry was undeniably burned in the years around 2000 by the actions of a few 'cowboy' operators. Equally damaging, however, was the failure by governments to reign in the industry and reassure motorists that their interests (rather than those of ethanol producers) were being protected. The relative ease with which LPG shook off early safety concerns provides an interesting contrast.

- *Price is powerful, but trust can trump it.* When ethanol and LPG were cheap (at least relative to petrol), they were popular. However, the willingness of motorists in New South Wales to switch to premium fuels rather than use E10 shows that distrust in a fuel can override its economic advantage.
- *Mandates are not magic*. Mandating the sale of a fuel may increase its consumption but will not overcome natural limits imposed by supply and demand. Mandating amid a lack of supply will make the mandate unenforceable, while mandating amid a lack of demand could make the product even less popular.



Key events and policies relating to the automotive use of ethanol in Australia



Key events and policies relating to the automotive use of LPG in Australia

3.1 Approach to the case

The aim of this case study is to examine the approaches that governments, producers and retailers have used to promote alternative motor fuels to petrol (or gasoline). The case reflects on how successful these approaches have been. Although the case study focusses primarily on ethanol, it also includes a brief discussion of LPG. Ethanol is the main focus of this chapter, because it has been the most controversial and widely used of the alternative motor fuels in Australia (at least in terms of the number of cars, if not overall volume). In addition, the scope of the chapter has been limited in order to offer a more in-depth analysis of the dynamics between promotional strategies and consumer responses.

This case study draws on two tranches of information. The first is technical or policy reports about biofuel policies written by government departments or other organisations. The second is newspaper reports obtained from the Factiva database. The latter have been consulted to paint a more detailed and vivid picture of how the debates played out in the public arena at the time that they occurred.

This case study is structured to be roughly chronological while permitting focussed discussions of specific themes. After a brief background on ethanol and biofuels, Section 3.2.2 examines the automotive use of ethanol in Australia up until the late 1980s, when the current era of ethanol use could be said to have begun. Section 3.2.3 looks at the largely unregulated but government-encouraged sale of ethanol-blended petrol that proliferated in the 1990s and early 2000s. This period left a legacy in terms of consumers' trust in alternative fuels. Section 3.2.4 examines how the federal government supported and subsidised ethanol production from the early 2000s, and highlights some of the actions and relationships that led to widespread perceptions of political favouritism and a further erosion of consumer trust. Section 3.2.5 examines the upturn in ethanol sales that occurred amid intensive promotional efforts and high oil prices between 2004 and 2007, while Section 3.2.6 explores the impacts of laws introduced in New South Wales and Queensland to mandate the use of ethanol in petrol.

LPG is discussed in Section 3.3, which briefly reviews issues relating to safety, economics, and competing technologies. Finally, Section 3.4 presents the lessons that the case study holds for future fuel developments.

3.2 Biofuels

3.2.1 A brief background

In Australia, as in most parts of the world, petrol (or gasoline) has long been the most widely used fuel for motor vehicles. Petrol, however, has well-known drawbacks. As a fossil fuel, it produces carbon emissions that contribute to the greenhouse effect. In addition, it produces particulates and other compounds that degrade air quality. It is also largely imported and subject to shocks and fluctuations in global petroleum prices.

These drawbacks have led to various efforts over the last century to promote the use of alternative motor fuels. One type of alternative fuel that has been promoted is biofuels, specifically ethanol and biodiesel. Another is liquid petroleum (or propane) gas, or LPG. Efforts to promote these fuels have met with varied success. Today, biofuels still account for a very small percentage of fuel use in Australia, while the use of LPG is steadily declining.

Ethanol is a biofuel composed of the same kind of alcohol as that found in alcoholic drinks. It can be manufactured petrochemically from oil or natural gas, or biologically through the fermentation of sugars with yeast. Ethanol fermented from biomass such as sugarcane or corn, is a renewable biofuel and is used in many countries as an additive to petrol. The most commonly used blend is E10, which contains 10 per cent ethanol by volume and can be used without issue in most vehicles. Also available in some countries is E85 (85 per cent ethanol), which can only be used in specially designed cars.

Biodiesel is made from animal or vegetable fats through a process called transesterification. Common feedstocks include canola oil, soybean oil, and tallow. While pure biodiesel (B100) can be used in some engines, more often biodiesel is blended with petro-diesel, most commonly at concentrations of 5 or 20 per cent.

Biofuels have long been of interest as an alternative to fossil fuels. Since the early 20th century, biofuels have been considered as a means of reducing dependence on imported oil while promoting local industry. Biofuels may also offer environmental benefits, such as a reduction in particulate emissions and greenhouse gases. Although biofuels produce carbon dioxide when burned, the same amount of carbon is absorbed from the atmosphere when the feedstock is produced. However, the greenhouse benefits of biofuels are offset by other inputs to their production, such as the energy required to farm the feedstock (if it is not a waste product) and to ferment and distil the fuel component. A review conducted by the Australian Government's Biofuels Taskforce in 2005 concluded that the greenhouse gas emissions produced from a 10 per cent ethanol blend would be between 0.7 and 4.2 per cent lower than those produced from regular petrol, assuming that the ethanol was derived from wheat or molasses.[1] As with the greenhouse credentials of biofuels, scientists have reached differing conclusions regarding their impacts on air quality.[2]

The social and environmental merits of biofuels have also been challenged on the grounds that their production may compete with the production of food, thus pushing up food prices. The 'food versus fuel' debate has motivated the search for a second generation of biofuels that can be produced from non-food feedstocks such as algae and wood biomass.[3] However, these have seen limited commercial development to date.

Despite the questions and challenges surrounding biofuels, governments around the world have introduced policies to promote their use, whether through targets, mandates, financial subsidies, favourable tax treatments, or some combination of

these measures.[4] The reasons for promoting biofuels typically relate to energy security, environmental concerns and regional economic development.

3.2.2 From Powerac to Petranol: early biofuels use in Australia

While the current status of biofuels in Australia has emerged from market and policy developments occurring in the last few decades, the use of ethanol as a fuel in Australia has a much deeper history. In the late 1920s, Shell, in cooperation with the Australian National Power Alcohol Company, opened a plant to produce ethanol—then known as *power alcohol*—alongside a sugar mill at Sarina, near Mackay.[5] Shell started distributing an ethanol-petrol blend branded as Powerac in early 1927. Amid rumours that the blend could damage carburettors, Shell quickly reformulated it and rebranded it as Shellkol,[6] which it distributed in Queensland from 1929 and launched in Sydney and Melbourne in 1941.[7] The concentration of ethanol in Shellkol was not publicly disclosed (at least not in newspapers), but blends of 15 per cent ethanol were in use at the time.[8] The extensive newspaper advertising of Shellkol in the early 1930s, an example of which is reproduced below, could be an indication that consumers were in fact reluctant to trust the new fuel. Shellkol appears to have been discontinued in the early 1940s.[9]

By mid-1932, the Sarina distillery was operating at well below capacity and faced the prospect of closing without greater demand.[10] Lobbying to the federal government elicited sympathy but no support in the form of subsidies or a national requirement for oil companies to incorporate ethanol into their products.[11] The industry's lifeline came in the form of legislation by the Queensland Government requiring motor fuel vendors to "to purchase one and one fifth gallons of power alcohol for every 100 gallons of petrol marketed"—that is, a mandate that ethanol account for 1.25 per cent of all fuel sold.

Scepticism abounded about how successful the mandate would be. A column in Lismore's Northern Star in February 1935, predicted that motorists would stick to regular fuels, noting that "In the far north, alcohol petrol fuel has proved fairly popular, but in central and southern Queensland it has never taken on to any great extent."[12] In September 1935, the Queensland Government fixed the price of alcohol blends to be cheaper than regular petrol, apparently to little effect. According to the Courier-Mail, "Leading garage proprietors reported that the majority of customers cheerfully paid the extra half-penny, and 'stuck to their favourite grades'".[13] Nonetheless, the quantity of ethanol produced in Queensland increased ten-fold in the following five years, during which time the mandated amount of production increased to two per cent.[14]

Figure 16 An advertisement for Shellkol, a petrol-ethanol blend, printed in The Telegraph on 18 February 1930, p. 7.

In the mid-1930s, the federal government began to explore the merits of developing a national policy to develop the power alcohol industry. At least two commissioned reports downplayed the opportunities that the industry presented. A report prepared in 1935 by Mr L.J. Rogers, the Commonwealth Fuel Oil Expert, about the possibility of producing ethanol from wheat and other surplus cereals found that "the establishment of such an industry would be economically unsound and not suitable for defence purposes."[15] A report from the Council for Scientific and Industrial Research (the precursor to CSIRO) concluded that ethanol in Australia could not compete economically with petrol, and that an industry could not be viable without legislation compelling its use, citing experiences in other countries.[16] Rogers again

advised in 1938 that "the production of power alcohol as a substitute for petrol is intrinsically uneconomic, and the industry can be justified, if at all, only by considerations of a national and defence nature."[17]

Defence considerations quickly came into play as World War 2 broke out in 1939. As an insurance policy against being cut off from fuel imports, the federal government built four new distilleries in Cowra (NSW), Warracknabeal (Victoria), Wallaroo (SA) and Collie (WA). Owing to a shortage of wheat, three of these never produced any ethanol, and the Cowra plant operated at below capacity.[18]

Interest in an Australian biofuels industry rose again in the 1970s amid skyrocketing petrol prices brought about by the oil crisis.[19] At this stage, ethanol was already being produced from corn in the US, and Brazil had begun to develop a state-sponsored ethanol industry based on sugar cane.[20] However, a report produced by CSIRO in 1979 found that renewable biofuels were at that time uneconomic in Australia and were likely to cost twice as much as petroleum-derived fuels. Nonetheless, the report recommended that research into biofuels continue, for reasons that included the need to move away from fossil fuels in the event that "future research showed that rising carbon dioxide levels in the atmosphere were likely to have deleterious effects on climate."[21]

In 1980, the federal government introduced what would arguably be the most consequential piece of legislation for the future ethanol industry by exempting ethanol used as a motor fuel from the customs and excise duty of 19.25 cents per litre that applied to ethanol used in drinks.[22] This gave ethanol a tax advantage over petrol, which at the time was subject to an excise of around five cents per litre.[23]

Government interest in biofuels subsequently waned,[24] but not before CSR and Shell had run a successful trial selling a 10 per cent ethanol blend called Petranol at service stations in Mackay.[25] The trial showed that motorists accepted the fuel. However, in a warning that would prove to be prophetic, a researcher at Melbourne University said that without a proper evaluation of mechanical and economic factors,

> *it seems likely that ethanol use might be restricted to small-scale use, not making a significant impact on a nationwide scale as a hydrocarbon substitute, and possibly leading to user dissatisfaction in the event of poor quality-control.*[26]

Another warning that would prove to be prescient was that given by a Canadian biochemist speaking in Melbourne in 1980 about the ethical implications of converting cereal crops to fuel when the world could be facing a global food crisis.[27]

3.2.3 Cowboys and bounty hunters

The late 1980s saw the opening of a new frontier for biofuels in Australia. As early as January 1989, the Queensland Government was working with a company called Queensland Science and Technology Limited (QSTL) to explore the feasibility of an ethanol industry in the state. QSTL, which was on the verge of collapse without government investment, proposed to use local sugar cane as a feedstock, which was

an appealing prospect for an industry that had become sensitive to global price fluctuations.[28] Claiming the potential to produce 300 million litres of ethanol a year, QSTL said that only political will was preventing the industry from going ahead, noting that the Queensland Government had existing (though long dormant) powers to direct oil companies to add ethanol to all petrol sold. The Australian Cane Growers Association was supportive, claiming that a 10 per cent blend of ethanol in petrol would lead to better air quality outcomes, while boosting the octane level.[29]

The Queensland Government, however, was cautious. The premier, Mike Ahern, was sceptical about the economic viability of the industry. He also wanted to avoid perceptions of cronyism, as two board members of QSTL were closely connected with the previous premier, Sir Joh Bjelke-Petersen, whose reign of two decades ended amid numerous corruption scandals. Ahern also resisted calls to use the government's powers to compel ethanol blending, preferring to rely on persuasion than on force.[30]

By mid-1989, petrol containing 10 per cent ethanol had already been sold for 15 months in a trial at three petrol stations in Mackay "with no notable difficulties in mixing and distributing the blend".[31]

The ethanol industry in New South Wales can be traced to the building of an ethanol plant at Nowra by the Manildra Group in 1991. The plant took starch effluent from Manildra's wheat processing operations. The New South Wales Government was at this time warming to the possibilities of an ethanol industry, offering in 1990 a $2 million research grant to develop technologies that could reduce production costs.[32]

At least as early as September 1992, petrol blended with 10 per cent ethanol from Manildra's plant was being sold at seven independent service stations in Wollongong. The Sydney Morning Herald reported that consumers took well to the product, or at any rate were not concerned about it:

> *"At the moment its going extremely well," Manildra's technical manager, Mr Geoff Grace, said. "At these stations, the buyer has no choice – it's blended both with leaded and unleaded fuel and we're not getting any consumer resistance at all."*[33]

The success was such that in 1994, the Bogas company introduced the 10 per cent blend, known then as gasohol, in 23 of its service stations in the Central Coast and Newcastle area. As Ken Bowen, the managing director of Bogas, explained:

> *We sell all the fuel in super leaded and unleaded blends at the same price as petrol. The response is great because customers see it as a green, renewable fuel made from an Australian commodity.*[34]

As had been the case in the 1930s and 1970s, ethanol was still substantially more expensive to produce than petrol. Retailers such as Bogas were only able to make a profit from ethanol blends, and to price them on par with petrol, because ethanol was exempt from the fuel excise that applied to petrol, which was about 34 cents per litre in the 1990s.[35] In addition, these retailers were able to take advantage of a bounty

scheme, introduced by the Keating government in 1994, that paid out 17.5 cents per litre of locally produced ethanol.

The rollout of gasohol in New South Wales was not without hiccups. Ken Bowen noted that "about once a month a customer would suffer a clogged fuel filter because ethanol tended to clean out fuel systems."[36] Bogas also encountered an issue that was unique to one of Australia's most iconic cars:

> *Many Ford Falcon owners reported that after they filled their tanks with the stuff, their fuel gauges went haywire. It turned out that the problem was not with the fuel but with a motoring oddity peculiar to many Falcon fuel gauges: while other cars use a float system, these models have an electronic probe that responds strangely when too much ethanol is present.*[37]

So popular was the Ford Falcon that this issue forced Bogas to reduce the concentration of ethanol in their fuel to seven per cent. Bob Beale, a journalist for the *Sydney Morning Herald*, wondered if the issue could be an omen of things to come:

> *It remains to be seen whether that act turns out to be symbolic of the way Australia embraces fossil-fuel substitutes. It can be said, however, that for a nation priding itself on a high level of public awareness of environmental issues, Australia has been notably slow to explore the potential of this renewable fuel additive.*[38]

The economics of ethanol became more challenging in 1996 after the newly elected Liberal-National Coalition Government, led by John Howard, scrapped the ethanol bounty. The government claimed that the bounty had "failed to achieve its objective of establishing a robust fuel ethanol industry" and concluded that "a fuel ethanol industry would be unlikely to survive without government subsidy".[39] John Howard went as far as to accuse the Australian Democrats of "flogging a dead horse" for continuing to support the bounty.[40]

Over the course of 1999 and 2000, ethanol had a resurgence as the global oil price rose (see Figure 17). This new price environment incentivised the blending of ethanol into petrol. Without state or federal regulations to limit such blending or require its disclosure, some independent retailers in Sydney and Brisbane began blending ethanol at levels higher than 20 per cent, while many more (mostly around Sydney) sold weaker blends without informing customers.[41]

Figure 17 The global crude oil price in US dollars per barrel, adjusted for inflation. (Source: https://www.macrotrends.net/1369/crude-oil-price-history-chart)

Organisations such as the Australian Competition and Consumer Commission (ACCC) and the Australian Automotive Association condemned such practices as both deceptive and dangerous in light of the broadly accepted view that blends of more than 10 per cent ethanol could damage many cars.[42] However, the federal government resisted calls for regulation to limit ethanol concentrations to 10 per cent. In December 2002, when Cabinet voted against a 10 per cent limit, John Howard said that the evidence for such a limit was "not sufficiently compelling",[43] and suggested that the issue of labelling be handled by the states.[44] Meanwhile, the government had its own ethanol taskforce exploring the possibility of allowing blends as high as 20 per cent ethanol.

Frustrated by government inaction, the NRMA set up its own 'ethanol hotline' to gather evidence from members who had experienced mechanical problems after using ethanol blends.[45] In January 2003, an article in the Sydney Morning Herald observed:

> *The Government may have damaged Australia's wider interests by waiting until yesterday to insist on clear labelling of ethanol at the petrol pump. The public has been made needlessly apprehensive.*
>
> *A Coalition Government may well decide that happy farmers and reduced dependence on oil are an electorally attractive blend. But it may also discover significant public resistance to ethanol as an additive at any concentration because it moved so slowly to curb the sale of unlabelled, potentially damagingly high-ethanol fuel.*[46]

While the controversy around uncapped ethanol limits played out in New South Wales, BP began selling a 10 per cent blend, branded as E10, at six of its service stations in Brisbane in mid-2002.[47] BP had planned to expand the sale of E10 to 50 more

service stations across the state, but by February 2003 were forced to pull the product entirely after sales plummeted amid reports of cars being damaged in New South Wales.

As a headline in the Australian Financial Review put it, BP had been "burnt badly by Sydney's ethanol cowboys."[48] A BP spokesman said that "while the trial of E10 had been a 'technical success' because no harm had been done to car engines, it was clear consumers had lost confidence in the fuel."[49] According to a survey done by BP, only a quarter of motorists were confident that ethanol would *not* damage their cars. Soon after BP had pulled E10 from its petrol stations, the independent chain Neumann's followed suit, leaving no petrol outlets in Queensland selling ethanol blends.[50]

Independent petrol retailers, who in New South Wales had been the only ones selling ethanol blends, were forced to go on the defensive to regain consumer trust. In early 2003, many retailers began erecting signs advertising that their petrol contained no ethanol.[51] As Figure 18 illustrates, such signs were still a fixture in Western Sydney many years later.

Figure 18 A petrol station in Western Sydney in 2012 reassures customers that their fuel contains no ethanol. (Source: https://www.carsguide.com.au/car-news/biofuel-and-e10-fails-to-ignite-motorists-20066)

In April 2003, having confirmed that ethanol blends of 15 and 20 per cent were indeed damaging to many engines, the federal government finally committed to ban blends of greater than 10 per cent, and to require labelling of ethanol content at the pump.[52] The move was welcomed from all quarters, but some commentators, such as the RACV's government relations manager, lamented that it had come too late:

> *We're glad to see common sense prevail. However, we would say that the product was introduced in such a poor way, the policy was introduced in such a poor way, that I'm not certain that there actually is a market for ethanol anymore, because the public has no faith in it.*[53]

Public trust in ethanol blends was further eroded in September 2003 by the leaking of a "secret government list" compiled by the federal government's ethanol working group warning that as many as 40 per cent of the cars on Australian roads, including models as recent as 1998, should not use ethanol. While some observers interpreted the list as a sign that car manufacturers were being overly cautious, both its contents and the secrecy surrounding it (the government had apparently sat on it for a month and refused to say when they would release it) only served to increase consumers' fears. RACQ, the peak motorists association in Queensland, urged its members "to avoid ethanol until they got clear and reliable information".[54]

3.2.4 Mates over motorists

Despite dismissing the economic viability of the ethanol in 1996 when axing the bounty scheme, the Howard government continued to support the biofuels industry. In 2001, the Coalition's re-election platform included an aspirational commitment to increase the country's biofuel production to two per cent of all fuel produced (or around 350 million litres a year) by 2010. The government also introduced a capital grants scheme to support the development of new ethanol and biodiesel plants. They also maintained the favourable tax treatment for ethanol, albeit in a modified form that protected local producers from cheaper imports. While previously all ethanol had been exempt from the 38.5 cents per litre excise (which was frozen against inflation from 2001 to 2014), the new scheme introduced in late 2002, which became known as the Ethanol Production Grants Scheme (EPG), applied the full excise to all ethanol but reimbursed local producers the full amount, thus ensuring that imported ethanol could not compete with the local product.[55]

Although always intended as a temporary measure to develop the industry to a point where it could stand alone, the EPG was repeatedly extended, not only by the Coalition government in 2003 and 2004, but also by the minority Labor government in 2011. Both governments maintained this financial support to the ethanol industry in spite of repeated advice to the contrary. For example, in 2003, when the government was debating the EPG and other subsidies for the biofuels sector, a submission to Cabinet from the Department of Finance which stated that

> *Finance does not support the inclusion of measures relating to ethanol production in this package…The measures…will do nothing for the sugar industry…offer no quantifiable environmental benefits, appear poorly targeted, impose significant costs on other Australian industries, especially rural and regional industries, and will potentially result in significant costs to the budget.*[56]

Along similar lines, a submission from Treasury noted that "ethanol is an inferior product to petrol, having only 60 per cent of the energy content of petrol, potential operability problems and, currently, significantly higher production costs than petrol." Even more

blunt was the assessment from David Trebeck, who had chaired the Government's Fuel Tax Inquiry in 2001, when he described ethanol subsidies as "one of the craziest examples of public policy I've come across in 30 years".[57]

A review being conducted at about the same time by CSIRO and the federal departments of Transport and Agriculture concluded that ethanol and other biofuels could not survive without "substantial and ongoing assistance", noting that "a full-scale ethanol industry would create fewer than 500 jobs but would cost the nation about $70 million annually to support".[58] The report also found that the benefits of ethanol subsidies to regional communities were "commonly overstated and difficult to predict", and that the environmental and health benefits of ethanol-blended fuels were minimal.

In August 2005, the government's own Biofuels Taskforce handed its report to the Prime Minister. Similar to previous assessments, the report questioned the long-term economic viability of biofuels without continuing assistance and found that the possible benefits to the environment and agricultural industries were not worth the expense. The taskforce estimated that each job created would cost $139,000 in public funds.[59] In 2008, a detailed analysis of Australia's biofuel subsidies undertaken by the Global Subsidies Initiative came to a similar conclusion, finding that "support for biofuels is not a particularly efficient means to achieve many of the policy objectives for which it has been justified."[60]

Many of the Howard government's own ministers were outspoken opponents of the generous subsidies provided to the biofuels industry, which by their nature were contrary to the free-market principles that the Liberal Party espoused.[61] Support for the industry from within the Coalition came primarily from members of the National Party, whose constituents included many of Queensland's cane farmers and allied industries. Similarly, the Labor Government's decision to extend the EPG in 2011 was part of a deal with independent MPs who represented regional interests.[62]

However, to many observers, the federal government's support for the ethanol industry owed much to negotiations taking place outside of the parliament. Starting in 2002 (if not earlier), a perception began to emerge that the government was, in the words of the Opposition Treasury spokesman Bob McMullan, "putting mates over motorists."[63]

In late 2002, at the time the government was delaying moves to cap and label ethanol blends, leaked memos tabled by the federal opposition suggested that the government was resisting a 10 per cent cap on blended ethanol in order to protect the interests of Manildra, which was a generous financial donor to both sides of parliament (but favouring the Coalition).[64] In the parliamentary debate that ensued, further documents emerged suggesting that legislation introduced in September 2002 to protect local ethanol producers may have been crafted at the prompting of Dick Honan, who had written to John Howard in August about a shipment of ethanol that was on its way from Brazil to supply Trafigura, a competing fuel supplier. Howard

changed the excise laws while the ship was still in transit, forcing Trafigura to sell the ethanol for a $600,000 loss.[65] A year later, Howard was forced to defend himself against allegations that he had misled parliament, after documents emerged showing that he had met personally with Honan on more occasions in 2002 than he had previously admitted.[66]

Concerns about Manildra's influence resurfaced in July 2003, when Cabinet was discussing a $50 million package of subsidies for new biofuel plants. Dick Honan had lobbied the government on the grounds that he would be forced to close Manildra's Nowra plant without continued government support. Writing in the Australian Financial Review, Laura Tingle claimed that "sections of the government are appalled at what is seen as the blackmailing, in effect, of the government by Manildra which accounts for about 90 per cent of Australia's ethanol production".[67]

To the present day, Manildra has remained the largest of just three ethanol producers in Australia, and the largest sole beneficiary of the various policies and subsidies that have been introduced to assist the biofuels industry. Between 2002 and 2015, Manildra received more than $600 million in government rebates.[68] Meanwhile, Manildra has remained a generous donor to state and federal political parties. Set against the lack of clear benefits flowing to motorists or the environment, these political circumstances have contributed to widespread cynicism about the merits of ethanol and the motivations for its support.

3.2.5 E10 bounces back

After initially positive public responses to ethanol-blended fuels in the 1990s, consumer acceptance had crashed in the wake of unregulated use and perceptions of political favouritism in the early 2000s. However, the years from 2004 to 2007 saw something of a renaissance for ethanol.

In mid-2004, the Queensland premier, Peter Beattie, became a forceful advocate for E10, instructing his government's car fleet to use it wherever possible while also lobbying the federal government to mandate its use.[69] Meanwhile, Manildra and the Australian Biofuels Association had both commenced advertising campaigns to promote ethanol fuels and bust supposed myths discouraging their use.[70]

In 2005, the Queensland Government launched an Ethanol Industry Action Plan which included more than $2 million to promote better community awareness of and trust in ethanol fuels. The motor racing legend Sir Jack Brabham was enlisted as a spokesman.[71] The Queensland Government also provided grants to help service stations upgrade their infrastructure to make E10 available.[72]

At the federal level, John Howard secured the agreement of oil companies to set and voluntarily work towards targets that would satisfy the Government's own aspirations of reaching 350 million litres a year by 2010.[73] The federal government's biofuels taskforce finally moved to allay concerns about damage to engines by announcing its findings that the ethanol was safe for the majority of cars on the road.[74] Car makers did their bit by announcing that all new models would be compatible with E10.[75]

Also helping ethanol's fortunes at this time was a climbing crude oil price (see Figure 17). In 2006, petrol prices became a huge political issue: the "number one barbecue-stopper" in the country according to one report,[76] and in the Prime Minister's own words, the greatest worry of his political life.[77] This added further fuel to Peter Beattie's enthusiasm, who even speculated about exporting ethanol to Asia. "The planets are lining up here," he told the Ethanol 2006 Australia conference. "This would not have been possible to do some years ago because of the oil price, but oil is now through the roof, so ethanol is a genuine, affordable alternative."[78] In August 2006, the federal government announced a $1.6 billion package to lower fuel prices, which included incentive grants for service stations to supply ethanol and capital grants for infrastructure upgrades.[79]

Price was the major selling point for ethanol at this time. The NRMA, which had previously been cautious about E10, called for it to be available at all stations to help keep petrol affordable.[80] E10 was indeed usually cheaper than regular unleaded—but usually only by a few cents per litre, which the RACQ and others pointed out was not enough to compensate for the lower energy density of ethanol.[81]

Over this time, consumption of ethanol increased. According to data collated by Quirke et al. (2008), Australian ethanol production fell from 57 million litres in 2002-03 to 28 million litres in 2003-04 and 24 million litres in 2004-05, but then bounced back to 40 million litres in 2005-06 and 84 million litres in 2006-07. In June 2005, E10 was available at only 49 service stations in Queensland; a year later, it was available at 131 stations, and at 181 stations by December 2006.[82] In June 2008, 330 of Queensland's 1,600 petrol stations stocked E10.[83]

This period provides evidence that, at least when combined with favourable market conditions, government actions such as production targets, public education campaigns, car fleet policies, and capital and incentive grants for petrol stations, had a positive impact on ethanol consumption. In the middle of 2007, however, there was still a large gap between the amount being produced and the federal government's target of 350 ML per year.

3.2.6 Messy mandates

In 2005, the report from the federal government's Biofuels Taskforce made the following observation in trying to explain why ethanol production had continually fallen short of the government's target:

> *Under current market conditions, and with no consumer demand, oil majors have little commercial incentive to promote ethanol blends as a bulk fuel. But without contracts for sales to oil majors, new ethanol producers cannot invest in bulk fuel ethanol production.*[84]

Faced with low demand for ethanol, one policy option that the federal government had available, but which it had consistently resisted, was to create demand artificially by mandating its use. Mandates for ethanol and biodiesel have been used to promote biofuels in various parts of the world (including Queensland in the 1930s, as

discussed earlier), and typically work by requiring biofuel to comprise a certain percentage of all fuel sold to or by retailers.

One reason why successive Australian federal governments have resisted calls for an ethanol mandate is to protect consumer choice.[85] In addition, a mandate would be financially expensive, as it would increase consumption of a subsidised product. As a report on the economic impacts of an ethanol mandate, prepared in 2008 by the Department of Parliamentary Services, explained:

> *A mandate increases demand for ethanol above what market forces (supply and demand) would otherwise determine… A mandate is thus a form of compulsory demand because it obliges motorists to buy ethanol even when ethanol is uncompetitive with petrol…Because it generally costs more to produce ethanol than petrol, a mandate would increase the price of fuel in the absence of an ethanol subsidy. The price increase is a redistribution of income from motorists to ethanol producers. A mandate is, in effect, a subsidy to ethanol producers paid by fuel users.* [86]

In 2002, the Treasurer, Peter Costello, claimed that a 10 per cent ethanol mandate would cost the government $700 million a year. In 2006, the Industry Minister, Ian Macfarlane, rejected a mandate on the grounds that there was insufficient production capacity to meet one. Meanwhile, biofuel producers claimed that the industry would readily boost capacity if a mandate were introduced. Cattle farmers, in turn, feared that increased ethanol production would push up the price of grain. These and other concerns were all considered by the 2008 parliamentary report, which concluded that there was no clear case for an ethanol mandate and identified several undesirable consequences that one could bring about.

While being rejected by successive federal governments, ethanol mandates remained appealing to some state governments. Both the Queensland and New South Wales governments presently have policies mandating the sale of ethanol in petrol. The mandate in New South Wales came into effect in September 2007, while Queensland's did not come into effect until January 2017, despite a commitment being made in 2006 to introduce a mandate by 2010. As the following discussion explains, both schemes have proven to be controversial and fraught with complications.

In February 2007, the premier of New South Wales, Morris Iemma, promised to introduce a two per cent ethanol mandate if re-elected in September 2007, and to raise it to 10 per cent in 2011.[87] A year after the mandate was introduced, the NSW Government announced a new interim mandated level of six per cent by 2010. This increased target elicited a rebuke from the federal government, which noted that if a six per cent mandate were met, it would create a $200 million shortfall in the federal budget due to lost excise revenue.[88] Concerns about a 10 per cent mandate were even more discomfiting. One analysis suggested that such a volume of ethanol would "chew up 20 per cent of the state's grain crop" in a typical non-drought year.[89]

In 2009, the targets were revised again to 4 per cent from January 2010 and six per cent from January 2011 (later deferred to September 2011).[90] In December 2008, the State Cabinet also decided to further strengthen the mandate by phasing out regular unleaded petrol within three years.[91]

The volume of ethanol sold in New South Wales increased sharply during the first three years of the mandate. As shown in Figure 19, sales of E10 as a percentage of total petrol increased from 10 per cent in the final quarter of 2007 to about 38 per cent in the final quarter of 2010—only marginally shy of the 4 per cent target.

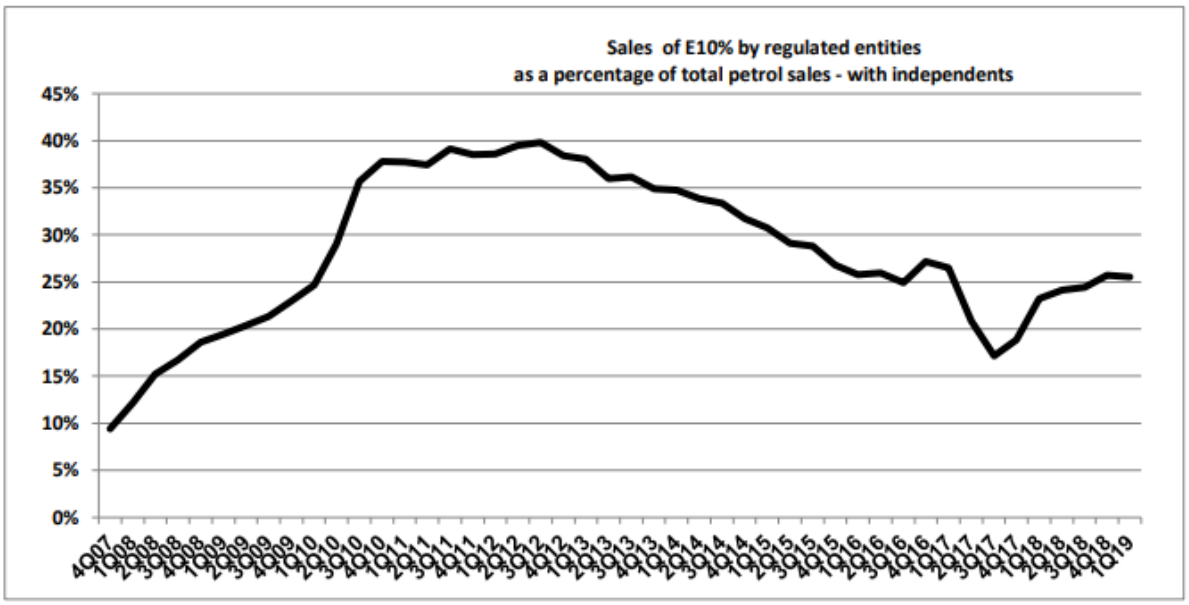


Figure 19 Sales of E10 fuel as a percentage of total petrol sales in New South Wales. (Source: https://www.fairtrading.nsw.gov.au/trades-and-businesses/business-essentials/service-stations/biofuels-marketplace-data)

Despite the increase in sales, the feelings of motorists and fuel retailers towards ethanol remained mixed. Even before regular fuel had been banned, its availability decreased as petrol stations prepared for the change or ditched their regular bowsers due to limited space. The NRMA, while not entirely against a mandate, were concerned about the impact on consumer choice.[92] By September 2009, there were reportedly 179 petrol stations in the state that no longer stocked regular petrol.[93] The rate of conversion would have been even faster if some retailers had not deliberately dragged their heels to avoid losing sales to outlets that still sold regular petrol.[94]

A similar story was unfolding in Queensland. In anticipation of a mandate being introduced in 2010, many petrol stations began replacing regular unleaded pumps with E10 pumps. The RACQ was heavily critical of this development, arguing that as many as 30 per cent of motorists had vehicles that were not E10 compatible and would therefore be forced to buy premium fuels that cost around 10 cents more per litre.[95]

In November 2010, Queensland was forced to delay the introduction of the mandate by 12 months in response to an announcement by the federal government flagging

changes to excise arrangements. At the same time, it was becoming clear that there would not be enough local ethanol to satisfy the planned mandate. Many petrol stations that had already converted their pumps to E10 were left stocking a product that customers did not want to buy.[96]

Major floods in Queensland in late 2010 and early 2011 forced two of the country's three ethanol plants to halt production, leading to further shortfalls. Prices for ethanol rose, reducing the margin between E10 and regular petrol to as little as 1.5 cents per litre—nowhere near enough to make up for the reduced efficiency of E10.[97] As retailers in New South Wales snapped up whatever volumes remained, Shell and BP removed hundreds of E10 bowsers in Queensland.[98] The Queensland Government subsequently abandoned its plans for a mandate. After having risen to 20 per cent of petrol sales under the expectation of a mandate, ethanol blends quickly plummeted to less than 10 per cent of sales. In August, Shell also withdrew E10 from 63 petrol stations in Victoria, where the fuel had never caught on despite being cheaper than regular petrol.[99]

The six per cent mandate took effect In New South Wales in October 2011, but had no apparent impact. Sales of ethanol blends did not increase beyond the level they had already reached, which amounted to less than forty per cent of all petrol sold (the ethanol itself constituted a tenth of this volume). Meanwhile, the government deferred, but did not back away from, its plans to phase out regular petrol. Already unpopular, these plans came under more scrutiny in January 2012 after leaked Cabinet papers revealed that it went against advice from several government agencies. The ACCC warned that the plan would raise petrol prices, while the Crown Solicitor warned that it could be unconstitutional. In addition, the leak "showed the government rejected suggestions it should advertise the change widely, giving the impression it was trying to sneak a policy to which there was a nasty hip pocket sting attached past an unsuspecting public".[100]

Showing how much the theme of cronyism still coloured the ethanol debate, Sean Nicholls, writing in the Sydney Morning Herald, said of the NSW Premier, Barry O'Farrell,

> *One of his biggest public relations problems is that not even the Greens support the E10 mandate as an environmental policy. So the government is left all but alone in defending a policy that in many people's eyes has only one beneficiary - the ethanol producer Manildra.*[101]

The public outcry forced the government to dump the policy to ban regular petrol, although many observers claimed that enforcing a six per cent mandate would result in unleaded petrol being all but unavailable anyway.[102] Acknowledging the realities of supply constraints, the state government also abandoned the 10 per cent target, freezing the mandate at six per cent.

As the availability of regular unleaded petrol diminished in New South Wales, motorists responded not by purchasing more E10 but by switching to more expensive premium fuels. Between the introduction of the mandate in 2007 and the end of 2014, sales of

premium fuels in New South Wales grew by 124 per cent, while the rest of the country they grew by only 26 per cent.[103] A report by Texas Tech University estimated that by 2014, this shift had cost motorists as much as $345 million dollars, based on the price difference between regular unleaded and premium.[104]

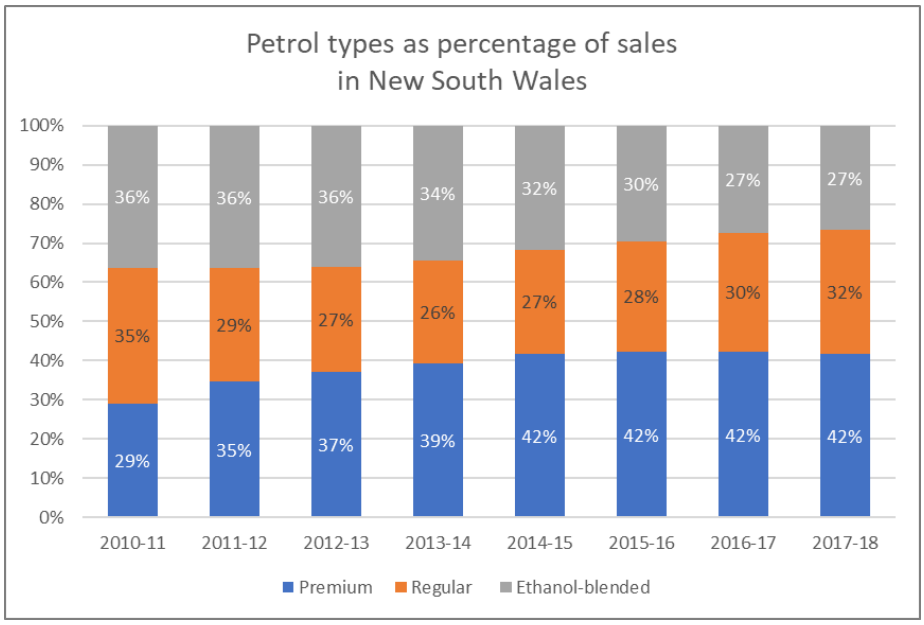


Figure 20 Premium, regular and ethanol-blended petrol as percentages of all petrol sold in New South Wales. (Source: Australian Petroleum Statistics, Issue 270, January 2019.)

From the beginning of 2014, sales of E10 in New South Wales began a steady decline, reaching just 25 per cent of all petrol sales at the start of 2019. One potential factor behind this decline is that the oil price (shown in Figure 17) from about 2015 has been significantly lower than in most of the previous ten years.

In an effort to enforce the mandate, the New South Wales government passed legislation in 2016 to force smaller retailers, which were previously exempt, to stock E10. Like previous policy decisions relating to ethanol, this was also done in the face of official advice. A report on the policy by the state's Independent Pricing and Regulatory Tribunal (IPART) concluded that "most options to increase ethanol uptake would increase the cost of an already expensive policy, with little economic gain for the NSW community", and also warned that small service station owners would be forced to increase prices to cover the costs of providing E10.[105]

An opinion column published in the *Australian Financial Review* in June 2016 captured the cynicism with which many observers held the mandate and related policies:

> *Having asked his pricing regulator (IPART) to review the efficacy of the mandate, and receiving IPART's damning verdict of it (despite a vain attempt to water down its findings by tweaking the original terms of reference), Baird has proceeded with plans to force all service stations (no matter how small or remote) to dig up their tanks and convert to selling an environmentally and economically deficient blend of petroleum that drivers don't even want to buy. The plan's sole beneficiary (according to NSW*

Treasury, no less) is the state's monopoly ethanol producer, Manildra Group, which is a big donor to the Liberal and National parties. It's dead set scandalous.[106]

At this time, the NSW Government also launched a $4.5 million advertising campaign to dispel fears that ethanol was damaging to cars. The continuing decline in sales suggests that the campaign had little effect.

The Queensland Government's ethanol mandate was legislated in December 2015 and came into effect in January 2017. The scheme required retailers above a prescribed size (defined by volume of sales or number of outlets) to sell a volume of ethanol equivalent to three per cent of all sales of petrol and ethanol. In July 2018, the mandated level increased to four per cent.

As shown in Figure 21, sales of ethanol-blended petrol initially rose under the mandate from just over 10 per cent to just under 20 per cent of all petrol sold. Since early 2018, however, sales have remained at close to 17 per cent, meaning that the overall volume of ethanol is less than two per cent of all total petrol sold.

Both of the state mandates came under fire in November 2016 when a report by the Productivity Commission[107] into the regulation of Australian agriculture concluded that biofuel mandates increased costs to consumers and did little to support farmers or environmental outcomes.

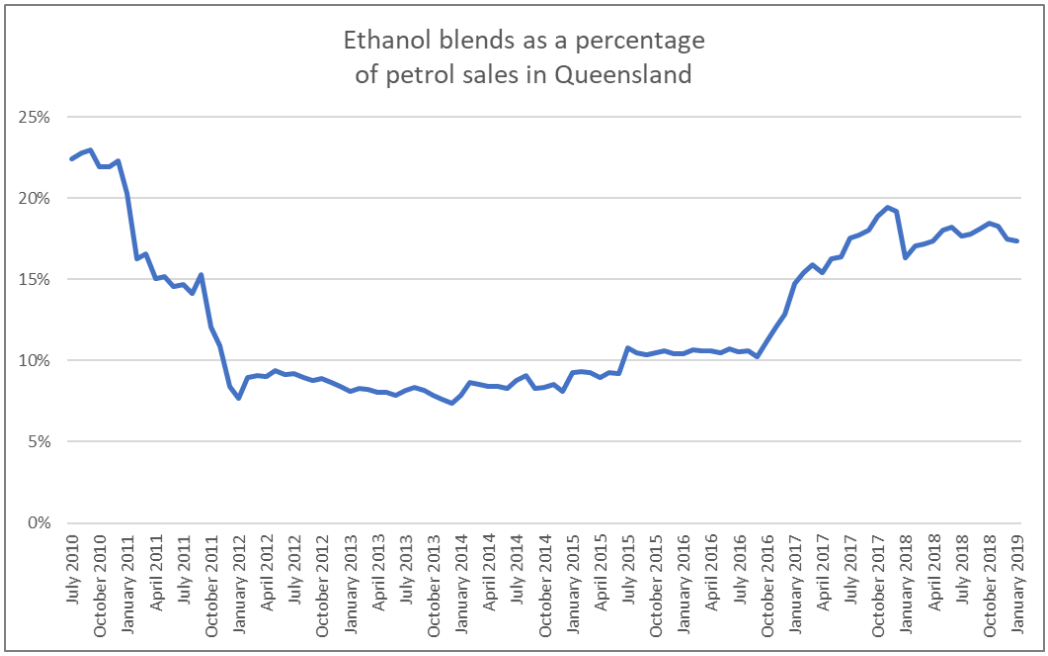


Figure 21 Ethanol blends as a percentage of petrol sales in Queensland. Source: Australian Petroleum Statistics, Issue 270, January 2019.

3.3 The rise and fall (and rise and fall) of LPG in Australia

LPG (liquefied petroleum gas) may consist of propane, butane, or a mixture of both. In Australia, LPG is usually just propane. Derived from natural gas, or as a by-product

of oil refinement, LPG can be kept in a liquid state at a modest pressure, enabling it to be stored in portable cylinders for use in cooking, heating or as a motor fuel.

This section discusses LPG's use as a motor fuel in Australia, examining some of the reasons for its successes and failures. The first subsection focuses on public concerns about the safety of LPG. The second subsection examines the role of economic factors such as petrol prices and government subsidies, and the third section examines how the rise of alternative technologies, among other factors, contributed to the eventual downfall of automotive LPG use.

Unlike ethanol, LPG is used as substitute for regular petrol rather than as an additive. The lessons that it holds for the adoption of future fuels may therefore be somewhat different—perhaps more relevant to the use of hydrogen as an automotive fuel than as a component of the domestic gas network. However, the observations in the following sections surrounding matters of safety, trust, and economics, are likely to be relevant to any future fuels in a wide range of contexts.

3.3.1 A rocky start

Interest in LPG as a motor fuel in Australia grew in the 1970s in response to rising oil prices and concerns about fuel security. In 1973, the federal government successfully converted a Holden ute to run on LPG, demonstrating that in principle, almost any ordinary car on Australian roads could be modified to run on the fuel.[108] By the late 1970s, the government was actively encouraging the use of LPG through measures such as removing taxes,[109] regulating the price, and working with industry to improve loading and distribution infrastructure.[110]

At about half the price per litre as petrol, LPG was the more economical fuel even after its lower energy content was accounted for. Even so, the price of converting a vehicle to LPG meant that it made sense only for high-use customers, such as taxis and vehicle fleets. By contrast, an everyday motorist might take four of five years to recover the costs of conversion.[111]

2 The Sydney Morning Herald, Thurs, June 28, 1979 2

LPG taxes dropped to woo motorists from petrol

From ANDREW KRUGER

MELBOURNE. — Federal Government taxes on liquefied petroleum gas will be dropped to encourage more vehicle owners to convert from petrol.

Motor vehicle manufacturers will be asked to build here, but it won't be possible to avoid it if we have a repe- cent of Australia's crude oil requirements.

home, the Government is offering immediate sales tax need for energy conservation is to be launched soon by the

Figure 22 A headline from page 2 of the Sydney Morning Herald (28 June 1979) about the removal of fuel excise from LPG (Kruger, 1979)

On top of the steep conversion costs, concerns about safety impeded the early uptake of LPG. While the federal government was keen to promote LPG, it was slow to develop comprehensive regulations to ensure that tanks were installed safely. In July 1979, General Motors Holden (GHM) began supplying conversion kits, but warned that the government that safety controls in Australia were inadequate. GMH's

managing director, Mr C.S. Chapman, noted that "the rapid escalation in conversions was a matter of real concern", as the demand "might lead to some inadequately trained people handling the job, with disastrous consequences."[112] The Victorian Government, at least, was making progress in this arena, introducing new regulations in August 1979 that covered the installation of LPG tanks in cars, including banning their placement on car roofs (an option favoured by motorists who could not spare the necessary space in the boot). Amendments made in the following weeks covered the licencing and certification of conversion mechanics and the introduction of labels on number plates to indicate LPG cars.[113]

In October 1979, the proprietor of a Caltex service station in the northern Sydney suburb of Waitara told a journalist from *The Sydney Morning Herald* that "LP gas vehicles are safer than those running on petrol, but when the first one burns it will be all over the headlines."[114] Within a week, he was proven right, as the front page of *The Sydney Morning Herald* carried the headline "LPG taxi explodes, driver injured."[115] The accident could hardly have been more public, happening in peak-hour traffic on the Pacific Highway in Newcastle. According to the report, "traffic was banked up for several kilometres around the major intersection for more than an hour after the blast. Glass from the shattered windows was scattered up to 100 metres along the highway." The driver survived only because a bystander was able to pull him out through the window.

The Sydney Morning Herald

FIRST PUBLISHED 1831

LPG taxi explodes, driver injured

By JOHN MINER

A taxi fitted with a liquefied petroleum gas (LPG) tank exploded in Newcastle yesterday, badly injuring its driver.

Mr Ron Shepherd, 53, was rescued by an unknown man who dragged him through a window of the blazing car.

The accident happened on the Pacific Highway in the suburb of Adamstown Heights about 4pm in peak-hour traffic.

Mr Shepherd, of Charlestown, was in a stable condition last night in Royal Newcastle Hospital with second degree burns to the back, neck and shoulders.

The manager of the Newcastle Taxi Co-operative, Mr Bruce Chisholm, said yesterday he believed the accident was the first in Australia involving a taxi powered by LPG.

A NSW Fire Brigade spokesman said last night he had not heard of a similar incident in Australia.

In his hospital bed last night, Mr Shepherd told how he had smelled gas leaking from the LPG tank in the boot of his taxi and was driving to his base to check it.

He was driving on petrol, but had to leave the cab at every red light because of the fumes inside.

At the intersection of the Pacific Highway and Northcott Drive, Adamstown Heights, there was an explosion and the cab caught fire.

Mr Shepherd said the doors of the cab jammed but he heard a voice outside. He got his head and shoulders through the window "and that is the last thing I remember."

Traffic was banked up for several kilometres around the major intersection for more than an hour after the blast.

Glass from the shattered windows was scattered up to 100 metres along the highway.

The boot and inside of the cab were gutted. The rear window frames were bent to about 45 degrees by the blast. The fire melted the door handles.

Sergeant Peter Anforth, of the Newcastle police rescue squad, said an inquiry into the cause of the accident would begin at once.

"This sort of thing is always happening with boats, and it was just a matter of time," he said.

Police cordoned off sections of the two roads after the accident and warned residents of the dangers from gas which was still leaking after the fire had been put out.

Mr Shepherd's relatives said last night they hoped the man who pulled him from the cab would come forward.

They were sure he must have been burnt too. He had saved Mr Shepherd's life.

Mr Shepherd owned the taxi he was driving. He has been driving cabs for 10 years.

About one-third of Newcastle's 120 taxis have been converted to LPG.

The State Government is encouraging the conversion of cars to LPG as an anti-pollution measure.

It is also aware of public fears over its safety and is considering various controls.

Bankstown Council has imposed a freeze on LPG tanks at service stations because it says a safety code is needed.

A member of the police rescue squad examines the taxi after the fire.

Figure 23 Australia's first major accident involving an LPG tank was front-page news (Miner, 1979)

The accident was attributed to a faulty O-ring that caused gas to leak into the car. It soon emerged that the New South Wales government had previously been alerted to 10 other cases of leaking LPG tanks, all of them involving a popular line of tanks manufactured by Rheem which had written to LPG installers to warn them of the situation. "On hindsight," the chief inspector from the relevant department said, "if we

had known we were going to have an accident like the one in Newcastle, we would have taken more stringent measures."[116] The state government ordered the 2,500 vehicles that had these tanks installed (these accounted for most of the state's 3,000 LPG vehicles) off the road until Rheem had recalled the faulty tanks and addressed the issue.

The accident was the first of its kind reported in Australia, but immediately drew attention to similar incidents. The day after the accident was reported, three more incidents involving LPG tanks made the news.[117] In Adelaide, two men fled from a garbage truck after a suspected leak caused a fire in the cabin. In Blacktown, Sydney, police evacuated four houses amid fears that a leaking LPG tank in a parked utility truck might explode. A similar scene unfolded in the Melbourne suburb of Bulleen, where 15 firemen were called in to remove a leaking LPG tank from a taxi. Several more such incidents occurred in the following days.[118]

In response, the federal government ramped up its revision of the design standard pertaining to LPG in vehicles[119]—a task that was helped by a letter sent by the Society of Automotive Engineers to the Australian Standards Association detailing more than 40 flaws in the existing regulations.[120] Meanwhile, the NSW Government introduced laws requiring every LPG conversion to be inspected and approved by the Department of Motor Transport.[121]

However, the damage to the LPG industry was done. Demand for vehicle conversions crashed,[122] and did not recover until the mid-1980s, by which point nearly all taxis in Melbourne and Canberra, and most of those in Brisbane and Sydney, ran on LPG.[123]

As the next section details, LPG vehicles would eventually enjoy substantial success in Australia, at least for a time. This success was underwritten by improved safety standards, even if some people never shook the memories of backyard conversions and rooftop tanks. This is not to say that accidents ceased to happen: indeed, LPG tanks in cars exploded on several occasions between 1991 and 2015, sometimes causing injuries or even deaths.[124] Interestingly, however, these incidents were not accompanied by widespread concern or calls for action. They seem to have been treated at some level as normal and acceptable, rather than as something that called into question the inherent safety of the fuel.

3.3.2 Drivers of the appetite for LPG: a rebate fuelled boom

Up until January 1991, the price of LPG in Australia was regulated by the federal government. The price was kept to about half that of petrol, but on occasions had been well above the world market price.[125] Deregulation brought with it the prospect of lower prices, sparking greater interest in LPG from ordinary motorists. However, Alan Fels, then the Chairman of the Prices Surveillance Authority (later the Chairman of the Australian Competition and Consumer Commission), warned motorists not to convert to LPG on the assumption that LPG prices would stay low. Like petrol, he warned, LPG prices would fluctuate with the global market. He also reminded motorists that the

price of LPG still depended on government policy, noting that "LPG is cheap at present because there is no government excise on it."[126]

During the 1990s, LPG gained some favour among motorists but did not significantly expand its place in the market. Drivers interested in LPG vehicles increased, and there were a growing range of options beyond converting existing cars. For example, Ford and Holden began offering factory-fitted LPG tanks in new Falcons and Commodores,[127] while Mazda offered a dual-fuel four-wheel-drive Bravo.[128] Better still, new engine designs reduced the performance gap between LPG and petrol.[129] However, concerns about safety lingered, even though standards and regulation had drastically improved.[130] But the biggest barrier for ordinary motorists was still the cost of conversion, which at around $2,000 would still take the average driver around four years to recover.[131] Many drivers would get a quote from a mechanic, do the sums, and then change their minds.[132]

Spikes in the price of LPG in 1996 and 1998 reminded motorists that just like petrol, LPG was now subject to the whims of the global market.[133] A series of government decisions would also remind motorists that LPG was subject to the whims of policy. In April 2000, the federal government announced that unlike petrol and diesel, LPG would be subject to a 10 per cent goods and services tax (GST), that would commence from July that year.[134] In October 2000, motorists in Western Australia received some more favourable news when the state government announced a $500 rebate for LPG conversions. The scheme was motivated partly to encourage greater use of a cheaper, cleaner fuel, but also to support the state's natural gas industry.[135]

In May 2003, following an inquiry into fuel taxation, the government announced that LPG would lose its excise-free status, with a tax of 25c per litre to be phased in from 2008 to 2012.[136] (As discussed in Section 3.2.4, ethanol—which was also excise-free—was supposed to come under the same arrangement.) Following this announcement, demand for LPG vehicles and conversions crashed, and existing orders were cancelled.[137] The downturn even sent Australia's largest supplier of automotive LPG tanks, Melbourne-based APA Manufacturing, into voluntary administration.[138] Responding to pressure from both the industry and motorists, the government announced a revised excise policy in December 2003, halving the excise to 12.5c per litre and promising a $1,000 incentive for new LPG-ready cars purchased in the three years from 2008.[139]

While these deliberations unfolded, demand for LPG conversions was again climbing on the back of rising petrol prices.[140] By 2004, the $500 rebate in Western Australia had become enormously popular. By August 2006, petrol prices were so high that the payoff period for an LPG conversion—even without any rebates—was as little as 18 months, half what it had been a few years earlier.[141] While the WA Government considered scrapping its rebate, the federal government took the opposite approach. Desperate to offer relief from spiralling petrol prices, but unwilling to tinker further with fuel taxes, the federal government announced a $1,000 rebate for new LPG cars (essentially bringing forward the rebate previously promised for 2008) in

addition to a $2,000 rebate for conversions, which at that time could cost between $2,000 and $4,000.[142] Following suit, the WA Government doubled its $500 rebate, allowing motorists in the state to claim $3,000 for a conversion—and to pocket the difference if the conversion was cheaper.[143]

Motorists flocked to take advantage of these rebates. The federal government's scheme received 4,200 claims in its first week.[144] Conversion mechanics were overwhelmed, as a shortage of skills and parts pushed waiting periods from weeks to months—an outcome that the industry said could have been avoided through better consultation ahead of the policy announcement.[145] At the end of the first year, around 70,000 motorists had taken advantage of the scheme, at a cost of $139 million, more than twice what had been budgeted.[146]

3.3.3 A hybrid-fuelled bust

This high point in Australia's automotive LPG industry was driven by a combination of high petrol prices and generous government subsidies. Neither of these things could be expected to last forever.

In April 2008, the newly elected federal government, led by Kevin Rudd, toyed publicly with the idea of wrapping up the rebate scheme[147]—an action that resulted in a further rush of applications.[148] Eventually the government backtracked, opting in November to *increase* the incentive for new cars to $2,000.[149] However, the scheme's demise was set out in the following year's federal budget. Starting from July 2009, the scheme would be scaled back by $250 each year until 2012, when it would remain at $1000 until being totally abolished in 2014.[150] Along the way, the government capped the scheme at 25,000 vehicles a year from mid-2011 to help pay for flood reconstruction.[151] Western Australia's rebate scheme ended in 2009.[152] Meanwhile, the 12.5c/liter excise was phased in between 2008 and 2012, gradually pushing up the price at the pump.

After reaching dizzying heights in late 2008, the price of petrol plummeted, bringing demand for LPG conversions down with it.[153] While the petrol price soon rebounded, interest in LPG cars and conversions did not recover, in part because of the retraction of subsidies, but also because of the increasing market price of LPG. In 2010, LPG became so expensive that even taxi drivers started to abandon it. In its place, taxi drivers turned not to petrol but to new diesel and hybrid electric cars, which now offered an economic alternative for high-use drivers.[154] Private motorists, meanwhile, were turning to smaller, highly efficient petrol models, which removed the incentive to use a cheaper fuel and reduced the available room for an LPG tank.[155]

By the middle of 2012, the LPG industry was in freefall. In the space of three years, the number of new LPG cars sold per year dropped from 13,378 to just 244, while the number of conversions had fallen from 96,401 to 27,976 between 2008 and 2011.[156] Further sealing the fate of automotive LPG in Australia was the closure of local car factories by Holden and Ford.[157] In recent years, mechanics who previously converted petrol cars to LPG have begun converting LPG cars to run on petrol, as dwindling

numbers of LPG pumps at petrol stations, and a scarcity of parts for repairs, make owning an LPG car more difficult and expensive.[158]

The experience with LPG in Australia shows that while initial safety scares can be damaging, they can be overcome through time and better regulation. Although memories of rooftop tanks and backyard conversions lingered for some time, and accidents involving LPG tanks never ceased to occur, consumers from the 2000s and onwards, clearly had no qualms about using LPG as long as the price was right. The problem with LPG was that the right price could be maintained only through generous government subsidies, whether in the form of rebates or tax exemptions. Without these subsidies, LPG had no natural economic advantage over petrol, even if it offered some environmental benefits. Furthermore, since LPG was a mature technology, there was never any prospect that production costs would come down to offset the removal of subsidies. These challenges notwithstanding, it is conceivable that LPG might have maintained or expanded its place in the automotive fuel market if it had not been for the arrival of diesel and hybrid vehicles.

3.4 Lessons for future fuels

3.4.1 Trust requires good governance as well as good behaviour

As the most recent and prominent example of an alternative and renewable fuel being introduced to the Australian market, the experience with ethanol sets an unfortunate precedent. Ethanol has become an object of distrust and cynicism, largely as a result of poor regulation, inadequate communication and questionable policy decisions that have diverted considerable sums of public money to a seemingly small number of beneficiaries while producing poor outcomes for consumers. Variably promoted as a means of reducing pollution, stimulating industry, improving energy security or reducing petrol prices, ethanol—at least in the low-concentration petrol blends used in Australia—has been shown time and again to have little positive impact on any of these objectives, and yet has enjoyed the support of both federal and state governments. The fact that one of the main beneficiaries of state and federal ethanol policies since the 1990s has also been a generous donor to both sides of politics has contributed a widespread impression, especially in New South Wales, that government support for ethanol has been driven by little more than political favouritism.

The experiences with ethanol and LPG in Australia demonstrate how easily consumer trust in an alternative fuel can be lost, and (at least in the case of ethanol) how hard it can be to regain. Anecdotes presented in this case study show that when retailers in New South Wales first started blending ethanol into petrol in the 1990s, many motorists were happy to use it. Consumer confidence in ethanol only collapsed in the early 2000s amid a lack of regulation and transparency blended with an air of political scandal. Had regulation been introduced sooner to cap and disclose the strength of ethanol blends with authoritative information about the risks to vehicles reached the public in an open and transparent manner, it is possible that Australian motorists would not have turned against ethanol-blended fuels. Similarly, had LPG conversions been

more effectively regulated in the late 1970s, the incident that brought the emerging industry to a halt in 1979 might never have happened.

It would be fair to say that certain industry actors—especially the independent 'cowboy' retailers who took advantage of lax regulations in the early 2000s—played their part in eroding the public's trust in ethanol. Thus, a lesson for industry to take from this story is to *keep your own kind in check, lest everyone be burned by the actions of a wayward few*. Realistically, however, self-governance has its limitations. Historical precedent shows that companies acting in their own interests can be expected to explore the full limits of their legal constraints. Furthermore, it is easier to trust a party to do the right thing if there are consequences for doing otherwise.

Arguably then, the more important lesson to be learned from this case study is that *gaining the public's trust requires good governance as well as good behaviour*. To the extent possible, industry should devise and follow its own codes of conduct and ethics that promote the public interest. Ultimately, however, the policies and actions of government regulators will have equal or greater impacts in assuaging public concerns about the safety of a product or the benefits of an industry.

An interesting contrast between the experiences with ethanal and LPG is that consumer trust in LPG was never a major issue (at least as far as can be gauged from newspaper reports) except in the aftermath of the accident that occurred in Newcastle in 1979. When incidents involving leaks or explosions occurred in later years, they were generally not followed by debates about safety and calls for tighter regulations. The reasons for these differences are difficult to pinpoint, but they may have something to do with the contrasting political environments around the two fuels. Whereas ethanol was promoted and regulated amid claims of cronyism and conflicts of interest, LPG was rarely, if ever, the subject such claims.

As with ethanol prior to the early 2000s, consumers in Australia appear to have an open mind about using hydrogen in a domestic setting. But this case study illustrates the kinds of events and situations that could cause this sentiment to turn. A lax regulatory environment around blending and labelling, for example, could lead to accidents or poor performance that could turn consumers away from hydrogen. So too could any perceptions that government support and promotion for hydrogen serve interests other than consumers and the public at large. The provision of limited or incomplete information about how consumers and appliances would be affected by hydrogen would similarly be expected to make consumers distrustful.

3.4.2 Price is powerful, but trust can trump it

This case study illustrates the power of price in determining the fortunes of a new or alternative fuel. It also shows that the price that matters is not the absolute price of the alternative fuel, but its price relative to other options. The popularity of both ethanol and LPG has always been highly responsive to fluctuations in the global oil price. When the price of oil has increased, so too has the popularity of these two fuels. The relatively low oil price (compared to the previous 10 years) since 2015 has

coincided with a decrease in ethanol consumption in New South Wales, even as the government took additional steps to enforce its mandate. In the 1990s, when the oil price was relatively low and stable (at least compared to the years that followed), the aggressive subsidisation of ethanol through excise exemptions and a production bounty made the fuel appealing to both retailers and customers.

However, this case study also shows that price is not everything. Indeed, the increasing popularity of premium fuels in New South Wales suggests that *when consumers do not like or trust a fuel, they will happily pay more for an alternative*. Anecdotal evidence even suggests that many motorists in the 1930s responded in the same way when Queensland's first ethanol mandate was introduced.

One lesson that these observations suggest is that the best way to encourage the use of an alternative fuel is to *keep it cheap and keep it trustworthy*. If the product has merit, and is widely accessible, then the market should do the rest. On the other hand, if trust is lost or never gained, making it cheap will not be enough. If consumers were to reject a new reticulated gas product, they might sooner switch to an electric appliance or alternative gas supply (LPG cylinders, for example) than keep using it, even if these alternatives cost more.

Some journalists and other observers contributing to the discourse around ethanol have concluded from the experience that Australian consumers are not willing to pay more for an environmentally friendly fuel. This conclusion should be treated with great caution, if for no other reason than that the net environmental benefits of E10 are, according to some analyses, negligible or even negative. A better indication of Australian consumers' willingness to pay for greener energy might be found in the uptake of green electricity options, which available evidence suggests has been substantial although variable across different groups of consumers, and sensitivity to other market factors.[159]

It is worth noting in this context that the greenhouse benefits of blending hydrogen with natural gas at a 10 percent concentration are similar to those attainable from E10 fuel. A ten per cent blend of hydrogen gas blend has been estimated to reduce greenhouse gas emissions by about three per cent,[160] while corresponding estimates for E10 range from about one per cent up to about four per cent (see Section 3.2). The marginal greenhouse benefits of an 'H10' gas blend could make the product a hard sell unless it is presented as part of a broader strategy or narrative – for example, as the first step in a transition to pure hydrogen.

3.4.3 Mandates are not magic

The experiences with ethanol mandates in New South Wales and Queensland suggest that while mandates on alternative fuels do increase consumption, they cannot overcome natural limits imposed by supply and demand. Despite the claims of biofuel proponents that mandates would stimulate production capacity, the ethanol mandates in these two states repeatedly had to be deferred or reduced because the mandated volumes were not available. On the demand side of the equation, the

experience in New South Wales, where many motorists have apparently chosen premium fuels over ethanol blends, suggests that there is little point in mandating an untrusted product if consumers can choose an alternative, even if the alternative is more expensive. The end result is that consumers are worse off, and consciously so.

Beyond their immediate market-distorting effects, the mandates on ethanol in Queensland and New South Wales had various unintended consequences. One was their impact on petrol retailers, who were forced (or in some cases merely encouraged) to convert their infrastructure, often with their own funds, to make E10 available. Because consumers preferred regular petrol, those retailers who converted to E10 first were effectively punished for doing so, as they lost sales to outlets that still stocked regular petrol. The punishment was compounded for first-movers in Queensland when the mandate was deferred just as it was supposed to come into effect. Retailers, then, are another important stakeholder group who can be unjustly affected by heavy-handed measures to promote alternative fuels.

Another issue that emerged in the implementation of the ethanol mandates was a lack of cross-jurisdictional coordination. Because of the federal excise rules, the decision by New South Wales to introduce and increase its mandate on ethanol had the potential to divert considerable revenue from the federal budget. Contrarily, the federal government's announcements in 2010 about changing the excise arrangements threatened to undermine the viability of Queensland's proposed mandate, and contributed to its ultimate deferral. Queensland's plans were also complicated by the mandate in New South Wales, which reduced the availability of ethanol.

There is some debate about the extent to which ethanol mandates in Australia have pushed up the price of grain feedstocks, in turn affecting other industries such as cattle feedlots. However, the mere potential for this to occur is sufficient to highlight the problems that could occur if a mandate diverts a limited resource away from another economically or socially important use.

The limited success of these recent ethanol mandates echoes efforts of the Queensland and federal governments many years earlier. Queensland's first mandate, though it had some initial impact on ethanol production, was ultimately never enforced. The three unused ethanol plants that the federal government build during World War 2 were further testaments to the misallocation of resources that can result from ignoring realities of supply and demand.

In other words, *mandates are not magic*. If supply is constrained or demand is weak, a mandate will not help. Mandating amid a lack of supply will make the mandate unenforceable, while mandating amid a lack of demand could make the product even less popular. If consumers do not want the product, they will choose alternatives, even if they are more expensive. In addition, the market-distorting effects of mandates can have undesirable consequences, such as punishing compliant retailers and diverting resources from other valuable uses.

This is not to say that all mandates are problematic. As noted in the next case study, coal seam gas development in Queensland was successfully stimulated by a state government policy introduced in 2000 mandating that 13 per cent of electricity in the state be generated from gas by 2005. In appraising that mandate, however, it is important to note certain differences between coal seam gas (at least at that time) and ethanol. Firstly, there was no shortage of coal seam gas; indeed, the state's reserves had barely begun to be tapped. Secondly, coal seam gas at that time was not widely controversial. And thirdly, the mandate did not change the nature of the product (electricity) that reached consumers.

As noted in the COAG Energy Council's discussion paper titled *Attracting hydrogen investment*,[161] a production or sales mandate is one measure by which the uptake of hydrogen, or other future fuels, could be promoted. However, proposals of this nature should be pursued with caution, given the limited success with which mandates on alternative fuels have been implemented in Australia. Without adequate supply or consumer support, the mandate could become unenforceable, eroding its own credibility and power. In the case of promoting renewable hydrogen, a shortfall of renewable electricity could cause the mandate to fail or electricity prices to rise. Allowing hydrogen to be sourced from non-renewable sources would provide for flexibility in satisfying a mandate but would of course raise other questions about the environmental credentials of the product.

3.4.4 Mind the manufacturers

In the early 2000s, the public's concerns owing to government's reluctance to regulate ethanol blends was exacerbated by a lack of clear information from car manufacturers about the compatibility of their engines. It is possible that the loss of trust at this time would have been less dramatic if car makers had moved faster to reassure motorists that ethanol blends would not void warranties.

If hydrogen were to be introduced to domestic gas networks, a similar dynamic could come into play. Leaving consumers in the dark about whether their appliances are compatible with a new fuel blend would be a sure way to lose their trust. Compelling manufacturers to provide clear and accessible information about appliance compatibility would be a logical step towards avoiding such an outcome.

In the longer term, the most effective way of neutralising concerns about appliance compatibility would be for government to enforce it—that is, to require all appliances sold after a certain date to be compatible with specified fuel blends or types. For example, measures taken by the Brazilian Government to ensure that all cars sold can run on ethanol fuels have been seen as integral to the success of the ethanol industry in that country.[162]

Finally, the varied successes of these alternative fuels in Australia may hold useful lessons for future efforts to introduce hydrogen or other renewable fuels. While there are parallels to be drawn between the use of biofuels or LPG and the use of hydrogen as an automotive fuel, this case study is of equal if not greater relevance to

considerations about the introduction of new fuels to domestic gas networks. Just as biofuels were introduced in the form of low-concentration blends to ensure compatibility with conventional engines, hydrogen is being introduced to gas networks in Australia in low concentrations so as not to affect existing appliances. Similar issues of consumer awareness and trust may therefore apply. Furthermore, the production and sale of hydrogen could conceivably be stimulated through similar policy mechanisms as those that have been applied to ethanol.

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4 CASE STUDY 3: COAL SEAM GAS DEVELOPMENT

Case study 3 – Coal seam gas development

How and when was the fuel introduced?

Coal seam gas (CSG), also known as coalbed methane or coal seam methane, occurs underground in coal seams. It is chemically similar to natural gas and can be used in the same ways. The Australian CSG industry developed in central Queensland in the 1990s to supply domestic gas networks and electricity generation. Starting in the mid-2000s, CSG development expanded rapidly to support exports of liquefied natural gas (LNG) from Gladstone. Commercial production of CSG in New South Wales began near Sydney in 2000, but subsequent state government policies and community reactions have limited further expansion.

What issues and challenges emerged?

The CSG industry developed almost without issue during the 1990s and early 2000s. However, it became controversial when expansion encroached onto prime agricultural and rural residential areas in southern Queensland. Land access conflicts arose as gas companies used their legal and financial advantage to drill gas wells on land managed by farmers. In addition, farmers and the wider public became concerned about the impacts that CSG development could have on water resources and the environment more broadly. Communities in southern Queensland and in various parts of New South Wales soon mobilised to oppose further development, claiming that the industry lacked a social licence to operate. Finally, due to the breath-taking speed of the construction phase of three parallel projects, costs exceeded estimates, efficiencies of scale were casualties of competition, and Australian firms along the supply chain lost opportunities to foreign firms.

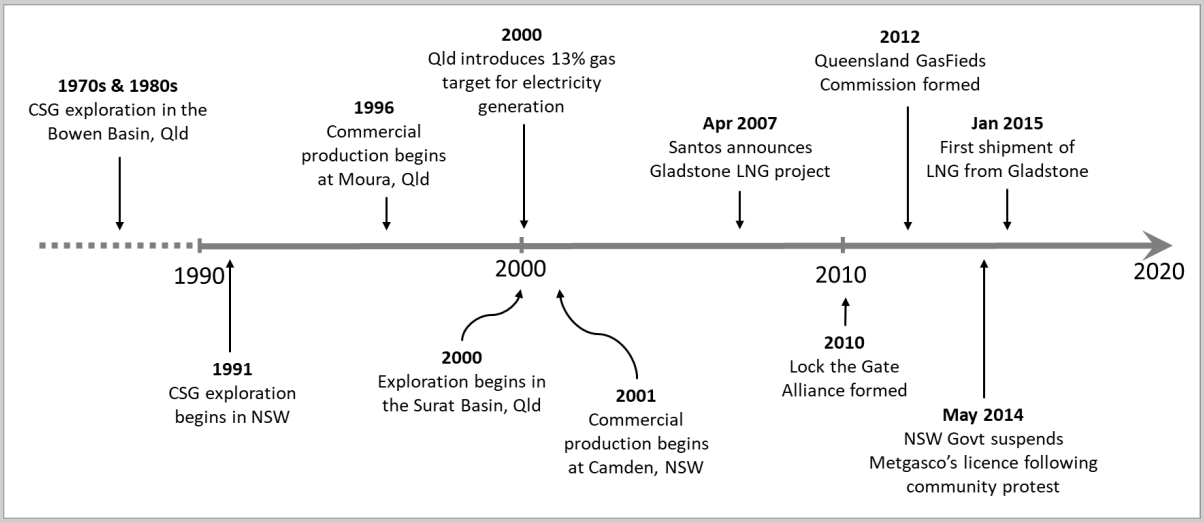
In New South Wales, this community opposition prompted the state government to impose a moratorium on new petroleum licences, virtually bringing the CSG industry to a standstill. In Queensland, the industry was allowed to continue under an expanded regulatory framework to manage environmental risks. To facilitate better coexistence with agricultural communities, the Queensland Government established a dedicated body (the Gas Fields Commission) representing communities, landholders and the CSG industry.

The reorientation of east-coast gas producers towards exports has, ironically, led to fears of domestic gas shortages, and pushed up the price of natural gas for east-coast consumers.

What are the lessons for future fuels?

- *Social licence can affect legal licence*. The fate of the CSG industry in New South Wales shows that under the right political conditions, community opposition can lead directly to regulatory action, including the literal loss of a legal licence to operate.
- *Pursue long-term relationships as well as short-term opportunities*. Had CSG companies acted in the early days with more restraint, and with more of an eye to building long-term relationships with landholders and communities, it is likely that the industry would have faced less of a battle in gaining social acceptance.
- *Trust in industry is tied to trust in government*. The experiences of the CSG industry demonstrates how public trust in an industry can be bound inextricably to public trust in the regulator and regulatory regimes. The perceived competence and integrity of government oversight will be a critical component in building and retaining public trust in future fuels

- *Be cautious of international investment.* Although the capital funding available from foreign governments and Joint Venture (JV) partners is attractive to rapid expansion of mega-projects, there are unanticipated costs to Australian firms along the value chain. These costs could be better mitigated by a more moderate pace of development and thorough consideration of the Australian context.



4.1 Approach to the case

The development of coal seam gas (CSG) resources in Australia began in the 1990s. However, it became a major source of controversy when the exploration and extraction of coal seam gas ramped up in the mid-2000s in response to export opportunities and domestic energy policies. Conflicts around land access, along with concerns about impacts on water, landscapes and regional economies, have created rifts between gas companies and communities while facilitating new and unlikely alliances between farmers and environmentalists, and between rural and urban activists. Meanwhile, the export of liquefied natural gas (LNG) from Queensland has reconfigured the eastern gas market, resulting in higher prices for domestic customers. Socially, politically, and economically, the coal seam gas boom has redefined the environment into which new gas products will be introduced.

This case study begins with a detailed overview of how the CSG industry has developed in Australia and of how the public has responded to the various social and environmental issues that have emerged. Events in Queensland and New South Wales are described separately, as the issues raised and the responses by government and community stakeholders have been quite different in each state. Following this overview, two subsections explore issues relating to social licence and coexistence in more detail, before the lessons for potential future fuels industries are synthesised in Section 4.5

In addition to published literature about the CSG industry, this case study draws on direct experiences of the report authors, who have both previously engaged with the CSG industry in Queensland through research and policy roles.

4.2 Summary of CSG development in Australia

Coal seam gas, also known as coalbed methane or coal seam methane, occurs underground in coal seams. Consisting primarily of methane, it is chemically similar to conventional natural gas, and can be used in the same ways, whether for electricity generation, industrial processes, or domestic purposes such as cooking and heating.

Due to the way in which coal seam gas occurs, and the techniques required to extract it, coal seam gas is classified as an 'unconventional gas'. Whereas conventional gas reserves exist in permeable rock layers that can be readily tapped, unconventional gas reserves remain trapped in less permeable reservoirs, often in the same the layers in which the gas formed.[1] In the case of coal seam gas, the gas is held within the pores and cleats of coal by the pressure of groundwater. Before the gas will flow, some of this water must be pumped to the surface, sometimes in very large quantities.[2] In some cases, the coal seam also needs to be physically stimulated to produce an adequate flow of gas. This stimulation is achieved through a process known as hydraulic fracturing, or 'fracking', in which a mixture of water, sand and chemicals is injected into the ground at very high pressure. Although this practice has been used in only a minority of coal seam gas wells in Australia to date,[3] the term 'fracking' is often used colloquially as a catch-all term for unconventional gas development, including coal seam gas extraction.

Commercial production of coal seam gas began in the United States in the early 1980s, following exploration in the 1970s. While exploration of Australia's coal seam gas resources also began in the 1970s, the challenge of adapting drilling techniques to the local geology meant that commercial production did not begin until 1996 with the commencement of supply from a gas field near Moura in the state of Queensland.[4] As shown in Section 4.2.1, most coal seam gas development in Australia has occurred in southern and central Queensland. In the state of New South Wales, commercial development has been constrained to a small area south-west of Sydney, although there has been substantial exploration in other parts of the state. In other Australian states, there has been no commercial production of coal seam gas, and only limited exploration activity.

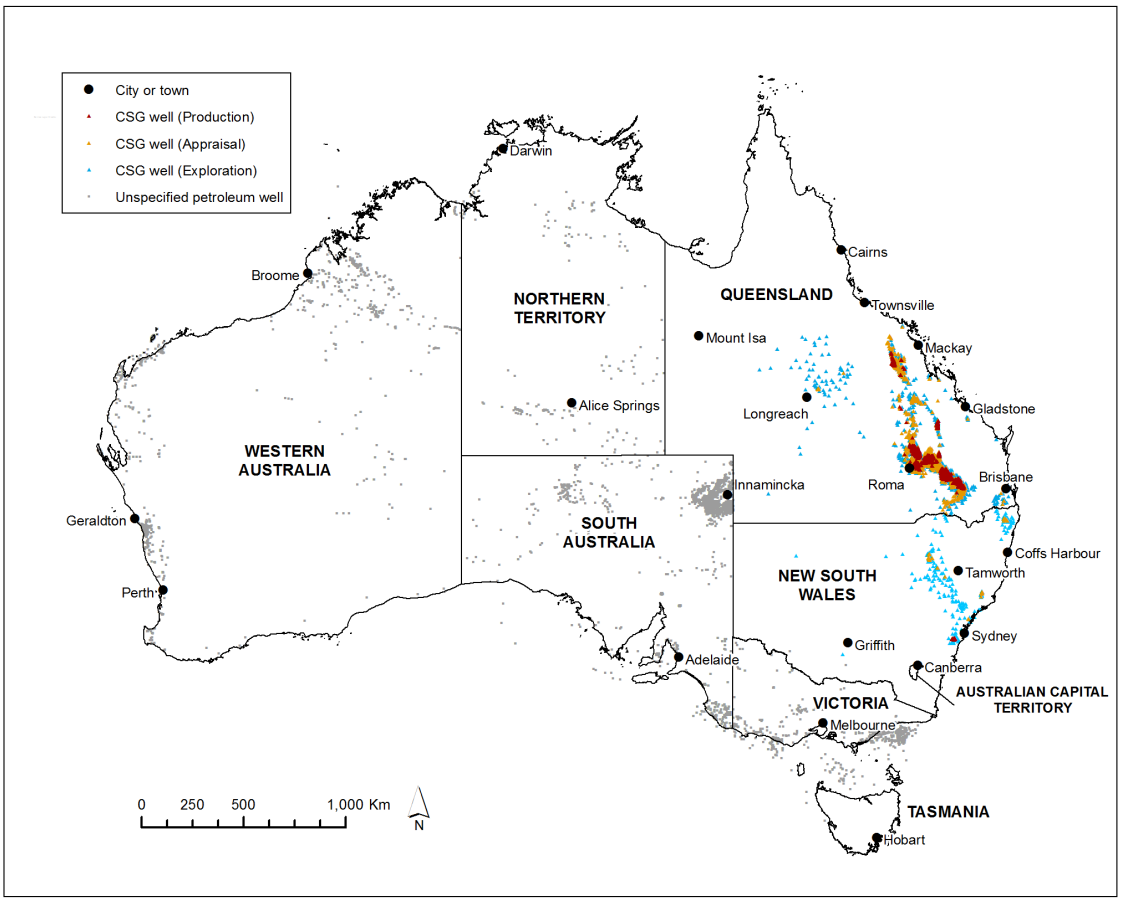


Figure 24. The location of CSG wells and other petroleum wells across Australia (CSG and other petroleum wells are not distinguished in the available data for states other than Queensland and New South Wales).[5]

4.2.1 Coal seam gas development in Queensland

Figure 25 summarises the spatial and temporal progression of coal seam gas development in the state of Queensland from 1991 to 2015. The figure shows how many coal seam gas wells have been drilled within a moving 30-day window, and the geographic location of all wells drilled within three longer time periods. The wells are coloured according to the purpose for which they were drilled. Exploration wells are drilled to determine whether gas is present at a given location; appraisal (or pilot) wells are drilled to determine the size and extent of the gas reserve; and production (or development) wells are drilled to exploit an economically viable reserve. (Note that a well drilled for the purpose of exploration or appraisal can subsequently be used for production, which is why the first production well does not appear in this data until 1998, even though production began in Queensland in 1996.)

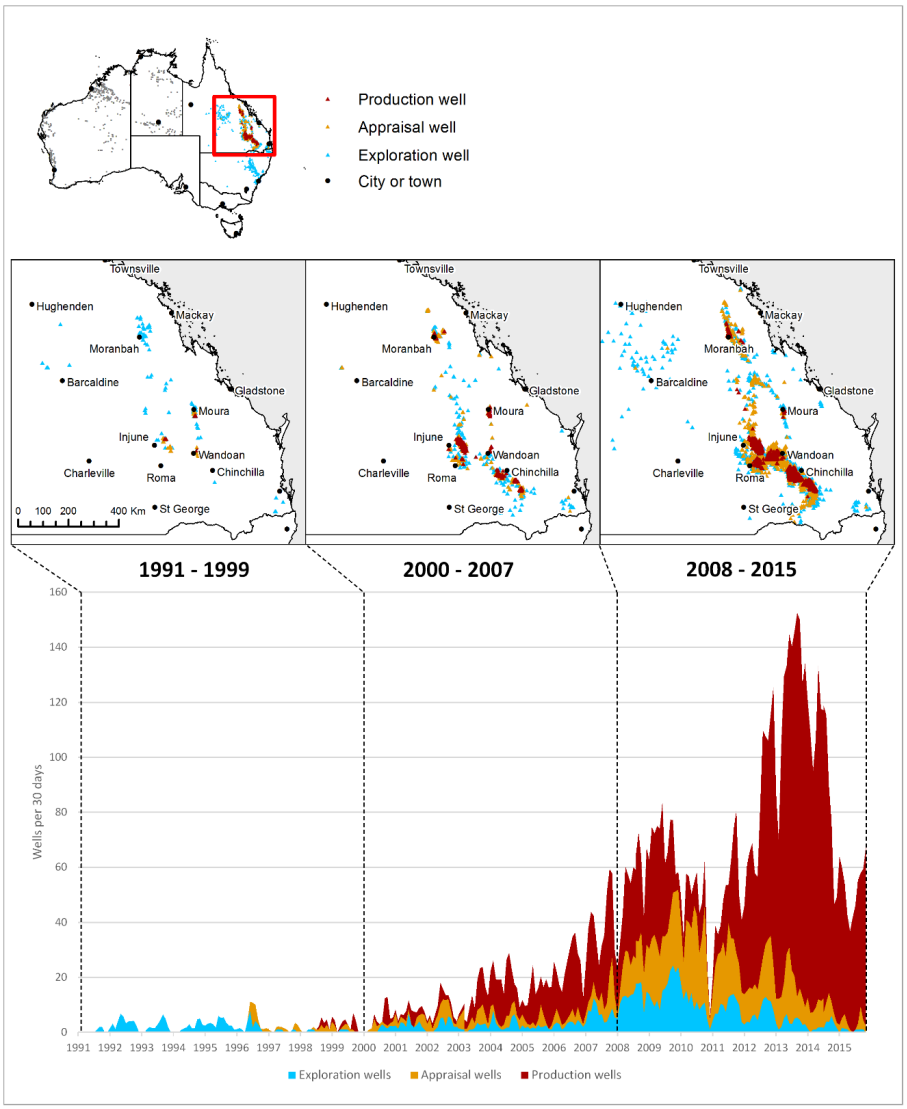


Figure 25. Coal seam gas wells drilled in Queensland from 1991 to 2015, showing the temporal and spatial distribution of exploration, appraisal and production wells.

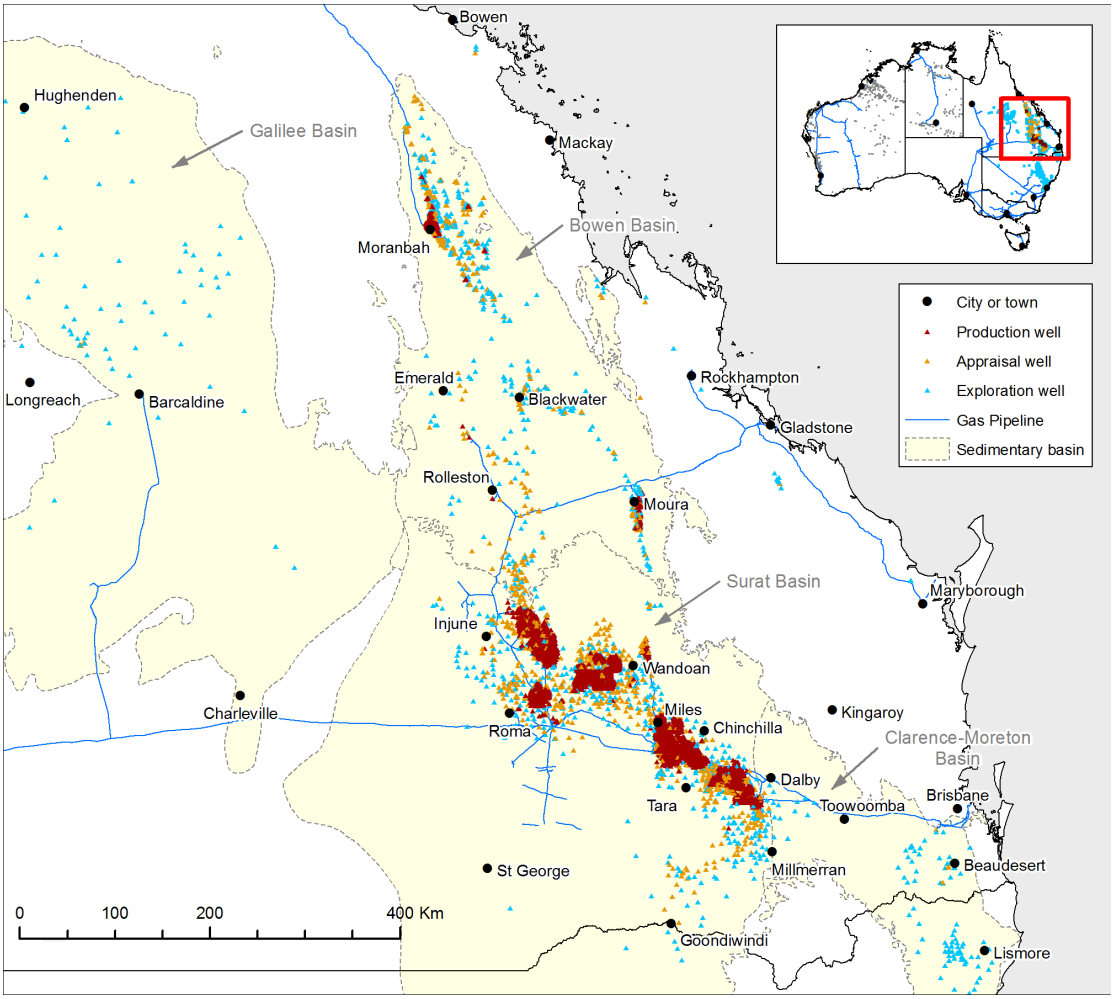


Figure 26. Coal seam gas wells, petroleum pipelines, and selected sedimentary basins in central and southern Queensland.

Figure 26 illustrates two important shifts that have occurred in the development of the coal seam gas industry in Queensland. The first is a shift in location, and the second is a shift in the rate of development. Up until the year 2000, nearly all coal seam gas development in Queensland occurred in the Bowen Basin (Figure 26). Commercial production began near Moura in February 1996 followed at gas fields near Injune in October 1997 and near Moranbah and Wandoan in 2002. Exploration of the Surat Basin began in the year 2000, bringing the industry into to the Darling Downs and Maranoa regions. The growth in CSG development in the years following 2000 has been attributed to the State Government's mandate, introduced in 2000, that 13 per cent of the state's electricity be generated from gas by 2005.[6]

Commercial production from the Surat Basin began in 2005 and increased dramatically, to supply global exports of liquefied natural gas (LNG) from shipping facilities at Gladstone. Exploration for coal seam gas has also taken place on a smaller scale in the Clarence-Moreton Basin to the south of Brisbane, in the Galilee Basin around Barcaldine, and near the coastal towns of Gladstone, Bowen and Maryborough. By the end of 2015, a total of 9,144 coal seam gas wells had been drilled in Queensland, more than two thirds of which were in the Surat Basin.

Controversy about coal seam gas development in Queensland has emerged largely in response to developments in the Surat Basin, especially in the Darling Downs region. Unlike in the Bowen Basin, where the majority of gasfields are situated away from populated areas and high-value agricultural land, the gas-producing areas in the Surat Basin overlap with some of the most valuable agricultural land in the country, and are in close proximity to towns that have not previously had any exposure to petroleum development. The result has been a spate of conflicts around land use and access. From these conflicts has emerged a debate about the potential for coal seam gas development to coexist harmoniously with other land uses, especially agriculture.[7]

Another widely debated issue has been the observed and potential environmental impacts of coal seam gas development, especially the possible depletion or contamination of water resources.[8] Fears have also been expressed about the impacts of fugitive gas emissions, not only due to the potency of methane as a greenhouse gas,[9] but also due to perceptions that the gas can affect human health.[10]

Amplifying all of these concerns has been the speed at which development has occurred, especially since 2007. A defining moment in the development of the coal seam gas industry in Queensland was the announcement in April 2007 by Santos, one of the four major gas producers in Queensland, of their intention to convert coal seam gas into LNG and export it from the port of Gladstone.[11] Similar announcements soon followed from the other three major gas companies in Queensland: Origin Energy, Arrow Energy, and Queensland Gas Company (QGC). In their race to be the first to export coal seam gas from Gladstone, these companies undertook massive wellfield development programs while also building gas pipelines and liquefaction facilities. These developments fuelled a resource boom which brought about rapid social and economic changes, both positive and negative, to various regional communities, especially those in the Darling Downs.[12]

In response to this broad range of social, economic and environmental concerns, various sectors of the community have mobilised to oppose or moderate the development of coal seam gas resources in Queensland. Included in this mobilisation is an unlikely alliance of farmers and environmentalists—groups that have historically been at odds on many issues—under the banner of the Lock the Gate Alliance, which has become the peak organisation campaigning against coal and gas development in Australia.[13]

Despite widespread public concerns, the Queensland State Government has allowed the industry to proceed under an adaptive management approach whereby uncertainties about environmental impacts are addressed through ongoing monitoring and assessment.[14] This regulatory regime has been underwritten by a raft of newly developed policies relating to groundwater impacts, surface water management, and protection of agricultural land, among other matters.[15] While environmental impacts and resource development in Australia are primarily matters regulated at the state level, the Commonwealth Government of Australia has also

introduced new regulatory measures in response to concerns about coal seam gas. As well as introducing a 'trigger' for federal involvement in the approval of coal seam gas projects that could affect water resources, the Commonwealth Government has established in Independent Expert Scientific Committee to advise about matters relating to the environmental impacts of large coal and coal seam gas projects.[16]

4.2.2 Coal seam gas development in New South Wales

Figure 27 shows the spatial and temporal pattern of coal seam gas well development in the state of New South Wales from 1991 until 2013, while Figure 28 situates this development within relevant geological boundaries.

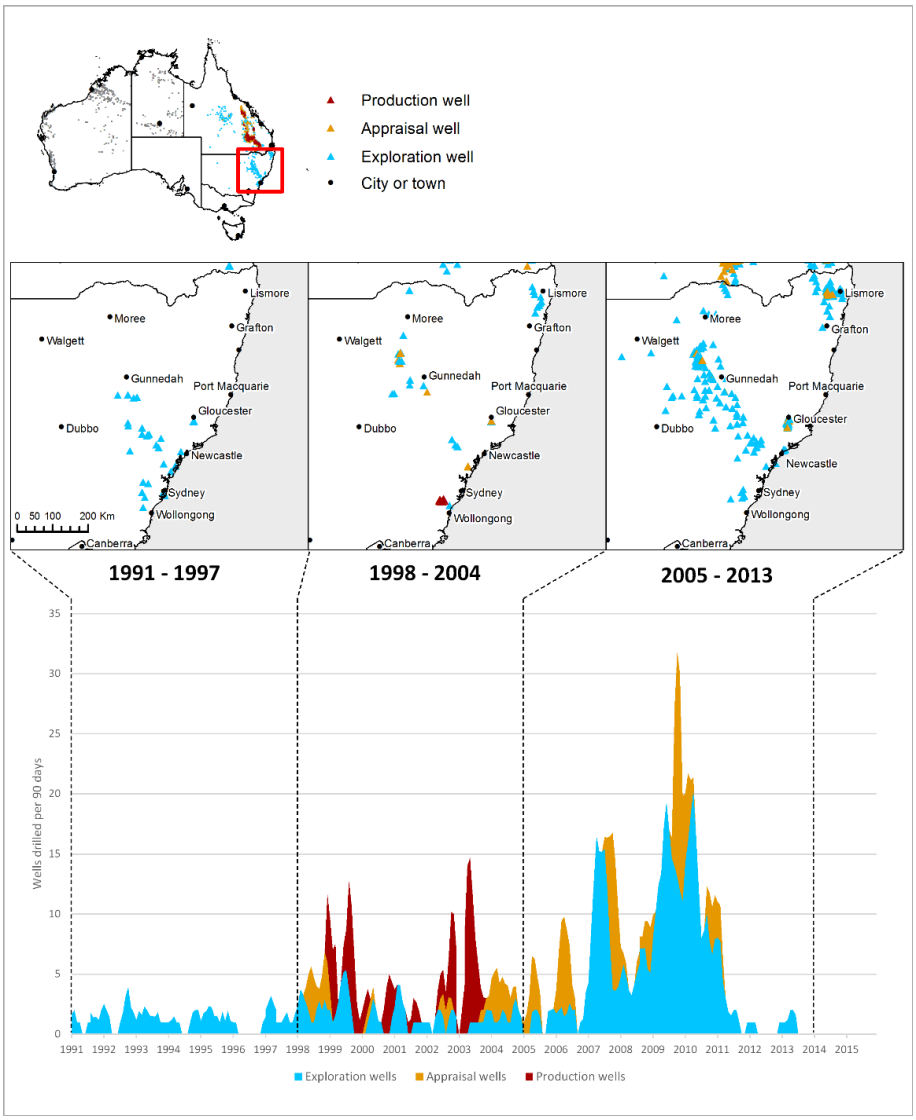


Figure 27. Coal seam gas well development in New South Wales, showing the temporal and spatial distribution of exploration, appraisal and production wells.

The development profile in New South Wales differs from that in Queensland in at least three important respects. Firstly, the overall magnitude of well activity has been much smaller. As at the end of 2013, a total of 421 coal seam gas wells had been drilled in New South Wales, compared to the nearly 10,000 wells drilled in Queensland by the

end of 2015. Secondly, all new wells drilled in New South Wales since 2004 have been for exploration and appraisal rather than for production. As noted earlier, commercial production of coal seam gas in New South Wales has been limited to a small area to the south-west of Sydney.

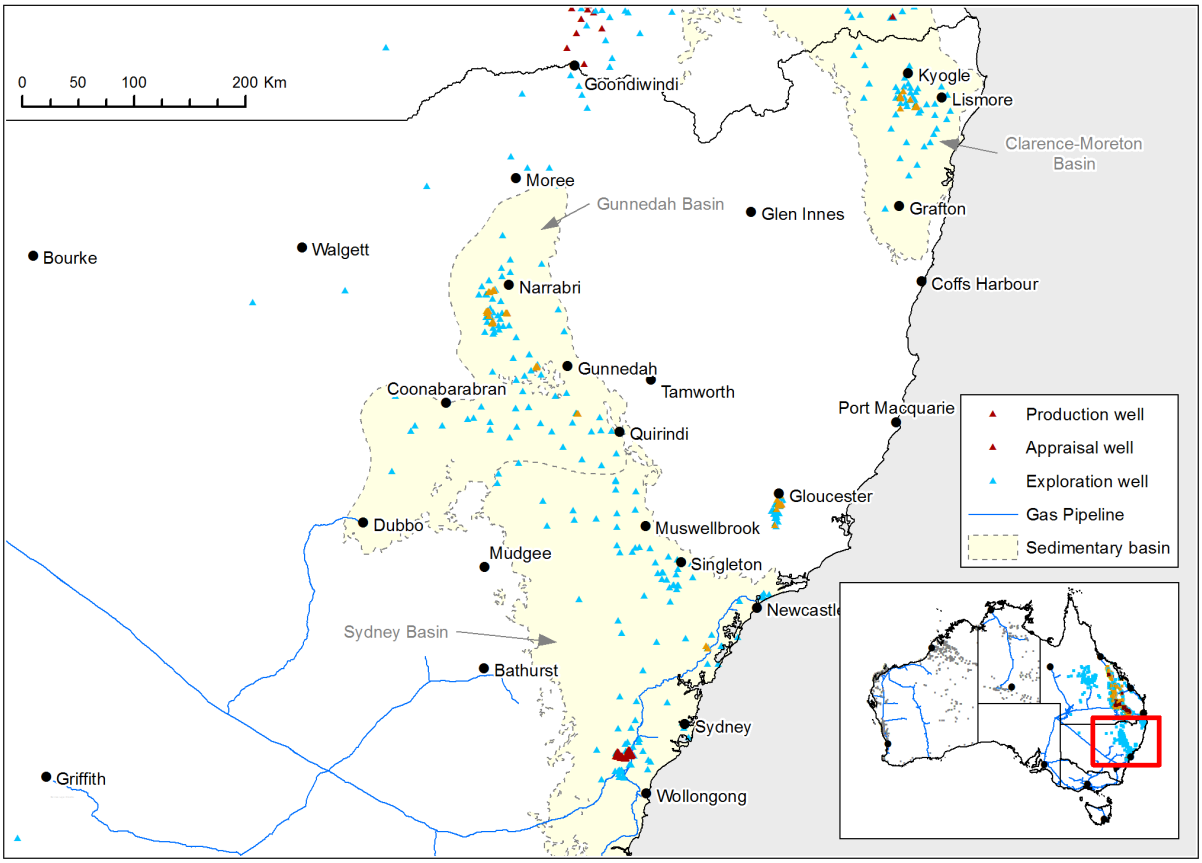


Figure 28. Coal seam gas wells, petroleum pipelines, and selected sedimentary basins in New South Wales.

The third and most notable difference between the development paths in New South Wales and Queensland is that the drilling of new wells essentially ceased in New South Wales after 2011, soon after a sharp increase in drilling activity. This cessation was the result of a moratorium imposed by the New South Wales State Government on new petroleum exploration licences.[17] This moratorium was accompanied by a host of other regulatory responses designed to manage or discourage further gas development.[18] Among these responses was a Strategic Land Use Policy which addressed land use conflicts by establishing exclusion zones around residential areas, strategic agricultural land, and the wine-making and horse-breeding industries in the Hunter Valley.[19] Meanwhile, the New South Wales Chief Scientist and Engineer undertook a comprehensive scientific review of coal seam gas activities in the state, focussing on human health and environmental impacts. In September 2014, the review concluded that many of the risks posed by the industry could be managed, but only under a comprehensive regulatory framework supported by high-quality scientific information.[20] The state government responded by placing further gas development on hold until such regulation and information could be established,

cancelling several exploration licence applications and buying back some licences that had previously been granted.[21]

4.3 Lessons from the GasFields Commission

In 2012, the Queensland Government established an independent body called the GasFields Commission Queensland (GFCQ) "to facilitate sustainable coexistence between landholders, regional communities and the onshore gas industry".[22] The group consisted of a chair plus six commissioners representing communities, landholders and the CSG industry. Following an independent review of the body in 2016, the GFCQ documented the lessons learned from the activities of the Commission and its predecessor, the Surat Basin CSG Engagement Group, which was formed in 2010.

The resulting report, titled *On New Ground: Lessons from development of the first export coal seam gas industry*, drew on insights from commissioners and commission staff, in addition to almost 80 face-to-face interviews. It provides detailed discussions of key issues and solutions with respect to governances and operations, accessing and operating on private land, and impacts on regional communities. The report identifies the following six 'golden rules' for long-term successful coexistence with landholders and the community:

- Land access is a business to business relationship
- There must be a robust and trustworthy regulatory framework
- The gas industry must understand all impacts on the community
- Trust facts not emotion (especially good science on geology and water)
- Pursue effective communications and engagement
- Leverage legacy opportunities.[23]

Communication and engagement are central to many of the lessons identified in the report, which states:

> *It is clear in the feedback from key stakeholders that mistakes were made in the development of the CSG industry in Queensland. At their core was a lack of effective communication. The speed of the development left some people feeling ill-equipped to negotiate effectively and created varying degrees of concern in the community.*[24]

The report also notes that "the recurring complaint from landholders was the lack of respect and understanding shown by company representatives",[25] and that "the most consistent calls are for better communications sooner and a greater disposition by the gas industry towards information-sharing and collaboration."[26]

Many of the lessons identified in the *On New Ground* report resonate with those identified in the present case study and serves as a useful companion to the present report as it pertains to issues of industry coexistence with landholders and communities.

4.4 Community trust and social licence

This section provides an overview of the concept of social licence and its connection to trust in the context of CSG development. It also highlights the contrasting manifestations of social licence as it affected the CSG industry in Queensland and New South Wales.

4.4.1 The social licence concept and the role of trust

Perhaps the clearest lessons to be learned from the experience of coal seam gas development in Australia concern the consequences of failing to gain the trust and acceptance of affected communities. On this front, the CSG industry had significant hurdles to clear from the outset, given its inherent environmental risks and potential for social disruption. In Queensland at least, the industry cleared these hurdles at a legal level, as all four major CSG projects gained regulatory approval. Many sectors of the community, however, remained unconvinced that the social and environmental risks could, or would, be successfully managed.

In other words, while the CSG industry gained a legal licence to conduct their business, they failed, at least in the eyes of some, to gain a *social licence to operate*. Over the last two decades, the concept of social licence has become widely used in the context of extractive industries to capture the idea that regulatory compliance alone is not enough to ensure the successful operation of a contentious project or industry. Social licence is a concept without a precise definition, finding different articulations both within scholarly literature and in the public domain, where industry and community stakeholders have each appropriated it to their own ends.

Despite the various and imprecise definitions, discussions of social licence tend to focus on similar themes. Parsons and Moffat (2014) suggest that social licence "can be seen as an intangible construct associated with acceptance, approval, consent, demands, expectations and reputation". To this list can be added the concept of *trust*, which various authors have identified as critical for an industry or company to obtain approval or acceptance from a community. For example, by analysing data collected from Australian communities affected by coal seam gas development, Moffat and Zhang (2014) found empirical evidence that trust in a resource company is the critical pathway through which factors such as procedural fairness, quality of contact with the community, and impacts on social infrastructure, can lead to higher or lower levels of community approval. While recognising the value of investments by resource companies in community infrastructure such as housing and roads, Moffat and Zhang concluded that

> *acknowledging the experiences of community stakeholders and including them in decision-making processes when dealing with these challenges seem to be more important. In large mining projects, it is inevitable that negative impacts will be experienced by local community members. Yet genuine community engagement, participation, and collaborative approaches to the development of strategies to mitigate these impacts will likely create greater community trust and acceptance in the longer term.*

In related work drawing on national surveys about trust in the mining industry, Moffat et al. (2017) have shown that community trust can be understood as a product of procedural and distributive fairness, governance capacity, and net impacts.

Stakeholder trust in the CSG industry was the subject of research data gathered using interviews and surveys with CSG stakeholders by Gillespie, Bond, Downs, and Staggs (2016). The study identified eleven key drivers of stakeholder trust. Seven of these drivers related to the actions of CSG companies with respect to: (1) integrity and transparency, (2) communication and interaction, (3) competence and efficiency, (4) community impact and contribution, (5) coexistence with landholders and the community, and having (6) a shared versus divergent identity, and (7) a positive versus negative comparative reputation. The four remaining drivers related to the CSG industry more broadly, these being: (8) environmental concerns, (9) governance and regulation, (10) uncertainty and unpredictability of the industry, and (11) the power differential between CSG companies and stakeholders.

4.4.2 Rocky relationships with landholders in Queensland

Through a survey of 561 CSG stakeholders, Gillespie et al. (2016) found that with the exception of CSG company employees, most stakeholders expressed only low to moderate trust in CSG companies and in the industry as a whole. Of the stakeholder groups surveyed, landholders expressed the lowest levels of trust. This finding is unsurprising given how interactions between landholders and CSG companies unfolded when CSG exploration first began to ramp up in the Surat Basin in the mid-2000s. Whereas earlier CSG development in the Bowen Basin had occurred in sparsely populated cattle grazing areas, exploration and subsequent development in the Surat Basin often occurred near towns and high-value farming activities such as irrigated cropping. In addition, early development in the Surat Basin occurred in a time of severe drought, creating heightened tension around the huge volumes of groundwater that were extracted incidental to the production of gas.

Under Queensland state law, gas companies with a petroleum authority have a legal right to access private land to explore and exploit underground gas resources. While authority holders must negotiate with landholders about acceptable compensation and terms of access, landholders ultimately have few legal avenues to prevent gas companies from operating on their land.[27] Furthermore, the negotiated land access agreements were usually confidential, meaning that landholders could not collectively determine fair levels of compensation. As well as being at a legal disadvantage, landholders were also outflanked financially by the gas companies, which could afford much greater access to information and legal representation.

The resulting power imbalance, combined with the urgency with which gas companies wished to explore and develop the resource, meant that relationships between gas companies and landholders began, in many cases, on an adversarial note. By acting on their legal authority without first earning the trust and approval of the most affected stakeholders, CSG operators contributed to a conflictual dynamic that would colour community relations for years to come. Indeed, when the public

did eventually mobilise in a coordinated way, it was under the banner of *Lock the Gate*—a slogan that explicitly invokes the struggle of farmers against the unwelcome entrance of gas companies.

Further contributing to low levels of trust in CSG companies in the Surat Basin, were various organisational factors that affected how interactions with gas company personnel and contractors played out on the ground. The rapid growth and restructuring that the gas companies underwent during the boom period meant that at any one moment, not all staff and contractors had learned or fully internalised their company's principles and practices of social performance. Relationships with co-workers and contractors were often not fully formed, and chains of command with respect to policies and practices were at times unclear. For the community, the rotation of staff and contractors meant that the face of a company kept changing, and personal relationships and trust were hard to establish.

These themes feature prominently in the GFCQ's analysis of lessons learned, which observes that "one of the legacies of inadequate communications in the early development of the CSG industry was the breeding ground it created for fear and confusion".[28] The report also highlights the importance of ongoing relationships and the "frustration resulting from companies changing land access representatives", the result of which is that "relationship-building with multiple company representatives is time consuming, historic interactions and issues are lost, and the company no longer takes ownership of earlier incidents".[29]

4.4.3 Social licence grows teeth in New South Wales

For all of the community opposition that CSG development faced in Queensland, the industry was ultimately allowed to proceed as planned, albeit with some amount of disruption and bad press, and under a considerable regulatory burden. One factor helping the industry in this regard was consistent support from the state government, which was enthusiastic about the anticipated royalties and regional employment outcomes. Also working in the industry's favour was that the industry's development and investment was so advanced by the time that the public mobilised against it, and that policymakers caught up, that imposing a moratorium on the industry—which many sectors of the community were calling for—was hardly a palatable option for the state government.

These protective factors were of less help to the CSG industry in New South Wales, where development was far less advanced when public opposition became vocal. As mentioned in the summary above, the NSW Government imposed a moratorium on new gas exploration licences in 2011 and implemented various other measures to slow or halt CSG development. The NSW Government's cautious stance towards the CSG industry can be read as a response to immense pressure from the electorate. Especially from 2010 onwards, opposition to the industry became highly politicised—a response that has been attributed in part to the release of the American documentary film *Gaslands*.[30] Communities mobilised against the industry in many parts of the New South Wales, but nowhere more dramatically than in the Northern

Rivers region, which lies in the north-eastern corner of the state and is as famous for its natural beauty as for its alternative lifestyles and progressive politics. Community mobilisation in this region included the blockade of a drill site at Bentley operated by the gas company Metgasco,[31] and a formally administered poll of voters in the City Council election in Lismore in 2012.[32]

According to Curran (2017), the events at Bentley, which led to the suspension of Metgasco's exploration licence, demonstrate a successful politicisation of social licence by the community, who strategically infused the concept with a powerful 'democracy frame', construing the company's actions as undemocratic given the community's strong opposition. In doing so, the community directly targeted the government, making it central to the debate and compelling it to act. In any case, this example shows how a lack of social licence can, in the right political setting, lead to an erosion or loss of legal licence as well.

4.5 Lessons for future fuels

4.5.1 Climate-friendly does not mean risk-free

As the work by Moffat et al. (2017) illustrates, the overall balance of impacts over benefits caused by mining activities is a large determinant of social acceptance, both in direct terms and via its influence as a driver of trust. Given the range of environmental and social risks posed by CSG development, it is therefore unsurprising that the CSG industry faced an uphill battle in gaining social acceptance.

While the exact nature of a prospective hydrogen industry or other future fuels development is not yet known, it seems likely that its environmental risk profile will be quite different from, and in many respects much lower than, that of CSG. The footprint of new infrastructure is unlikely to be as large or as dispersed (except perhaps in the case of wind farms) as CSG infrastructure. The amount of water needed to produce hydrogen, while significant, will not be of the same scale as the groundwater that is extracted during CSG extraction; nor are future fuels likely to involve any processes as dramatic and risky as fracking. The greenhouse credentials of any future fuel should also afford it greater public acceptance than CSG, which has been opposed as a fossil fuel and a source of methane emissions.

Nonetheless, the CSG and potential future fuels industries are not entirely without overlap in their environmental and social risks. Any new future fuels industry will require new infrastructure, whether in the form of renewable energy facilities, conversion or compression equipment, or new or upgraded transmission pipelines. If these occur near sensitive land uses, similar community responses to those witnessed with CSG development could conceivably arise. Water could also be a flashpoint with the community. As access to water for agricultural and industrial purposes is decreasing in many parts of the country (whether due to climate change or regulatory change), any new granting of water rights will likely attract considerable scrutiny and even resentment if (as was the case with CSG development) any unfairness or double-standards between uses are perceived.

The acceptance of future fuels on the grounds of their greenhouse credentials can also not be taken for granted. While 'green' hydrogen made from renewable electricity would likely be welcomed on environmental grounds, the same cannot be assumed for 'blue' hydrogen made from methane in combination with carbon capture and storage (CCS). The latter could easily be framed as an attempt by the fossil fuels industry to remain relevant while championing a technology that is viewed with scepticism by much of the public. In light of the ongoing controversy around fugitive methane emissions attributable to CSG production in Australia,[33] it is also possible that proposals to develop biomethane or synthetic methane at scale will encounter some resistance.

Future fuels developments could also conceivably have impacts on regional towns. While boomtown effects such as swelling populations, increased rents, diverted workforces and strained infrastructure, are generally associated with extractive industries, there is no reason why similar outcomes could not result from a construction boom to facilitate a future fuels industry if development were to occur rapidly and close to population centres. This possibility is noted in the COAG Energy Council's *Hydrogen at scale* issues paper.[34]

In addition, future fuel developments such as the domestic use of hydrogen could open up a new physical domain of contestation—that of suburbia. While regular maintenance of suburban gas networks often occurs with minimal fuss, a network upgrade to support the introduction of hydrogen could—like the conversion to natural gas discussed in Case Study 1—create a more sustained and intrusive presence of activity and personnel, especially if access into homes is required. This presence, combined with the novelty of the product being delivered, could trigger conflicts and anxieties if not managed well. On this front, lessons from CSG development concerning land access and public interactions—for example, ensuring that on-ground employees and contractors are well-trained and build lasting relationships—could be well heeded.

4.5.2 Communities are organised and ready

Even if the risks described above are deemed to be low in the context of future fuels development, they should be assessed in light of the fact that public trust in the gas industry as a whole, and in certain companies in particular, may still be low in the wake of the controversies around CSG. Genuine efforts by the gas industry to promote more sustainable fuels could be viewed with suspicion. Any points of alignment with CSG or fossil fuel operations are likely to be exploited by parties who simply distrust the gas industry or who view low-carbon gas as an inferior decarbonisation option to electrification.

Furthermore, if communities or consumers do decide to resist future fuel developments or products, they will be able to draw on symbolic and tactical resources developed through opposition with CSG. Networks, both online and offline, that emerged to counter CSG could be reactivated. And if consumers wanted to resist contractors entering their properties to convert pipes and appliances, they would have to look no

further for a rallying cry than the 'Lock the Gate' signs that remain fixed to some suburban front gates to this day.

4.5.3 Social licence can affect legal licence

At one level, the concept of social licence is defined as categorically distinct from legal licence: the concept is invoked precisely to emphasise that regulatory approval is not all that matters. In many cases, some separation between social and legal licence is maintained. In Queensland, for example, the CSG industry's difficulties in gaining community acceptance did not prevent it from gaining the necessary regulatory approvals to proceed (although it might have made the process less straightforward). However, the fate of the industry in New South Wales (see especially Section 4.4.3 above) shows that under the right political conditions, a community's claims about social licence can lead directly to regulatory action, including the literal loss of a legal licence to operate.

4.5.4 Pursue long-term relationships as well as short-term opportunities

The conduct of some gas companies in the early development of the Surat Basin is now widely viewed as a contributing factor to the ongoing trust problems that the CSG industry has experienced. In pursuit of an ambitious development schedule, these companies took full advantage of their legal rights to enter private land and exploit an underground energy resource. They also took advantage of their superior legal and financial resources, meaning that negotiations with landholders rarely took place on a level playing field. The legacy of this aggressive approach has been a deficit of trust that the CSG industry has had to work hard to correct. Had the gas companies acted in the early days with more restraint, and with more of an eye to building long-term relationships with landholders and communities, it is likely that the industry would have faced less of a battle in gaining social acceptance.

Like the CSG industry, a future fuels industry could conceivably come under pressure to develop at a rapid pace. In addition to meeting export supply contracts, the industry could be motivated to develop quickly in order to meet national or international carbon abatement goals or to take advantage of government incentives and market opportunities. At this stage, it is unclear how or to what extent such development could affect existing land uses or stoke tensions with communities. Should such conflicts or tensions arise, however, the future fuels industry would do well to avoid taking a 'develop-at-all-costs' attitude, and to make early investments in fostering goodwill with affected stakeholders.

4.5.5 Trust in industry is tied to trust in government

Like the case study on ethanol-blended petrol, the case of the CSG industry demonstrates how public trust in an industry can be bound inextricably to public trust in the regulator and regulatory regime. As Gillespie et al. (2016) observed in their study on stakeholder trust in the CSG industry,

> *Interviewees raised concerns about the governance and regulation of CSG operations that created trust concerns. Trust in the CSG industry was*

> *undermined by the perception that CSG regulation and legislation was ineffective (e.g. overly bureaucratic, not fit for purpose), weak (e.g. regulatory bodies lack expertise and resources, and are under staffed) and lacked the capacity to effectively monitor CSG operations and enforce standards in the field. A common perception was that the government lacked independence and was too aligned with the industry in the quest for royalties, resulting in unfair advantage and representation to the CSG companies over affected landholders and communities.*

The perceived competence and integrity of government oversight will be a critical component in building and retaining public trust in future fuels. This will apply not only to any environmental and social risks associated with the industry, but also, and likely even more so, to the safety issues surrounding the domestic use of hydrogen or other new fuels. In this regard, research conducted to date suggests that the Australian public generally trusts the government to enforce appropriate safety standards for consumers.[35] Such trust could easily be lost, however, if the perception arises that government is acting incompetently or not in the public interest.

Unless existing revenue arrangements are changed (as discussed in the COAG Energy Council's *Attracting hydrogen investment* issues paper[36]), Australian governments will not stand to gain royalties or tax revenue from renewable future fuels. Compared with fossil fuel resources, this may may therefore be one less way in which the government could be perceived to have a conflict of interest in approving future fuel developments. However, as the case study on ethanol (Section 3.2) shows, there are other kinds of arrangements and events that can tarnish a government's image in the promotion of alternative fuels. For example, if the production or use of future fuels is to be subsidised or mandated, these measures must be perceived to be to the public's benefit. Any hint of favouritism between politicians and hydrogen producers could quickly lead to the perception that the industry is being promoted without due regard for consumers' safety and choice. The issue of public benefit is discussed further in section 4.5.6 below.

Confidence in the regulatory regime was also highlighted as an issue in the GFCQ's report on lessons learned in the CSG industry. That report notes the importance of independent advisory bodies (such as the Office of Groundwater Impact Assessments) in building governance capacity and integrity amid technical uncertainty and competing agendas. The report recommends that independent advisory bodies be established early to provide factual information, facilitate stakeholder discussion, coordinate research, and facilitate issues resolution.[37]

4.5.6 Make sure benefits flow both ways

The power imbalance that characterised early negotiations between CSG companies and landholders contributed to what many perceived as a lack of *procedural fairness* in how approvals and decisions were made in the development of the CSG industry. For many stakeholders, the outcomes of these negotiations and decision-making processes was an unfair distribution of benefits, or a lack of *distributional fairness*. As covered in Section 4.4, research into social acceptance

shows that perceptions of both procedural and distributional fairness are fundamental drivers of trust towards resource companies and industries.

CSG development shows how issues of distributional fairness can arise at different scales, from the personal to the societal. At one end of the spectrum, some individual landholders felt that the financial compensation they received for hosting gas infrastructure was incommensurate with the inconvenience that the infrastructure caused, and with the profits that the gas companies made. At the community level, the disruptions to towns and economies caused by strained infrastructure, housing shortages and social disharmony were, by some accounts, not sufficiently offset by benefits such as local employment and state royalties. The industry has helped to correct this perceived imbalance through measures such as sourcing materials and labour locally, and by contributing to local infrastructure, training and services.

There have also been questions about the net benefit of the CSG industry at the state and national levels. Aside from concerns about profits flowing to foreign companies, there has been considerable debate about the impact that LNG exports have had on domestic gas prices. Whereas gas from Queensland was previously used only by domestic customers, it is now being sold at contracted quantities on the global market. This has created two related problems for domestic consumers. The first is that the amount of gas available for domestic consumption has become smaller even as the amount being produced has increased exponentially. Industry analysts have warned that eastern Australia could end up having to import gas to meet local demand, even while sending much larger quantities overseas. The second problem for local customers is that the gas fetches higher prices on the global market than it had on the domestic market. This price difference, combined with the 'shortage' created by export supply contracts, has led to increases in local prices.[38] Gas consumers in eastern Australia are effectively paying a premium to accommodate a new export industry.

One measure that has been proposed to address this issue is a gas reservation policy requiring gas producers to keep a portion of gas for the domestic market. Such a policy has been operating successfully in Western Australia since 2006. To date, however, a reservation policy has not been introduced in the eastern gas market, although the federal government came close to doing so in 2017.[39]

On this issue, there are clear parallels between CSG and a potential hydrogen industry. Hailed by some as the 'next LNG' on account of its export potential, hydrogen in Australia, like CSG, could end up being traded on both domestic and global markets. As with LNG, hydrogen is likely to be exported at contracted quantities, and potentially at a different price to that paid on the domestic market. Policy consideration may be warranted to ensure that domestic and export future fuels industries do not come into conflict. Even leaving aside the matter of price, pressures to export hydrogen could undercut any policies (such as targets or mandates) designed to increase its usage domestically.

The COAG Energy Council's *Attracting hydrogen investment* issues paper notes that several of the responses to a request for information regarding the National Hydrogen Strategy raised concerns about the overall flow of benefits from a hydrogen industry. A domestic reservation policy was among the measures suggested to address this issue.[40]

4.5.7 Every community is different

As with the introduction of natural gas and of alternative motor fuels, communities have reacted to CSG development in different ways in different places and times. The accounts given in the above sections do not do justice to the diversity of relationships and interactions between gas companies and stakeholders even within southern Queensland, let alone in other exploration and production areas. Before encountering resistance in the highly productive agricultural regions of the Surat Basin, the CSG industry had operated in the Bowen Basin for years without controversy. When the industry entered the more populated rural areas of New South Wales, it encountered a different reaction yet again.

Nor has there been uniformity within stakeholder groups. While the Lock the Gate Alliance positioned itself as speaking for farmers, its message and approach did not resonate with all farming communities. Irrigators in the Central Darling Downs, for example, organised their own campaign that emphasised mutually beneficial relationships between irrigators and gas companies, and accepted CSG development on the condition that it did not damage land or water resources. Meanwhile, many cattle graziers, especially those facing lean times, welcomed the additional income stream offered as compensation for hosting gas operations on their land.

In other words, ***context matters***. Every community is different, and no community is homogenous. As future fuel industries prepare to engage with community stakeholders, they must guard against taking a one-size-fits all approach. Any guidance and advice that is employed, including that produced by this very project, must be carefully adapted to each new situation and community, both from the outset and as projects develop. Furthermore, this task should be done by staff or contractors who are specially trained in community engagement.

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5 REVIEW OF ACADEMIC LITERATURE

5.1 Approach to the literature review

This companion chapter to the case studies is intended to take a deeper dive into the CSR-theories that underpin this report: social acceptance theory (related to trust); and, participation theory (related to stakeholder engagement).

The theoretical conceptualisations in this chapter are not meant to applied – unfiltered – into commercial contexts which have legal, regulatory, and other considerations to accommodate. They are to serve as a coherent guide or framework towards developing coherent messaging strategies which enhance the trust profile of companies working on a project in communities.

With those limitations stated, this chapter reviews two related bodies of academic literature to provide theoretical foundations and empirical reference points for this report. The first body of literature relates to the social acceptance of renewable energy technologies, and the second relates to the design of a community participation model for major projects. The relevant findings are presented below.

5.2 Social acceptance of energy technologies

Any new development in the energy sector requires careful development and strategic deployment in order to succeed. Over the past couple of decades, a body of academic literature has emerged concerning the social acceptance of energy technologies.[1] Social acceptance is directly correlated with trust, a key factor in establishing and maintaining a social license to operate (SLO).

One of the initial drivers for this research into social acceptance of energy technologies was the varied reactions by local communities to the siting of wind farms. The distribution of opinions from supportive to opposed developed despite evidence of broad public support for the technology.[2]

In addition to wind farms, researchers have examined the social acceptance of various other energy technologies including: carbon capture and storage, hydrogen fuel stations, and most recently, smart grids, micro-grids, and neighbourhood-scale distributed energy systems.[3] This section, however, specifically reviews responses to hydrogen-related technologies proposed for Australia.

5.2.1 Social acceptance of hydrogen

To date, most of the research into the social acceptance of low-carbon gases and technologies has focussed on fuel-cell vehicles and associated infrastructure, mostly in Europe. This research has revealed varied attitudes to hydrogen infrastructure, both across and within communities. Researchers have offered various explanations for the observed support or resistance, focussing on factors such as proximity to infrastructure, knowledge about the technology, and trust in government or science.[4] However, the apparent effect of these factors varies from study to study, allowing few generalisations to be made.[5]

A few studies have examined public acceptance of hydrogen beyond its automotive use. In Germany, Schmidt and Donsbach (2016) combined results from a representative telephone survey of stakeholders, analyses of stakeholder documents and German news media to better understand the acceptance of hydrogen. They found that while the most commonly discussed, and widely known arguments in support of hydrogen related to the storage of renewable energy, familiarity with these arguments did not correlate strongly with individuals' acceptance of hydrogen.

More relevant to the Australian context is a study by Lambert and Ashworth (2018) of the Australian public's perceptions of hydrogen as an energy source in a variety of contexts, including transport, domestic heating and onsite electricity generation. Drawing on findings from focus groups and a national online survey, the study found that the Australian public currently has limited knowledge about the properties and uses of hydrogen, but is generally supportive of emerging opportunities for its use. Cost, safety, and environmental benefits were identified as major factors in people's acceptance of these opportunities. Knowledge also appears to be an important factor, as people with more knowledge about hydrogen tended to be more supportive of its use. The study also found that participants were unconcerned about hydrogen being blended at 10 per cent in natural gas networks, but were less sure about higher concentrations.

5.2.2 Insights from gas network pilot and demonstration projects

Numerous pilot projects involving the injection of hydrogen or synthetic methane are underway or being planned around the world, including in Australia. These projects will potentially be a rich vein of insights into how communities react to the introduction of new fuels into gas networks. To date, however, very few published findings from these projects have emerged.

König et al. (2018) offer a small-scale study of social acceptance of power-to-gas technology in Germany, where several pilot and demonstration projects are in operation. Through phone interviews and focus groups, they found that energy experts and nearby residents were supportive of the technology and confident that the public would accept it. Important among stakeholders' for supporting the technology were its advantages as a decentralised energy solution. The source of electricity for electrolysis, and of carbon for methanation, were identified as important factors in the acceptance of new infrastructure.

In the UK, work is already underway to assess the feasibility of converting gas networks to 100 per cent hydrogen, as is being proposed in the H21 Leeds City Gate project. A report prepared by Frazer-Nash Consultancy (2018) into the logistics of hydrogen conversion includes an examination of public acceptance issues, drawing on input from a range of stakeholders including regulatory bodies, appliance manufacturers, academics, and domestic installation and servicing organisations. A stakeholder workshop produced the following list of questions that communication with householders should address to bring customers on board with a gas network conversion:[6]

- Why a conversion to hydrogen from natural gas is being proposed, and what are the benefits at a national and also domestic level?
- Whether hydrogen is safe?
- How it is likely to impact them, both physically and financially?
- When it is likely to affect them?
- What alternative choices they have to heat their home and how do these weigh up against hydrogen?

The report also emphasises that many consumers may be unwilling to tolerate disruption for environmental benefits alone, and that other benefits should be provided to homeowners to encourage their participation and cooperation. Suggested incentives included fire and safety checks, free installation or replacement of carbon monoxide detectors, assistance with energy efficiency measures such as insulation and smart meters to offset the cost of new, hydrogen-ready appliances.[7]

5.2.3 General lessons from the social acceptance literature

The academic literature on social acceptance is varied in the methods and conceptual frameworks that it employs, and there is some contestation about the basic definitions, goals and approaches that should underpin the research. Insofar as findings across studies are comparable, they are not always consistent. Nonetheless, there are a few generalisable lessons that can be drawn from this body of research.

The first lesson is that *social acceptance operates at multiple levels and across different types of social aggregation*. 'The public' is not a uniform entity that either accepts or rejects a technology. In conceptualising social acceptance, separate attention should be given to *socio-political acceptance* (relating to the public at large, policymakers and political representatives), *community acceptance* (relating to citizens directly affected by proposals), and *market acceptance* (relating to actions of consumers and investors). Along similar lines, social acceptance may also be conceived at the macro (public), meso (community), and micro (consumer or citizen) levels. Most importantly, broad public acceptance of a technology in the abstract (such as hydrogen blending) will not necessarily translate to acceptance of a particular project by individual communities and customers; indeed, individual communities often oppose applications of technologies that society as whole embraces.

A second lesson from social acceptance research is that *the drivers of social acceptance are many, and every situation is different*. Researchers have sought to explain social acceptance (or the lack of it) by relating it to various psychological, social, and institutional factors. One of the few generalisable findings that have emerged from these efforts is that *local context matters*. What holds in one community may not hold in another. Local history, politics and culture, along with evolving dynamics within and between communities, proponents and regulators, can all be defining factors in determining how and whether a community accepts an action or proposal. Proponents and practitioners must therefore avoid taking a one-size-fits-all approach to stakeholder engagement and strategic communication. Rather, these

activities must be tailored to each project and be adaptive to changes in stakeholder dynamics and the broader environment.

A third consistent lesson of the social acceptance literature is that *social acceptance is not just a factor of costs and benefits*, whether real or perceived. While impacts and outcomes do matter, acceptance is also influenced by emotive, psychological and ethical factors. Of particular importance are perceptions of *procedural fairness* – that is, whether stakeholders' views and contributions are properly and adequately considered in planning and decision-making. Procedural fairness, in addition to other factors such as distributive fairness (the fairness of material outcomes), and trust in governance and regulation, is a key driver of public trust, which in turn is an essential component of social acceptance. The importance of trust and its connection with the concepts of social acceptance and social licence are discussed in more depth in Section 4.4 in the context of coal seam gas development.

5.3 Participation theory

Participation theory focuses on community participation in government and/or industry-sponsored projects. Participation theory prioritises inclusiveness through better-informed and creative decision-making, considering the affected communities' concerns, and using local knowledge.[8] Participation built into the design of large infrastructure projects helps decrease conflicts and increases their acceptance. Communities' participation in the decision-making process gives them a confidence that their interests will be represented and positively considered.[9]

This portion of the literature review covers three dimensions of participation using a theoretical lens. The first dimension, 'people with interests', has direct relevance with stakeholder theory. The stakeholder attribute and salience model proposed by Mitchell, Agle, and Wood (1997) provides the necessary background to explore the dynamics involved in stakeholder participation. The second dimension relates to five different levels of community participation visualised as a ladder of community participation. Blending the stakeholder attribute and salience model with the ladder of community participation provides a comprehensive framework for understanding stakeholder participation. The third dimension, 'phases of initiative', is explored using the project management life cycle. While stakeholder participation is dependent upon the interests of stakeholders, their interest keeps changing at different stages of the project life cycle. Each of these aspects are discussed in turn below.

Participation can take place for a range of reasons and objectives. Active community participation increases the responsiveness of companies and governments to public opinions.[10] Public participation ensures that the decisions are explicitly described in terms of stakeholder interests.[11] Community participation helps to:

1. build project-level trust with those who will be affected,
2. identify public concerns and values,
3. develop consensus among the affected parties, users (customers) and those who pay for the project (organisations or government bodies),
4. produce better decisions, and

5. enhance democratic practice.[12]

Community participation in decision-making allows for the co-creation of ideologies and discourses constituting shared understanding instead of being driven by competitive or individualistic motives.[13] Community participation ensures the greatest satisfaction of public interests according to the available range of priorities and expectations.[14]

Community participation encourages decision making at a local level[15] to identify common challenges, needs, and opportunities and in developing action strategies.[16] However, for some, participation can seem costly. Time spent participating on a project may take away from time spent on commercial activity, domestic activity, or leisure. These opportunity costs could make a difference for particular groups or individuals to decide whether to be part of the participation process of a large infrastructure project. However, the potential benefits inherent to a project often motivate people to participate, despite opportunity costs elsewhere.[17]

There are always risks in engaging with communities and the general public. One concern from government and businesses is that involving the public will result in sub-optimal decisions.[18] However, through awareness building and consultation with industry and government, the chances of making a bad decision can be minimised.[19] Another risk is that it will be too costly to engage with the public or undertake robust community participation; that financial and temporal overruns will occur. However, the literature clearly shows that when community participation is not engaged sufficiently on the front end of a project, the costs are simply deferred to another—often less convenient—time in the project. Reactive rather than proactive engagement can result in undesirable trust and transparency issues.

Finally, community participation is recommended on the following three grounds:

(1) Community participation is a core principle of sustainable development.[20]
(2) Community participation has become mainstream in ecosystem, environment and natural resource management.[21]
(3) It is a critical component of corporate social responsibility.[22]

Principles of participation can also be used with stakeholders who are *internal* to a project. This is especially important for mega-projects where multiple organisations are co-ordinating activities to achieve a common goal. The way organisations involve employees and contractors in decision-making processes can solidify the commitment and dedication of staff.[23] Over time, participation in pursuit of organisational goals and objectives develops a strong positive relationship among and between employees and contractors.[24]

In the project management sector, communities increasingly play pivotal roles in both planning and implementation phases. Consulting with communities during planning phases ensures that any infrastructure development or upgrade project is envisaged as per the needs and requirements of the community. During the implementation

phase, communities may have the option to become involved in project execution to ensure achievement of perceived objectives.[25] This may not include areas requiring specialised technical expertise, but it could include opportunities around placement of project assets, visual amenities, sound abatement measures, or appropriate landscaping.

One major area where community participation has contributed significantly is in the infrastructure development sector of project management literature.[26] Customarily, infrastructure development projects range from construction of dams, roads, tunnels, commercial and residential buildings. In Australia, it also includes the construction of pipelines and electricity grid networks.

Depending on the scale and objectives of a project, the dynamics of community participation change throughout the project lifecycle.[27] Especially, in cases where a project has a clear objective, community participation can have a significant impact on how the project is delivered.[28] It is worth mentioning that community participation in an infrastructure mega-project is several factors more complex than a routine construction project.[29] Each community affected by the mega-project requires its own consultation, engagement and participation plan to accommodate its particular stakeholder profile.

Although, measuring the success of a project is a complex task, the most common success criteria relate to the achievement of project objectives within the stipulated time and budget.[30] However, empirical evidence of perceived project failures suggests reconsidering this success criterion.[31] A recent literature review revealed that the description of 'project success' has changed over time.[32] In 1970, only the technical aspects of a project were considered to determine success achieved. In the 2000s, researchers identified Critical Success Factors (CSFs) which incorporated stakeholder satisfaction as a success factor. The 21st century is even more stakeholder focused with the stakeholder viewpoint increasingly weighted.[33] In addition, depending upon stakeholder interests, levels of participation also vary. The level of participation also changes at different stages of project implementation as illustrated below in Figure 29.

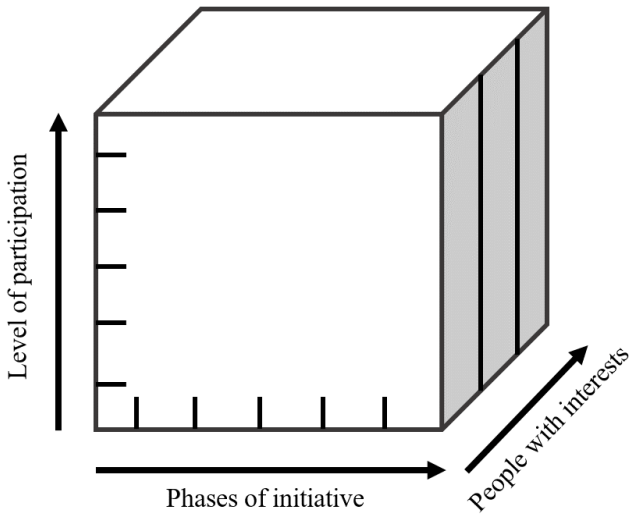

Figure 29 Three dimensions of participation

Finally, in project management literature, researchers have discussed two different dimensions of project success: macro and micro (Lim & Mohamed, 1999). Macro level success reflects the achievement of the original concept of the project. Micro-level success deals with the achievement of the smaller level of project components. If a project has achieved its small component level targets, the initiators consider it successful at the micro level; however, it does not mean that it is also successful on a macro level. The ideal situation is for a project to result in a win-win situation for all stakeholders. Unfortunately, this seldom happens as project success is subjective to judgment from different stakeholder perspectives.[34] Mega-projects are even more difficult to assess in terms of whether or not they achieved 'success' due to the vast network of affected stakeholders.

5.4 The first dimension of participation – people with interests

In CSR research, the individual and/or groups with an interest in an activity are referred to as 'stakeholders'.[35] Stakeholders are the individuals or groups that can affect—or be affected by—the achievement of a firm's objective – that is by its functioning, implementation of strategies and policies, successful achievement of goals, and objectives.[36] In a business scenario, stakeholders could be employees, shareholders, owners, investors, managers, suppliers or other beneficiaries of the business and may have power to force the firm to respond to their voice and focus on their interest. Stakeholder theory implies that decision makers such as managers of a business organisation, government and donors have the responsibility to cater to the interests of both internal and external stakeholders. Due to its theoretical depth and broad perspective, stakeholder theory has become a central theme in the academic literature.[37]

Many scholars consider Freeman the 'father of stakeholder theory'.[38] *Strategic Management: A Stakeholder Approach* (Freeman, 1984) is one of the most cited books and continues to attract the attention of researchers.[39] Stakeholder theory's popularity has burgeoned in recent years, both in academia and common

parlance.[40] Its framework is important and commonly adopted for business and management research.[41] One of the essential implications of stakeholder theory is managerial decision-making and corporate social responsibility.[42]

Stakeholder theory is used to describe shared concepts and normative concerns of the relationship between organisation and stakeholders.[43] Stakeholder theory articulates two questions: first, what is the purpose of the firm?; and second, what responsibility does management have towards its stakeholders?[44] In answering the first question, managers develop a sense for the value they want to create for stakeholders (e.g., provision of energy); and in answering the second question, managers articulate, what kind of relationship they want to create with their stakeholders including the level of participation each stakeholder should have in the project (e.g., a relationship built on trust and transparency).[45]

'Descriptive accuracy', 'instrumental power', and 'normative validity' are three distinctive but interrelated aspects of stakeholder theory.[46] The descriptive aspects tell us whether a stakeholder's interests are considered. The instrumental aspects are concerned with the impact on stakeholders; whereas the normative aspect provides the reasons why organisations must consider stakeholder's interest even in the absence of any apparent benefit to the organisation. The traditional model considers investors, suppliers, and employees as contributors while only customers are the beneficiaries. In contrast to the traditional input-output model of corporations, Donaldson and Preston (1995) present the stakeholder model (Figure 30) to reflect all persons or groups with some interest in a firm as both beneficiaries and contributors simultaneously.

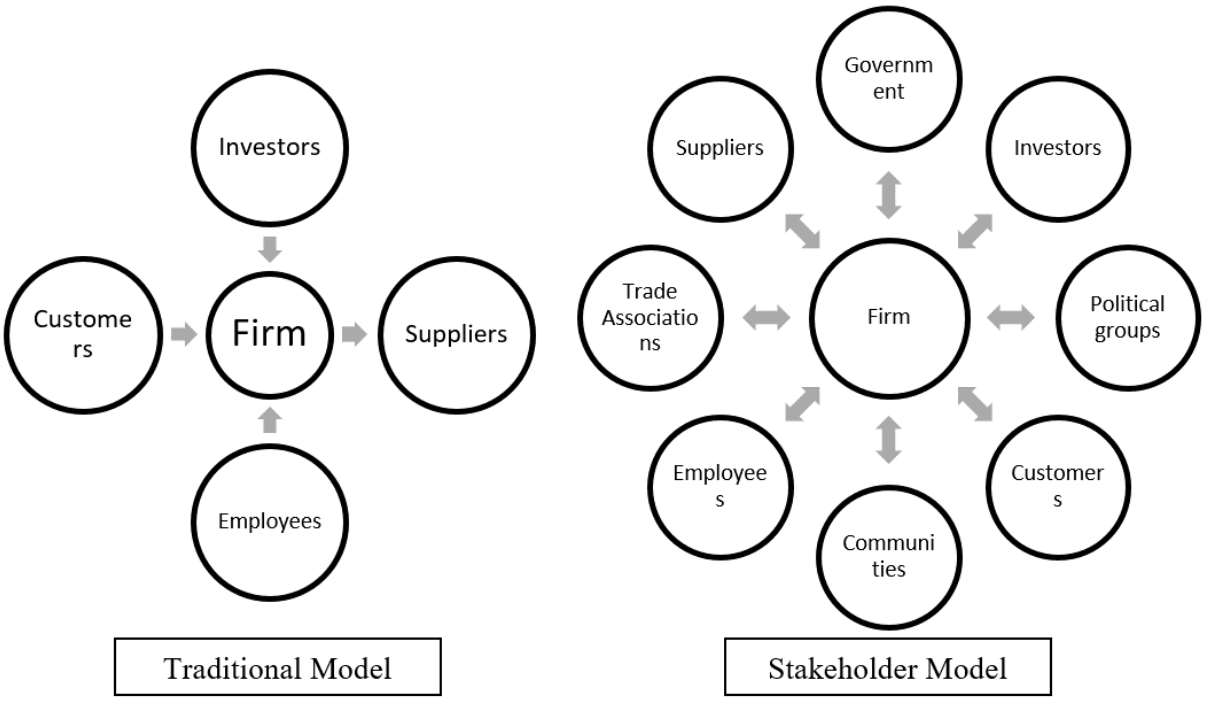

Figure 30 Traditional & stakeholder model of corporations – Adopted from Donaldson and Preston, 1995, pp. 68-69

Stakeholder theory within the CSR literature asserts that business organisations, including both firms and projects, should consider the interests of individuals or groups affected by their activities.[47] As stakeholders, each group and individual may have the potential or capacity to help or hinder the activities of the business or project.[48]

Stakeholders are categorised into two major groups: 'necessary stakeholders' and 'contingent stakeholders'.[49] *Necessary stakeholders* are those with an integral and internal connection to business. *Contingent stakeholders* are external or not integrally connected to a business. For example, shareholders such as top management, trade unions, government, customers, lenders, suppliers, employees, and partners are necessary stakeholders whereas, the public, companies connected through common trade associations, and NGOs are contingent stakeholders.

Researchers divide stakeholders into groups based on their interests: primary and secondary stakeholders;[50] principal and other stakeholders;[51] necessary and contingent stakeholders;[52] internal and external stakeholders;[53] collaborative and threatening;[54] and, fiduciary and non-fiduciary stakeholders.[55] These divisions reflect significant and insignificant interests and roles of each stakeholder. The group of stakeholders categorised as primary, principal, internal, necessary and fiduciary has significant interests and roles in the project. Their participation and involvement is necessary to achieve project objectives. Secondary, other, contingent, external and non-fiduciary stakeholders are insignificant stakeholders and they do not have any direct, positive or negative, impact on the outcome of the project. Similarly, collaborative stakeholders have a positive affiliation and role, while threatening stakeholders has the potential to negatively impact the outcome of a project.[56]

It is difficult to draw a hard and fast boundary around stakeholder interests.[57] Their interests are influenced by personal preferences, roles as well as several economic, cultural, and political factors.[58] Therefore, the identification and management of stakeholder interests is a central question.[59]

Mitchell et al. (1997) used three key attributes – power, legitimacy, and urgency – for the advancement of stakeholder-centric research[60]. Originally these attributes were identified by Freeman (1984) as essential factors affecting stakeholders' performance; however, Mitchell et al. explicitly utilised these attributes for identification of stakeholders and their salience. Identification and prioritisation facilitate assigning an appropriate level of participation to each stakeholder. Based on these attributes, Mitchell et al. divided stakeholders into eight different groups: dormant, discretionary, demanding, dominant, dangerous, dependent, and definitive stakeholders, and non-stakeholders (Figure 31).

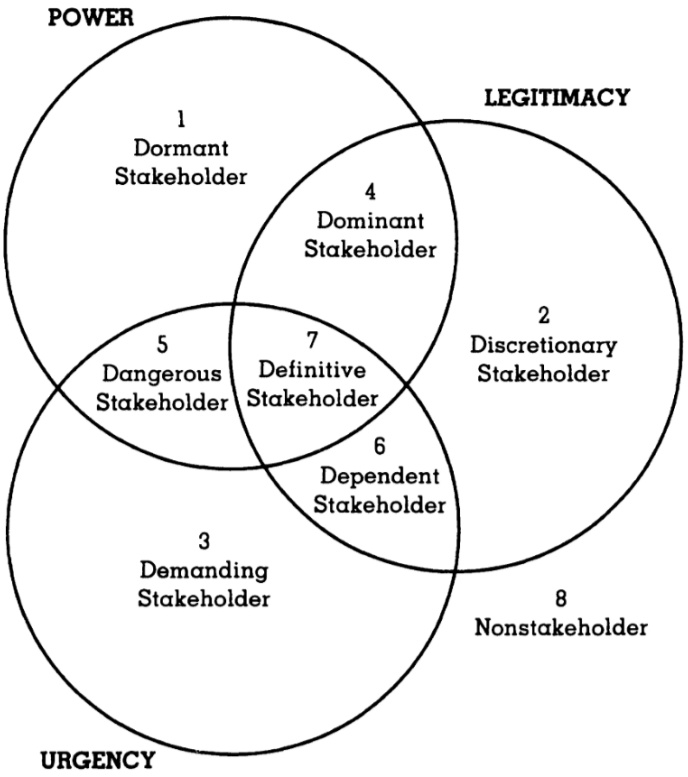

Figure 31 Stakeholder typology (Mitchell et al., 1997, p. 874)

In contrast to the other researchers, who divided stakeholders into different groups on the basis of either their roles or interests,[61] There are three basic attributes that not only define a stakeholder's degree of influence but also their salience or significance. In other words, stakeholder salience is the degree of priority for each stakeholder's claim.[62] The salience of a stakeholder will be high if all three attributes are perceived to be present in a particular stakeholder. While stakeholders with only one attribute have low-level salience, stakeholders with a combination of any two attributes are moderately salient.

Stakeholders with only the 'power' attribute are 'Dormant Stakeholders', lacking the legitimacy to use their power to influence the decision-making. They also have no urgent claim; therefore, their power often remains unused. The 'Discretionary Stakeholder' possesses legitimacy but lacks both power to influence and urgency. The sole attribute of 'Demanding Stakeholder' is urgency. These stakeholders have opinions and demands, but lack both the power to fulfil their claims and legitimacy to be heard. The salience of these three stakeholders (dormant, discretionary and demanding) is lowest due to possession of a singular attribute.

Next are the moderately salient stakeholders because of the combination of two attributes. 'Dominant Stakeholders' possess power and legitimacy, creating 'authority'. Authority not only gives a right to *make* orders and decisions but to have them *accepted* and *implemented*. Stakeholders with urgency and power are 'Dangerous Stakeholders'. They lack legitimacy, however, and might not be able to implement their interests despite power conferring importance. The 'Dependent

Stakeholder' has the legitimacy and urgency but lacks power to implement orders and decisions. To achieve their aims, they need the help of other stakeholders and in this way are dependent.

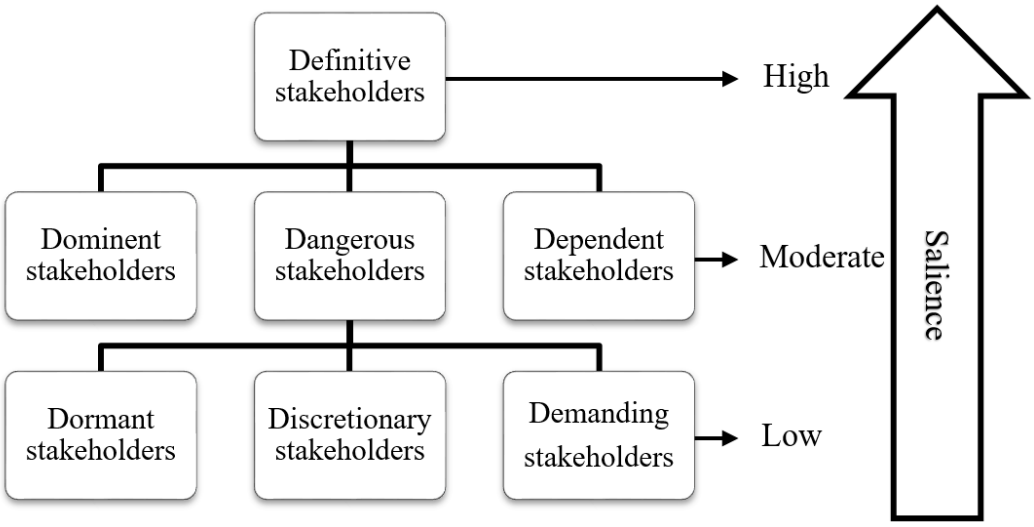

Figure 32 Salience of stakeholders

The 'Definitive Stakeholder' is the only stakeholder possessing all three attributes, and the highest level of salience (Figure 32). They have the urgency of need in addition to power and legitimacy required to implement their decision. The salience of stakeholders' increases or decreases by the attainment or loss of attributes during the project life cycle. The salience of any stakeholder is a continuous and dynamic process ripe for further research and empirical studies (Elias, Cavana, & Jackson, 2002; Parent & Deephouse, 2007). In the next section, the individual attributes are examined in detail.

5.4.1 Power

Simply, power is defined as the ability to do things.[63] In utilitarian terms, it also refers to the ability to participate and control people's resources, behaviors, and actions.[64] R. J. Yang et al. (2014) describe two different perspectives of power: resource occupation and relationship dependency. Resource occupation reflects power as an attribute of a stakeholder and suggests that the more critical resources a stakeholder acquires, the greater the power he or she has. These resources not only refer to tangible assets like money and goods but also include intangible social capital such as prestige, esteem, love, and acceptance. Consequently, the relational dependency perspective reflects power as an attribute of social relationship with other stakeholders and members of the society. So a stakeholder could be considered powerful or powerless with respect to other social actors in a specific social relationship.[65] The nature of this relationship also influences the behaviour of the stakeholder and consequently, the stakeholder with particular demands.[66]

Power may be tricky to define but it is easy to recognise because possessors of power have the ability to achieve desired outcomes.[67] There are several definitions of power

in the management literature. One definition is that power is the ability of an actor to impose its will on a relationship in a coercive and utilitarian manner.[68] Another is that power confers the means and authority for a person, or persons, to impose a decision on others.[69] Power is, "a relationship among social actors in which one social actor, A, can get another social actor, B, to do something that B would not have otherwise done".[70] Power is a dynamic attribute and a stakeholder has the power at one moment of time but not necessarily at other time.[71] Power could be acquired as well as lost and it could be an impact of external forces like political and social forces.[72] The term 'power' means a stakeholder with influence over other stakeholders to perform certain tasks to comply with his/her/their interest.

5.4.2 Legitimacy

Legitimacy is a generalised perception or assumption that the behavior and actions of any stakeholder are desirable or appropriate within a socially constructed and accepted system of values, beliefs, and definitions.[73] This socially constructed system could apply at the individual, organisation or societal levels. A behaviour is considered as legitimate only if it is congruent within a particular social context.[74] Similarly, a stakeholder is considered legitimate when their claims and actions are considered appropriate, desirable and proper.[75] Legitimacy forms a generalised assumption that a stakeholder will behave properly and will follow socially constructed norms, values, mandate, and procedure. Positive application of the legitimacy attribute enhances the chances of success of a project.[76]

The concept of legitimacy plays a central role in the normative aspect of stakeholder theory.[77] Normative refers to the reasons why organisations must consider a stakeholder's interests. To be legitimate, a stakeholder should not only follow laws and regulations, but also moral principles and values.[78] In sum, legitimacy is not only about being legal, but it also needs to be morally and socially acceptable to other stakeholders.

5.4.3 Urgency

In stakeholder theory, urgency is referred to as the degree to which a stakeholder calls for immediate attention.[79] An urgent situation means that a delay in response could either cause major damage to stakeholders or compromise the achievement of organisational objectives. Urgency is both time sensitive[80] and helps stakeholders to respond in a timely fashion.[81] The urgency attribute is different from the other two attributes due to dependency on time and external factors including resource unavailability, political agendas, project schedule, and administrative.[82]

5.4.4 The relevance of the stakeholder salience model

The stakeholder *salience and attribute model* can be used to explore stakeholder participation in the context of infrastructure projects in order to: (i) determine the significance of different stakeholders in attaining both project success and sustainability; (ii) explore stakeholder attribute dynamism and, (iii) identify the factors restricting stakeholders' participation and movement from low to high salience

position. Next, is an explanation of the significance of stakeholder salience and the attribute model in light of these three goals.

The stakeholder salience model is the first framework to close a significant gap in stakeholder theory related to stakeholder identification.[83] This model uses Freeman's (1984) stakeholder theory to prioritise: stakeholders;[84] stakeholder management strategies;[85] stakeholder influence;[86] and, the dynamics of stakeholder attributes.[87] The attribute and salience model not only provides insight for stakeholder identification, but also helps to prioritise stakeholders in order to assign them an appropriate level of participation.[88] A combined stakeholder attribute and salience model has the potential to contribute much to the normative understanding of how organisations may best manage stakeholders' interests and influence throughout a project lifecycle.[89]

5.4.5 Stakeholder theory: issues to resolve

Prioritising stakeholder attributes is an important issue for research because stakeholder salience depends on a clear hierarchy of stakeholder attributes to determine the true stakeholder salience. Scholars agree that power, legitimacy, and urgency are important attributes; however very few have tried to prioritise these attributes.[90] In one empirical study, the perspective of top management in 80 large US firms suggests that urgency is the most important attribute of stakeholders.[91] However, this finding is inconsistent with the conclusion of other scholars who consider power the most important attribute.[92] This lack of consensus leaves room for further investigation.

If the possession of stakeholder attributes is a dynamic process, and changes at different stages of the project life cycle, then Mitchell et al.'s (1997) stakeholder attribute and salience model is insufficient to accommodate and reflect these changes.[93] The stakeholder attribute and salience model is helpful to explore the stakeholder-manager relationship, but has serious limitations when exploring stakeholder-organisation relationships.[94] Despite existing research gaps, Mitchell et al.'s stakeholder attribute and salience model remains a significant contribution to the stakeholder theory.[95]

Scholars criticise the stakeholder attribute and salience model due to: lack of dynamics in stakeholder relationship;[96] the role of dependent stakeholders;[97] and the absence of networks or interaction among different stakeholders.[98] Scholars have critically analysed the attributes and raised a very basic question, "are power, legitimacy, and urgency suitable measures of stakeholder salience?".[99] In short, the stakeholder attribute and salience model is useful but not comprehensive enough to explore the dynamic nature of stakeholder salience.[100] Further research is needed to close these existing gaps.

5.4.6 Summary of the first dimension

The idea of 'people with interests' is central in stakeholder theory. Stakeholder theory asserts that businesses should also consider the interests of 'individuals or groups

affected by the business', termed as stakeholders.[101] In recent years, stakeholder theory has gained centrality not only in *academe* but also in common parlance. In management literature, stakeholder theory is an important and widely accepted theme of research. The identification of stakeholders and their interests is central to stakeholder theory. Mitchell et al.'s stakeholder attribute and salience model identifies three attributes – power, legitimacy and urgency – to recognise stakeholder and their salience. The cumulative possession of attributes reflects higher stakeholder salience. High salience stakeholders attract more attention of decision-makers compared to low salience stakeholders. The primary focus of stakeholder theory research remains on managerial decision-making and stakeholder-manager relations. The factors that affect possession of stakeholder attributes, and ultimately stakeholder salience and participation, are underexplored and require focused research.

5.5 The second dimension of participation – "level of participation"

There is a critical difference between ritualistic participation and having a real influence on the decision-making process because each can produce dissimilar outcomes.[102] Different levels of participation, therefore, is the second important dimension of participation. The difference in various levels of participation is encapsulated by management theorists in the form of a 'ladder of participation'. The initial contribution was made by Arnstein (1969) by introducing the 'ladder of citizen participation'. Arnstein's 'ladder of participation' consists of eight rungs (Figure 33). These eight rungs correspond to the extent of a citizen's control in determining the ends of a project. The first two rungs, manipulation, and therapy, equate to non-participation; the third, fourth and fifth rungs refer to tokenism, which only allows participants to share their voice. The fifth rung is the highest in this second group but still reflects that stakeholders' lack of power to affect decision-making even though they can give advice. The third group consists of the sixth, seventh and eighth rungs indicating managerial power. The eighth rung reflects the full control of participants over complete project activity.

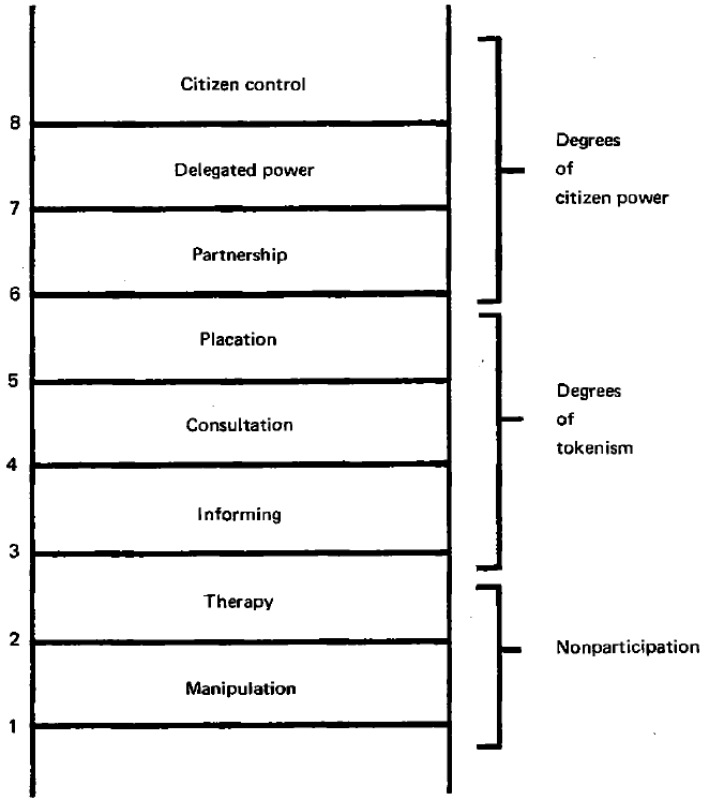

Figure 33 Ladder of citizen participation (Arnstein, 1969, p. 217)

'Empowerment' is the highest rung reflecting a community's maximum control over a project. The second step down is 'partnership', reflecting the joint decision making of a community with other decision makers, such as government and donors. 'Conciliation' is the stage where a community can share their view and can persuade decision makers to act accordingly. In 'dissimulation', communities receive information solely for approval purposes, and is the final stage in which communities can have a role. In the next step down, 'diplomacy' or 'manipulation', the other stakeholders seek an opinion from community members, but there is no assurance that their opinion deserves consideration. The 'informing' step is a one-way flow of information from project decision makers to the community without allowance for feedback. The 'conspiracy' stage refers to 'rejection', where participation is not allowed at any level. The last step is self-management when community members, without outside support, solve their problems by themselves.[103]

Subsequent research carried out by Davidson, Johnson, Lizarralde, Dikmen, and Sliwinski (2007) combined and reduced Arnstein's (1969) and Choguill's (1996) eight-step ladders of participation into a five-step process (Figure 34).

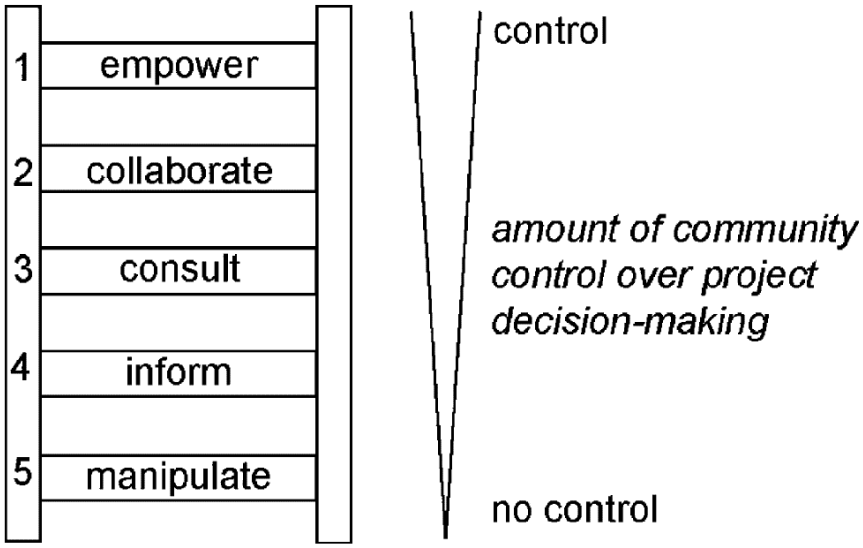

Figure 34 Ladder of community participation (Davidson et al., 2007, p. 103)

Davidson et al.'s (2007) ladder of community participation illustrates that if the community is involved in the decision making process of a project, and empowered to implement their decisions, they are at the highest level of control, referred to as 'empower'. As the levels descend down the ladder through collaborate, consult, inform and manipulate, the community loses its control over the decision-making process of a project. At the lowest level, those in power manipulate a community's interests to achieve the interests of other stakeholders. At this level, the community has no control over a project, rather, other stakeholders use the community to fulfill alternate interests.

Table 1 provides a combined view of both 'stakeholder attribute and salience' and 'ladder of community participation'. The advantage of a combined view begins to allow greater understanding of the dynamics of stakeholder attribution.

Table 1 Attributes and salience of different stakeholder groups

Stakeholder group	Attributes			Salience	Level of participation on the ladder
	Power	**Legitimacy**	**Urgency**		
Dormant	√	-	-	Low	Manipulate/inform
Discretionary	-	√	-	Low	Manipulate/inform
Demanding	-	-	√	Low	Manipulate/inform
Dominant	√	√	-	Moderate	Consult/collaborate
Dangerous	√	-	√	Moderate	Consult/collaborate
Dependent	-	√	√	Moderate	Consult/collaborate
Definitive	√	√	√	High	Empower

In the table, stakeholders with the highest level of salience achieve the position of 'empower' on the ladder of community participation. On the other hand, the low

salience stakeholders do not have any control over the decision-making process. If the community is empowered and considered as a definitive stakeholder, the community should have power, legitimacy, and urgency to affect the decision making process.[104] Without the power to make a decision, and the legitimacy to implement it, community participation will not be effective. As for the third attribute, urgency, if a project aims at fulfilling a community's need and compelling demand, the community possess the urgency attribute, naturally.

In the ideal situation, a community should be empowered (highest level at the ladder of community participation) if that community has all three attributes to be a definitive stakeholder (salience and attribute model) in order to gain control of a project. The degree of control over the decision-making process differentiates various levels of participation. As per the ladder of participation, greater control over the decision-making process represents a high level of participation, while on the other end, low control leads to non-participation and manipulation of stakeholders' interests. The ladder of participation, introduced by Arnstein (1969) is the most discussed scale of participation in management research.[105] The blending of Mitchell et al.'s (1997) stakeholder salience model and Davidson et al.'s (2007) ladder of community participation (see Table 1), provides a comprehensive view to explore the dynamics involved in stakeholder participation.

5.6 The third dimension of participation – "phases of an initiative"

An initiative, or a 'project', is a temporary but discretely well-defined endeavour undertaken to create a unique product or service.[106] A continuing and/or a routine activity could not be considered as a project, because a project has specific time, resources, and objectives, which cannot be easily achieved by the existing arrangements.[107] Project Management Institute (PMI) defines a project as: discretely

> *A temporary activity to create a unique product, service or result. The temporary nature of the project indicates a definite beginning and end. The end is reached when the project's objectives have been achieved … temporary does not generally apply to the product, services or result created by the project.*[108]

Governments, NGOs, and business organisations initiate projects to achieve certain objectives such as developing new products or services, implementing change, developing or acquiring new business models, constructing new building or infrastructure, or adopting new business models.[109] Contrary to the traditional functional organisation, the idea of project-based organisation is currently popular in the business literature due to its suitability in the management of complex and fast-changing markets, customer-focused innovation, and cross-functional business expertise.[110] A project-based firm carries most of its activities as a project to be more dynamic and to meet the expectations of the customers.[111] Many firms are using projects to accomplish specific tasks or to resolve particular problems.[112] The focus of project-oriented firms includes stakeholders. Establishment of cooperative network and trust-based relationship with its customers is a major concern of project-oriented

organisations,[113] therefore these firms are adopting project management techniques to deliver their best results while also addressing the stakeholders' needs and requirements.[114]

Although projects vary in sizes and complexity, they follow the same life cycle phases.[115] The project life cycle has four phases: initiation, planning, execution and closing or completing.[116] In the initiation phase, a project's goals, and means to accomplish these goals, are identified. In the planning phase, a more formalised set of plans to accomplish the goals are established. Support of top management and other organisations to provide necessary support in form of resources are also acquired in this phase. In the execution phase, the physical work of the project is performed. In the final phase of completion, resources assigned to the project are released and the project is transferred to its intended users.[117]

Each phase of the project life cycle has its own agenda of tasks and activities.[118] Tasks and activities of a project depend upon its size, context and objectives. Major activities in the initiation phase may include selection of asset and implementation approach, identification of required and available resources, and selection of project steering body. Subsequently, in the planning phase, detailed designs of allied infrastructure and cost estimates are prepared. If required, government, private and non-profit agencies, provide necessary support. Selection of project implementation teams, contractors and monitoring team are also completed in the planning phase. The project is rolled out on a proposed timeline and constantly monitored and adjusted as it moves towards completion.

Variation in the interests of stakeholder at different phases of the project life cycle affects their level of participation. Generally, projects range from very simple, small and short duration projects, to mega and long-term projects. Mega projects involve a large number of stakeholders with diverse interests. Due to the diverse interests of the stakeholders, it is highly unlikely that all project stakeholders will participate in the project at the same level.[119] Furthermore, the interests of stakeholders also vary at different phases of the project life cycle. For example, the government initiates many public infrastructure development projects, thus has a high level of interests and participation in initiation and completion phases. Other stakeholders, such as contractors, project professionals and suppliers do not have the same level of interests and participation in the initiation phase. However, in the implementation phase, the contractor has a high level of participation and interests.

While stakeholder participation is dependent upon their interests, it is important to analyse the interest of stakeholders at different stages of the project life cycle to understand the dynamics involved in stakeholder participation. A *project* is a temporary activity initiated to achieve a specific goal and/or objective. All projects, whether small or large, have an identifiable life cycle comprising four phases: initiation, planning, execution and closing. The activities in each phase vary according to the size, context and complexity of the project.[120] A simple project may involve only a few activities while a more complex and massive project may involve

many individual or set of activities. Likewise, a small-scale project may involve only a few stakeholders, yet a large-scale project involves interests of many stakeholders.[121] The stakeholders have diverse interests in the project, which may change at different stages of the project life cycle.

5.7 Lessons for Future Fuels

The academic literature on social acceptance and participation theory reinforces many of the themes identified in the case studies. The centrality of trust to social acceptance, highlighting the roles of procedural fairness and good governance in earning trust, have been demonstrated in numerous studies. So too has the observation that social acceptance and successful engagement are contingent on contextual and dynamic factors. More generally, there is a wide body of literature demonstrating the benefits of meaningful community participation throughout project lifecycles. At the same time, however, the literature shows that care must be taken to select appropriate engagement methods for different situations and types of stakeholders.

Specifically, it is important to be able to characterise stakeholders according to their relevance to aspects of the decision-making cycle of energy projects. With the scale of energy transition currently being contemplated at local, state/territory, and national levels, the potential to use academic terminology in a neutral way might provide more opportunities for collaboration across the sector. Suggestions for how to put these terms into practice are explored in a practical way in the companion toolkit.

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6 IMPLICATIONS AND RECOMMENDATIONS FOR INDUSTRY

"Those who do not learn from the past are condemned to repeat it."

- *George Santanaya (1938)*

6.1 High-level review

This report was designed to explore four foundational research questions (RQs) about prior infrastructure upgrades:

1. What were the drivers of earlier infrastructure upgrades and in what way were community stakeholders engaged from supply chain to whole-of-industry?

2. What factors influence the strategies industry uses to earn community trust as an important aspect of social license?

3. Which combination of methods is most effective in communicating key messages to primary community and government stakeholders?

4. What were the downfalls of infrastructure upgrade programs that were not successful and what strategies could be adopted to prevent this?

Lessons learned from addressing these questions are woven through each of the case studies reviewed in this report. Towards accomplishing that goal, a few general statements can be made of all three cases.

To answer RQ1, drivers of earlier infrastructure upgrades were very much profit-oriented. This is not surprising, given the profile of Australia's resources and energy industries and their importance to Australia's economy. The general pattern is that an energy-related natural resource is discovered (e.g., natural gas, coal, petroleum, CSG, solar, wind). Industry becomes enthusiastic about a new, valuable product that can generate vast sums of revenue. The public begins to hope for a new, less expensive fuel source. A great deal of effort and commitment is invested in infrastructure, as well as towards informing government and community-based stakeholders. This is where the similarities between the cases largely end.

The difference in each of the case studies is that the socio-political context was entirely distinct in each, as detailed in chapters 2, 3 & 4. Today's socio-political environment is different again; complicated by social media, variable quality of commercial news sources, equivocation and dissembling by politicians, and global concerns about the uncertainties of a warming planet. These developments, in combination, are unprecedented and require careful positioning by the energy sector in relation to its stakeholders.

In addition, interactions with stakeholders along the supply chain are a relatively recent development. In terms of the town gas and alternative motor fuel cases, it was not regular practice to interact with the community along the supply chain. In most cases it was the parent company or the retailer who had direct contact with the customer. In terms of CSG, the supply chain issues loomed larger simply because there were so many opportunities for contractors and sub-contractors to bid for work in a competitive and lucrative environment. That said, not all companies along the supply chain did an adequate job with community facing messaging. In fact, early in CSG development, poor practice in that area cost the industry dearly.

Regarding RQ2, community trust in large resource or infrastructure projects has declined from the high point during the town gas transition. Australia has grown from a population of around 4 million to almost 24 million in the last 50 years. Its energy needs are exponentially larger. Whereas in years gone by, the number of players in the energy space was smaller and trust in both the energy providers and government was much higher than today. There is a reason for the decline in trust. The case studies on alternative motor fuels and CSG clearly show that trust is related to the integrity of both the product and the process of excavating the product from its reserves, in addition to the perceived capability and integrity of the regulator. Ethanol and LPG were particularly vulnerable to quality and price uncertainty. CSG suffered a major loss of trust over concerns about fracking (only a small part of the gas liberation process), reliability of access to CSG at reasonable prices for domestic consumers, ongoing concern about the effect of CSG extraction on subterranean water stores, and persistent accusations of operating in bad faith towards rural landholders.

As for RQ3, the interview data did not reveal any specific combination of engagement strategies that would work in all situations. This is where the toolkit enters as a collation of industry insiders' wisdom on how to develop resilient relationships with stakeholders over the life of a project. Each community, each project team, each subset of interest groups with internal or external stakeholder groups will need a slightly different approach. Some prefer to search out information on their own on the internet. Others prefer town meetings or small group gatherings. Still others prefer circulars distributed to their mailbox or a door knock campaign. Usually, a combination of communication methods needs to be selected.

Engagement with community stakeholders is a time intensive process, but to forego the process just kicks the can down the road on engagement. As one interviewee said, either you can do the engagement up front where you have proactive control over the process, or you can wait for engagement to be sprung upon you when a group of stakeholders is tired of feeling that their concerns have been ignored.

Engagement with government stakeholders is fraught with its own challenges. The political tenor of the day often shapes the outline of what is possible. In each case study, the legacy of pre-federation continues to cause difficulties within the regulatory environment. Each state and territory has its own set of technical terms, regulations, and legislation. This complicates the operating environment for the owner/operators

and it sows confusion for the general public. Efforts to harmonise these various laws and conventions could greatly assist Australia's move towards a 'future fuels' scenario including hydrogen, renewables, biofuel, and synthetic fuels.

Two more recommendations about engaging with government emerged out of the motor fuels and CSG cases. It is vitally important that industry does not move forward faster than regulators can keep up. Robust engineering knowledge needs to be made available to regulators so that they can assist in the smooth transition to future fuels. They need to be in a position to help industry, and that is partly industry's responsibility to ensure. As learned in the early days of CSG, industry hired away the most talented regulators and then had to second them back to government in order to smooth a path forward. The second point is that the energy sector will be in a much stronger position to negotiate with the various state, territory, and federal government bodies if they are operating in a relatively cooperative manner. As seen in early transitions, when industry proponents become overly competitive with one another, all stakeholders stand to lose.

As for RQ4, the following sections synthesise some key lessons from the case studies that can the energy sector to avoid repeating the mistakes of the past.

6.2 Trying to move too fast can be costly

The case studies identified various ways in which previous infrastructure upgrades and fuel transitions stumbled or failed. One recurring lesson that emerged relates to the perils of trying to do too much, too fast, especially in the early stages of development. Although the transition to natural gas was broadly successful, problems did occur in Melbourne when the Gas and Fuel Corporation raced to achieve an overly ambitious conversion schedule. Parties overseeing comparable transitions in the future should ensure that enough time is allocated in the early stages to identify and address teething difficulties before costly mistakes are repeated at scale. The pursuit of aggressive development schedules also proved costly in Queensland's CSG boom, after gas companies invested too little time in establishing better relationships with landholders and their communities. From this experience, the energy sector can take away the lesson that short-term gains should not be pursued at the expense of building long-term relationships with affected communities.

6.3 Trust requires more than just good behaviour

Another recurring lesson from the case studies is that trust in a fuel or industry is tied to trust in the regulator. Public trust in automotive ethanol was undoubtedly damaged by the actions of independent petrol retailers who sold high-concentration ethanol blends without informing customers. Perhaps even more damaging, however, was the slow and indecisive regulatory response that followed, which in combination with perceptions of political favouritism towards ethanol producers created a trust deficit that lingers to this day. Similarly, one reason why CSG companies had so much difficulty in gaining the public's trust is that many people doubted the integrity or competence of the agencies in charge of regulating the industry. In such situations,

industry proponents will need to work doubly hard to gain and retain public trust. Maintaining an appropriate distance from government actors, and not being too eager to obstruct proposed regulations, are two strategies that may help in this regard.

In more general terms, future fuel proponents must take care to ensure that both processes *and* outcomes of new fuel developments are perceived as fair by community stakeholders. A recurring theme of the case studies and academic literature reviewed in this report is that procedural fairness and distributive fairness are both crucial components of stakeholder trust and social acceptance.

6.4 Coordination is critical

A third common cause of problems observed in the case studies is a lack of coordination or communication among different parts of the supply chain. For example, the failure of government decision-makers to consult with auto mechanics who performed LPG conversions resulted in severe mismatches in supply and demand. After generous rebates were announced, mechanics were overwhelmed and motorists were frustrated by long waiting lists. Upon announcements that subsidies would be wound back, demand collapsed and many of the same businesses were left stranded. In a related fashion, announcements about ethanol mandates had knock-on effects that in some cases unfairly disadvantaged petrol retailers.

During the CSG boom in Queensland, poor coordination between different parts of gas companies, and between companies and their contractors, exacerbated many of the conflicts that emerged with community stakeholders. At a broader level, a lack of coordination between the gas companies resulted in duplicated infrastructure and unnecessary costs. At a higher level still, the impacts of LNG exports on domestic gas markets can be seen as resulting from a failure to coordinate public and private outcomes, and/or short- and long-term goals.

Proponents of new fuels would do well, therefore, to prioritise the coordination of activities, information and stakeholders not only within the industry but also between industry and government actors.

6.5 Government policies can make or break new fuels

Given that hydrogen and most other new fuels are not yet economically competitive with the fuels they seek to replace, some amount of government involvement is likely to be crucial to the initial uptake and wider adoption of new fuels. The case studies reviewed in this report illustrate the potential power of financial and policy mechanisms to promote the uptake of new fuels, but also highlight the problems that arise when new fuels are too dependent on these mechanisms.

Financial incentives and excise exemptions helped to create fledgling ethanol industries in Queensland and New South Wales in the late 1990s. The LPG industry benefited from similar arrangements. Indeed, neither ethanol nor LPG would have ever been competitive with petrol had they not been exempted from fuel excise. In

the case of LPG, widespread adoption only happened on the back of additional government subsidisation in the form of rebates for engine conversions or new LPG-ready cars.

The problem was that these subsidies, while effective, were unsustainable. LPG and ethanol drained tax revenue while generating only modest employment and environmental benefits. Meanwhile, no technological advancements occurred to reduce the cost of these fuels, meaning that they became less competitive when the subsidies were inevitably wound back. Both fuels now occupy only a marginal place in Australia's fuel mix, even despite policies mandating ethanol sales in Queensland and New South Wales.

Since technologies for hydrolysis and other components of future fuel production are still maturing, substantive drops in production costs can be expected over the coming years. Hydrogen and some other future fuels may therefore be good candidates for short-term government subsidisation. In addition, future fuels may warrant some level of ongoing government support on the basis of their environmental benefits alone, assuming that an economy-wide price on carbon is not imposed.

Future fuels proponents should be cautious, however, about proposing or promoting policies that seek to mandate the production or retail of new fuels. As the case study on ethanol shows, mandates can be ineffectual or even counter-productive if there are structural forces limiting supply or demand. The ethanol case study also shows that non-mandated production targets can be similarly ineffectual if not accompanied by genuine incentives and economic opportunities at all steps in the supply chain.

6.6 Large-scale fuel transitions are challenging but possible

Much of this report has focussed on the challenges that face fuel transitions and infrastructure upgrades, and on highlighting the things that can go wrong. To this end, the case studies and literature reviewed provide many examples of cautionary tales and mistakes to avoid. However, the case studies also illustrate positive achievements.

In particular, Australia's transition from town gas to natural gas in the 1960s and 1970s stands as a reminder that network-scale fuel switching has been achieved in many Australian cities before, albeit in an environment that was socially and politically simpler than that of today. Importantly, the case study shows that many of the successes of these conversions were attributable not just to technical diligence and logistical care, but to considerable investments in understanding, informing and engaging with customers and the broader community.

Such investments will only be more important in the contemporary environment, where consumers are less trusting of governments and gas companies, are more diverse in their activities and cultural identities, and are more connected and empowered thanks to the internet and social media. The successful introduction of new fuels and associated infrastructure into this complex environment will occur only on the back of strategic customer engagement and tight stakeholder coordination,

not to mention well-chosen policy settings. The analyses and guidance provided by this report and the accompanying toolkit are offered here to give the Australian energy sector the best chance of rising to these challenges.

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