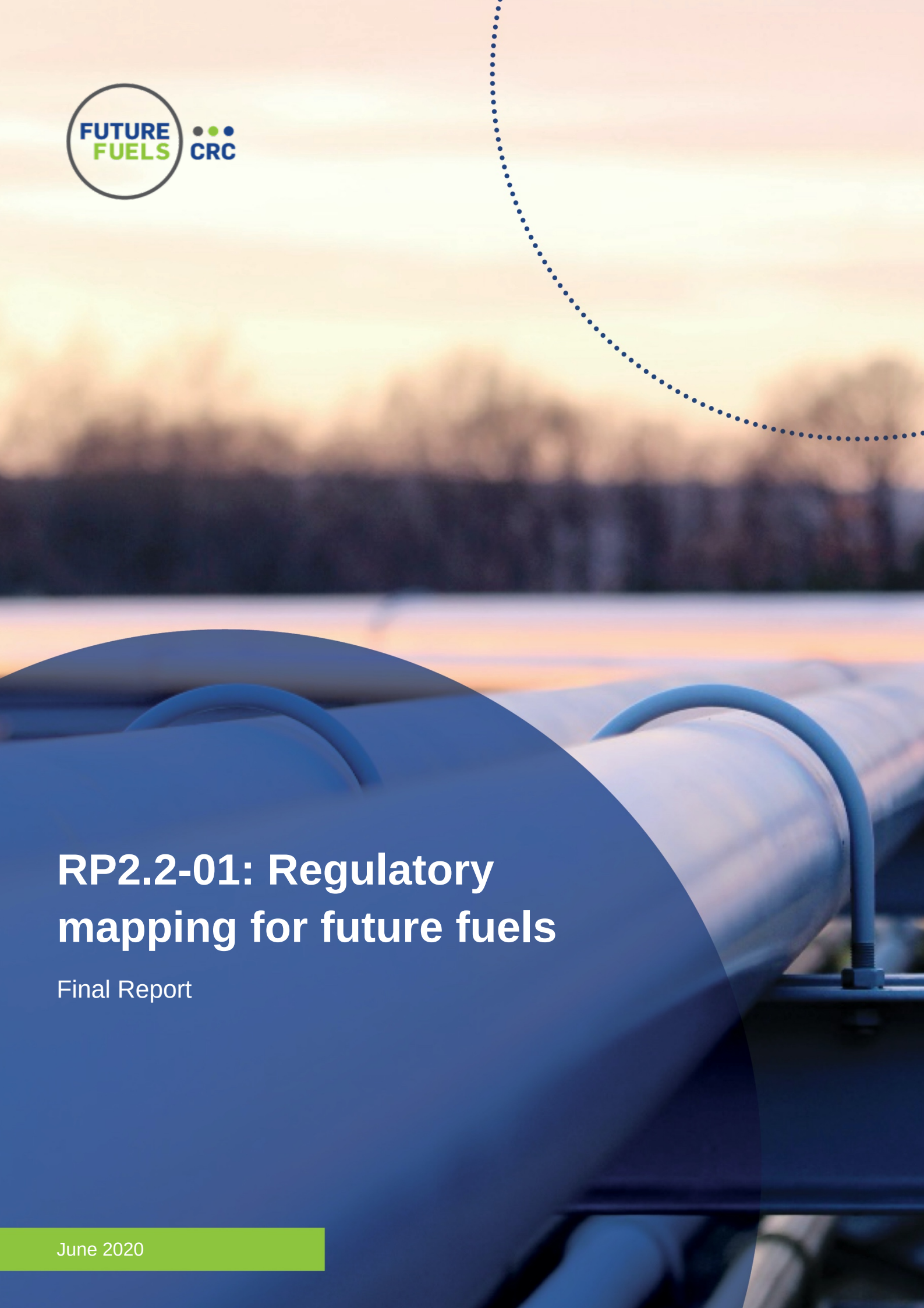

RP2.2-01: Regulatory mapping for future fuels

Final Report

June 2020

Project number: RP2.2-01

Regulatory mapping for future fuels

Authors:

Orana Sandri (RMIT)
Sarah Holdsworth (RMIT)
Jan Hayes (RMIT)
Briony O'Shea (GPA Engineering)
Daniel Krosch (GPA Engineering)
Lynne Chester (University of Sydney)

Project team:

Jan Hayes (RMIT)
Sarah Holdsworth (RMIT)
Brynne Jayatilaka (APA)
Joshua Moran (Jemena)
Briony O'Shea (GPA)
Andrew Robertson (APGA)
Orana Sandri (RMIT)
Alexandra Wickham (SA DEM)
Janice Wong (RMIT)
Enzo Alfonsetti (ESV)
Justin Betlehem (Ausnet)
Lynne Chester (University of Sydney)
Daniel Krosch (GPA)
Tyler Mason (ESV)
Dennis Van Puyvelde (ENA)
Hugh Smith (ATCO)
Scott Young (APA)

Australian Government
Department of Industry, Science, Energy and Resources

Business Cooperative Research Centres Program

This work is funded by the Future Fuels CRC, supported through the Australian Government's Cooperative Research Centres Program. We gratefully acknowledge the cash and in-kind support from all our research, government and industry participants.

Important Disclaimer

Future Fuels CRC advises that the information contained in this report comprises statements based on research. Future Fuels CRC makes no warranty, express or implied, for the accuracy, completeness or usefulness of such information or represents that its use would not infringe privately owned rights, including any parties intellectual property rights. To the extent permitted by law, Future Fuels CRC (including its employees and Participants) excludes all liability to any person for any consequences, including but not limited to all losses, damages, costs, expenses and any other compensation, arising directly or indirectly from using this report (in part or in whole) and any information or material contained in it.

Acknowledgement

This work is funded by the Future Fuels CRC, supported through the Australian Governments' Cooperative Research Centres Program. The cash and in-kind support from the industry participants is gratefully acknowledged.

Project Information

Project number	RP2.2-04
Project title	Regulatory mapping for future fuels
Research Program	Social Acceptance Public Safety and Security of Supply
Milestone Report Number	3
Description	The report identifies the existing Australian legislation (including Acts, regulations, statutory policy and referenced standards) that may restrict or prevent the introduction of future fuels such as hydrogen or biogas into existing natural gas infrastructure. The regulatory review includes relevant Acts and their associated regulations and standards across all aspects of the supply chain (extraction, manufacturing, storage, transmission, distribution and use) relevant to the introduction of future fuels into existing gas infrastructure.
Research Provider	RMIT University; GPA Engineering, University of Sydney
Project Leader and Team	RMIT: Jan Hayes, Orana Sandri, Sarah Holdsworth GPA Engineering: Briony O'Shea, Daniel Krosch University of Sydney: Lynne Chester
Industry Proponent and Advisor Team	Alexandra Wickham (SA DEM), Brynne Jayatilaka (APA), Joshua Moran (Jemena), Andrew Robertson (APGA), Enzo Alfonsetti (ESV), Justin Betlehem (Ausnet), Tyler Mason (ESV), Dennis Van Puyvelde (ENA), Hugh Smith (ATCO), Scott Young (APA)
Related Commonwealth Schedule	Commonwealth Milestone Output 2.2.1
Project start/completion date	Oct 2019/ May 2020
IP Status	Confidential
Approved by	Alexandra Wickham (South Australia Department for Energy and Mining)
Date of approval	15 May 2020

Table of Contents

1. Summary of Report

The report identifies the existing Australian legislation (including Acts, regulations, statutory policy and referenced standards) that may restrict or prevent the introduction of future fuels such as hydrogen or biogas into existing natural gas infrastructure. The regulatory review includes relevant Acts and their associated regulations and standards across all aspects of the supply chain (extraction, manufacturing, storage, transmission, distribution and use) relevant to the introduction of future fuels into existing gas infrastructure. The report provides a summary of key current regulation across three areas including safety and technical regulation, economic regulation, and environment and land use planning regulation. Detailed results are recorded in a spreadsheet which forms an electronic attachment to this report.

The report builds on previous works undertaken to assess the applicability of current legislation to future fuels. The report takes a conservative view such that industry proponents, policymakers and legislators may be better able to understand and respond to potential regulatory barriers to the introduction of future fuels such as hydrogen and biogas into the traditional natural gas supply chain.

The following summarises key findings from each regulatory area.

1.1 SAFETY AND TECHNICAL REGULATION

Manufacturing of future fuels and processing of natural gas is regulated by work health and safety legislation in most states with requirements (such as the need for a safety case) depending on the total stored quantity of hazardous chemicals. This legislation is written to cover a wide range of hazardous chemicals and so requires no modification to adequately address manufacturing of future fuels.

The safety and technical legislative framework that governs the gas transmission and distribution networks along with the end-users of natural gas is complex and varies significantly from state to state. In some states a single Act covers gas transmission, distribution and end-use, while in others separate legislation applies to each element of the supply chain.

The legislation broadly covers licensing of natural gas production (i.e. extraction), transmission and distribution assets, and the safety and technical requirements associated with safe construction, commissioning and operation of the assets as well as specification of gas quality and related requirements to ensure safe conveyance and consumption of the gas, and compatibility with installations and appliances downstream of the distribution networks.

The review has identified requirements in all states where the injection of future fuels into existing infrastructure could not be approved under the existing legislation, including where definitions of regulated substances preclude the future fuels under consideration. General themes emerging from consideration of whether the introduction of hydrogen or biogas into existing natural gas infrastructure may be conducted under existing legislation include the following reasons for precluding the substance:

- Object of the Act precludes alternate fuels such as hydrogen or biogas;
- Definition of petroleum may preclude hydrogen or biogas;
- Definition of natural gas may preclude hydrogen or biogas; or
- The substance is not contemplated under the legislation.

The legislation relies on, and in many cases specifies, compliance with standards and codes of practice to ensure that gas quality standards and other key requirements of the legislation are met for safety or security reasons. It is therefore important that the associated standards and codes of practice – particularly those prescribed as mandatory by the legislation – are also assessed to determine their suitability to specify requirements for future fuels such as hydrogen and biogas.

Existing standards that refer to fluid composition are categorised into three types:

a) Specific compositions that prescribe a speciality fluid composition or range;
b) A general fluid class which defines a fluid class such as “natural gas”; or
c) No specific composition or fluid class.

For the majority of the standards reviewed, varying fluid composition, or the introduction of a 'manufactured' fluid outside the composition range normally expected from a petroleum reservoir was either not considered or addressed; consequently, many of the standards either currently limit or prohibit unusual or non-naturally occurring components such as hydrogen, or, due to the absence of any guidance or considerations for this fluid, do not provide confidence in their application.

1.2 ENVIRONMENT AND LAND USE PLANNING REGULATION

Environmental and land use planning regulation of hydrogen and biogas manufacturing facilities varies across the different states and territories in Australia. However, due to the uniformity of dangerous goods and major hazard facility regulation across Australia, which includes hydrogen and biogas as dangerous goods, the environmental and planning triggers and processes remain unchanged with respect to the adoption of hydrogen and biogas as a fuel source in the existing network. The exceptions to this are waste and pollutants produced in the production of biogas. Carbon dioxide, hydrogen sulphide, and nitrogen are considered pollutants in environmental protection legislation across Australia. If these pollutants, among other wastes associated with biomass are produced, then biogas production differs from hydrogen production and these wastes and pollutants will need to be managed according to state based environment protection policies on a state by state basis. However, as biogas production/manufacture already exists in Australia, a regulatory framework already exists to manage these impacts, but addresses biogas for electricity generation.

Environmental and land use planning legislation across the different states and territories and across the different elements of the supply chain (manufacturing, transmission, distribution and end-use including building and appliances), use definitions of gas found within gas safety and technical legislation. Some of these definitions can preclude or limit the conveyance of hydrogen or biogas in gas networks. Definitional issues can differ between hydrogen and biogas depending on the definition of gas found within relevant regulation on a state by state basis. The following are implications for the inclusion of hydrogen and biogas in gas networks as a result of definitional issues:

- The planning legislation and associated triggers and processes that are affected by the introduction of hydrogen or biogas in transmission and distribution pipelines due to their reference to relevant pipeline legislation include the addition of:
  - 50% or more hydrogen in distribution pipelines in South Australia; and
  - any hydrogen or biogas in transmission pipelines in Western Australia.
- Where hydrogen is not included as part of a gas definition, and falls outside existing gas pipeline regulations, existing environmental management frameworks required under pipeline regulations are also omitted. In such cases, environmental approval processes would likely default to planning legislation and associated environmental management either within that framework or through a separate environmental regulatory regime. This is the case for the addition of:
  - 50% or more hydrogen into distribution networks in South Australia;
  - 100% hydrogen into transmission networks in Northern Territory; and
  - any hydrogen or biogas into both transmission and distribution networks in the Australian Capital Territory, transmission pipelines in South Australia and distribution pipelines in New South Wales.
- Gasfitting work using any hydrogen or biogas may not be licenced under existing regulations for appliances and installations in the Australian Capital Territory and New South Wales and 50% or more hydrogen in South Australia. This has implications for building occupancy permits if hydrogen or biogas gasfitting work is not licenced under existing regulations.

In addition to the above definitional implications for environment and land use planning legislation, for significant projects in all jurisdictions, Ministerial or other responsible authority discretion is a common legislative trigger. Significant projects may include pipeline works, or volume builds that require gas connections in areas where "significant" species/ecological communities or cultural heritage impacts are possible. Perceptions of risk associated with hydrogen in existing residential areas may influence environmental and land use planning processes for the construction or upgrade of gas infrastructure across the supply chain. While environmental risk from climate change lowers with a transition from natural gas to hydrogen, the different safety and technical risk profile of hydrogen compared to natural gas may challenge the safety and environmental objectives of planning and environment regulations with regards to environmental management plans, environmental impact statements, and pipeline corridor planning (such as overlays and industrial buffer distances). Increased potential

for hydrogen leakage in manufacturing, transmission and distribution and the risk this also poses with regards to third party interference are examples of how hydrogen can impact on the current objectives and decision-making criteria for such planning and environmental management instruments.

1.3 ECONOMIC REGULATION

The National Gas Law (NGL) and the National Gas Rules (NGR) determine if a gas transmission pipeline or distribution network is subject to economic regulation. The definition of natural gas contained in the NGL does not contemplate future fuels such as biogas and hydrogen. Without amendment to this definition, the scope for the injection of future fuels into Australia's natural gas infrastructure subject to economic regulation will be limited. The EU gas sector provides an example of requirements that are not fuel-discriminatory and which would permit more widescale injection of future fuels such as hydrogen and biogas into Australia's gas infrastructure.

Nearly one third of Australia's existing gas transmission pipeline infrastructure is subject to full economic regulation[1]. Over 72% of these gas transmission pipelines were commissioned more than 30 years ago, and 27% more than 46-50 years ago. This age profile suggests that regulated businesses would need to raise expenditure levels—subject to economic regulatory approval—to maintain pipeline integrity and reduce the risks of leakages and embrittlement with the injection of hydrogen, in particular.

More than 90% of distribution networks are subject to full economic regulation[2]. These networks have undertaken considerable mains replacement programs with pipes that are highly suitable to transmit hydrogen as well as natural gas or biogas.

Nevertheless, the nature of Australia's economic regulatory regime means that a significant set of issues will occur for the development and location of new gas transmission pipelines, and the use of existing regulated gas pipelines and transmission networks, for transporting future fuels. These issues arise from the processes of economic regulation structured by the NGL and the NGR, and potentially include contention about the levels of prudent and justifiable capex, efficient operating costs and safety expenditure for future fuel transport, and the inclusion or not within the regulated asset base of capital assets required to connect the production facilities of future fuels, export hubs and storage tanks to transmission pipelines and distribution networks.

The NGR, as currently written, contain a number of terms which are very open to interpretation. These terms include: 'reasonable', 'prudent', 'accepted good industry practice', 'necessary', 'maintain and improve', 'integrity', and 'comply'. This means that the economic regulator can form a view which may be at odds with that of a gas transmission pipeline or distribution network business.

There is scope for the economic regulatory process to not accept an operator's assessment of the risk posed by their gas transmission or distribution assets. This scope is provided by the discretion within the NGR for the economic regulator to determine what is a regulatory obligation or requirement. It is also provided by the authority of the economic regulator to prescribe 'micro' expenditure solutions notwithstanding the claim that only 'global' amounts for capex and opex forecasts are approved and not funding for specific projects or programs.

The issue of which future fuels-related assets are included in the regulated asset base poses a particular challenge for the economic regulatory regime. For future fuels transmission to occur, a connection with a manufacturing facility, export hub and/or storage tank will be necessary. It is this connection which poses the issue. Is the connection classified as part of the regulated asset base? Future fuels transmission cannot occur without the connection, which suggests that the capital assets denoted as the regulated assets of a transmission pipeline or distribution network will need to include the manufacturing, export hub and/or storage connection.

[1] This is based on the length (kilometres) of gas transmission pipelines, not the number of pipelines, in order to indicate the scale that is covered by the economic regulatory regime, and has been calculated from data in the Australian Energy Market Commission's *Gas Scheme Register*, and Vertigan's 2016 *Examination of the Current Test for the Regulation of Gas Pipelines* for the COAG Energy Council.
[2] See footnote 1.

2 Introduction

Decarbonising economies around the world to reduce the impacts of climate change is the great challenge of our time. The Australian Government, along with states and territories, have responded to this challenge by committing to a number of policies that aim to curb Australia's carbon emissions. On 10 November 2016, Australia ratified the Paris Agreement and the Doha Amendment to the Kyoto Protocol, reinforcing the Government's commitment to action on climate change. A critical part of decarbonisation is a transition to low carbon energy sources to power Australian industry, transport, businesses and households. Fuels such as hydrogen and biogas represent such energy sources and show great potential as future fuels to power a decarbonised Australian economy. This is recognised through initiatives undertaken by the Australian Government along with the states and territories to identify opportunities to support the transition to these low carbon fuels for both export and domestic use. The National Hydrogen Strategy and associated work are an example of governments' commitment to supporting future fuels across Australia. Through this work, it is recognised that Australia must develop reliable and affordable low carbon energy sources, suitable for commercial and residential energy needs into the future. In response to this national agenda, this report provides a review of legislative barriers within all Australian jurisdictions that need to be considered and addressed to support the transition to a future fuel economy within the existing gas networks of Australia. The purpose of this report is twofold. Firstly, this report provides input to companies who may be looking at specific future fuels projects so they can anticipate potential legislative barriers. Secondly, this report highlights to policymakers and legislators, issues that need to be resolved to remove potential regulatory barriers and support the sector going forward.

Australia's gas infrastructure is governed by a range of Acts, regulations, statutory policies and referenced standards (all referred to in this report as 'legislation') at state and Commonwealth levels. Legislation has been written on the basis that natural gas is the fuel used or contained in gas infrastructure. Definitions of natural gas vary as will be described further below, but it is typically defined as a gas that is primarily methane produced by extraction from geological reservoirs. Moving to a lower carbon economy can be facilitated by inclusion of other flammable gases in the fuels provided to natural gas users. A change to 'future fuels' means that different gases (hydrogen and biogas) with associated chemical properties and risk profiles will be introduced into the existing system. The scope of this review is to identify cases where introduction of future fuels affects the intent of these existing regulatory frameworks in meeting stated objectives, and hence where there may be difficulties in approving these projects under existing regulatory regimes relevant to natural gas. Future fuels considered are:

- Hydrogen blended into the natural gas system to a level of 10% or 50%;
- 100% hydrogen;
- Biogas blended into the natural gas system to a level consistent with current natural gas quality specifications; and
- 100% biogas (meeting current quality specifications).

It is important to note that this project is not primarily a review of whether future fuel blends can meet the technical requirements of legislation. The report will not determine, for example, whether a blend of 50% hydrogen meets the technical requirements of specific legislation, but rather evaluates whether or not such a blend may or may not be regulated by a piece of legislation as it is currently drafted.

Recent reports such as those issued by Standards Australia, the CSIRO'S National Hydrogen Roadmap, the COAG Energy Council Working Group and the National Hydrogen Strategy have identified the need to reform key legislation, regulation and standards to support the transition to a hydrogen economy. This, however, requires a deeper understanding of regulatory frameworks and their existing consideration of hydrogen as a fuel source, so that they can be updated where relevant. Two projects as part of the National Hydrogen Strategy have been undertaken recently that begin such review work.

The COAG Energy Council's Kickstart Project report 'Hydrogen in the Gas Networks' prepared by GPA Engineering for the South Australian Department for Energy and Mining and the Future Fuels Cooperative Research Centre, began such regulatory review work for the inclusion of a 10% blend of hydrogen into existing gas distribution networks across Australia. The review included legislation, regulation and standards to understand the gas quality, materials, network capacity and blending, and safety and risk impacts to the natural gas distribution network. The review found that, overall, there are no significant regulatory, gas quality, safety and risk aspects, materials, network capacity or blending implications with the introduction of up to 10% hydrogen in

distribution networks. There are however definitional issues within regulation in some jurisdictions resulting in some uncertainty for governance of distribution pipelines conveying blends of hydrogen.[3]

The 2019 report, 'Hydrogen Industry Legislation', prepared by Clayton Utz for the Department of Industry, Innovation and Science as part of the National Hydrogen Strategy also undertook a review of legislation, regulations and standards (Law) potentially relevant to the development of a hydrogen industry in Australia. The Hydrogen Industry Legislation report also made recommendations to facilitate the development of laws to support the hydrogen industry in Australia. This high level review identified legislation, regulation and standards relevant to a hydrogen industry in Australia.[4]

In addition to the two reports commissioned for the National Hydrogen Strategy, this work also builds on a report prepared by Johnson Winter & Slattery (JWS) for Energy Networks Australia, which considered the introduction of hydrogen or biogas into existing gas distribution networks in each jurisdiction in Australia. The JWS report reviewed only safety and technical regulation directly relevant to gas distribution networks, and did not consider the rest of the natural gas supply chain (production, transmission and end-use); nor did it consider non gas industry specific legislation such as environment and land use planning. In general, the JWS report took a more liberal interpretation of legislation than has been done in this analysis. A key example is consideration of the definition of *natural gas,* which would preclude hydrogen or biogas under the interpretations used in this report, but was interpreted by the JWS report not to pose any barrier to the blending of hydrogen in an existing natural gas distribution network. Conversely, this report has taken the interpretation that not contemplating, or excluding a gas such as hydrogen or biogas from the definitions employed by specific legislation, should be interpreted to mean that the gas is not covered by the legislation, and that this legislative omission should be rectified by policymakers and legislators, where possible, so as to maintain certainty for future projects aiming to introduce future fuels such as hydrogen or biogas into the existing natural gas supply chain. This work poses the question, if the legislation under review were *intended* to regulate future fuels such as hydrogen or biogas, what barriers are there to this regulation, and in such cases, what mitigative action should be taken?

This research has built on these studies to provide a broad overview of relevant Australian legislation sensitive to the fluids contained or used in gas infrastructure. The research project is guided by the following questions:

- What regulations exist in each state/territory and at Commonwealth level that impact natural gas infrastructure?
- Which parts of these regulations are specific regarding the gas composition/type/source of gas that they address?
- Are regulatory changes required to ensure that future fuels are appropriately covered?
- For future fuels not covered by hydrocarbon-based legislation, such as 100% hydrogen, what regulations apply and are they consistent with use of these substances as fuels?
- Are regulatory decisions significantly impacted by changes to gas composition and are decisions still consistent with policy objectives?

This review looks at regulations across the gas supply chain. The introduction of future fuels (in particular hydrogen and biogas), into the Australian gas networks, or the manufacture and transport of hydrogen for export, can occur in several ways, each with a different supply chain structure.

Unlike naturally occurring hydrocarbons (such as natural gas) which are extracted from the earth, hydrogen is manufactured from water in three main ways. It may be manufactured through electrolysis using electricity produced from renewable or non-renewable energy sources, or through thermochemical reactions using coal (gasification) or natural gas (steam methane reforming)[5]. For domestic consumption, hydrogen manufacturing

[3] GPA Engineering (2019) COAG Energy Council Hydrogen in the Gas Networks Kickstart Project: Technical and regulatory review (V2). Department for Energy and Mining (SA) and Future Fuels Cooperative Research Centre, http://www.coagenergycouncil.gov.au/sites/prod.energycouncil/files/publications/documents/nhs-hydrogen-in-the-gas-distribution-networks-report-2019_0.docx

[4] Clayton Utz (2019) Hydrogen Industry Legislation, Department of Industry, Innovation and Science http://www.coagenergycouncil.gov.au/sites/prod.energycouncil/files/publications/documents/nhs-hydrogen-industry-legislation-report-2019_0.pdf

[5] COAG Energy Council (2019) Australia's National Hydrogen Strategy, Commonwealth of Australia https://www.industry.gov.au/sites/default/files/2019-11/australias-national-hydrogen-strategy.pdf

facilities can be located near sources of natural gas which are usually far from towns and cities. In this case, existing high pressure gas transmission pipelines could be used to convey hydrogen or blends of hydrogen with natural gas over long distances to distribution networks. Alternatively, hydrogen production could occur on a smaller scale and be located close to existing distribution networks thus feeding directly into these networks. This approach avoids potential technical corrosion issues linked to introduction of hydrogen into high pressure transmission systems. Hydrogen can also be transported via trucks, ship and rail.

For export, the concept of a 'hydrogen hub' has been advocated by the International Energy Agency and also explored as part of Australia's Hydrogen Strategy. 'Hubs could be coastal industrial clusters or co-located near ports'[6] allowing for the manufacture of hydrogen in close proximity to ports for exports or industrial end-uses.

Manufactured hydrogen also needs to be stored and this can be done in one of three ways; as compressed or liquefied hydrogen or 'attached to a chemical carrier'[7]. End-uses of hydrogen will include consumer installations and Type A and B appliances, as well as use of hydrogen as a feedstock, rather than a fuel (although this report only addresses hydrogen use as a fuel).

The components of the hydrogen supply chain will depend on how it is produced and what it is intended to be used for, as well as safety and technical regulation and capacity of existing infrastructure, planning and environmental regulation and energy market regulation. The use of hydrogen as a fuel in vehicles is not within the scope of this report.

Although biogas is popular for use in electricity generation, the focus of biogas in this report is on injection into existing gas networks for residential and industrial consumption in gas appliances. Like hydrogen, biogas requires manufacturing, however, with the use of raw materials such as agricultural and municipal wastes, food wastes and other animal wastes or plant-based materials. Biogas is typically produced by breaking down these raw materials within an anaerobic digester which uses a closed system to allow the production of gas which is then captured and stored. This gas may then be further processed as required to meet the same specifications as natural gas and injected into gas transmission or distribution pipelines, or it can be produced on-site and supply gas for direct industrial use such as manufacturing plants[8].

The review captured safety and technical aspects of the gas infrastructure and industry while more broadly investigating other regulatory areas such as environmental and land use planning/development regulation and economic (market) regulation.

Safety and technical legislation, including standards, govern the minimum requirements and performance of the physical gas infrastructure and associated management practices, and in some jurisdictions is the main legislation governing all aspects of a pipeline development from licensing and environmental impact management through to operation and maintenance and eventual decommissioning. Environmental and land use planning legislation may apply to the construction and upgrade of gas infrastructure through mechanisms such as environmental impact assessments, environmental management plans, licencing of works and permits to generate pollution and waste (including gas), and mechanisms such as zoning to control land use. Economic legislation controls elements of the gas market across the supply chain and coordination of gas markets across Australia. Combined, these regulatory areas shape and control Australia's gas infrastructure to ensure safety, environmental, community and economic needs are met. Within this complex regulatory landscape there is the potential for barriers to arise that constrain the inclusion of future fuels in the gas supply chain such as the definitional issues found by GPA Engineering's review of gas distribution regulation. Along with this summary report, the review has produced a regulatory database to be used as a reference by other Future Fuels CRC projects. See Section 3.1 of the report for more information about the regulatory database.

[6] COAG Energy Council Hydrogen Working Group (2019) Australian Hydrogen Hubs Study, Arup Australia http://www.coagenergycouncil.gov.au/sites/prod.energycouncil/files/publications/documents/nhs-australian-hydrogen-hubs-study-report-2019.pdf
[7] COAG Energy Council Hydrogen Working Group (2019) Australian Hydrogen Hubs Study, Arup Australia http://www.coagenergycouncil.gov.au/sites/prod.energycouncil/files/publications/documents/nhs-australian-hydrogen-hubs-study-report-2019.pdf
[8] ENEA Consulting (2019) Biogas opportunities for Australia https://www.energynetworks.com.au/resources/reports/biogas-opportunities-for-australia-enea-consulting/

3 Research Methods

The first stage of the project comprised a desktop review of existing Acts, regulations, standards and statutory policies (referred to in this report as 'legislation') covering all state and Commonwealth jurisdictions across the existing gas network supply chain. This included relevant regulations governing:

- gas appliances (both domestic and industrial);
- distribution networks;
- transmission pipelines; and
- production/manufacturing facilities.

The focus of this project is on capturing the breadth of legislation across the sectors that influence the existing gas network functioning including:

- safety and technical legislation;
- environmental and land use planning and development;
- economic legislation; and
- other legislation that may be sensitive to the types of fuel used or contained in gas infrastructure.

The legislation was identified by, firstly, searching the legislative databases in each jurisdiction, using key words such as: appliance, gas, easement, hydrogen, biogas and gas related standards (see Appendix 1). Standards included in the review were limited to those referred to by the relevant legislation.

Legislation that was not relevant to the existing gas networks was removed (such as that relating to drugs, or weapons or any that mentioned a key word such as 'gas' but did not govern or affect the gas supply network), after the initial scan was completed. Relevant legislation was inserted into a spreadsheet database (see Section 3.1) and reviewed by regulators and industry stakeholders in Victoria and South Australia. Confirmation of relevant legislation was provided and any omissions were included in the database.

From this, a final analysis was undertaken on the remaining likely relevant legislation to determine sensitivity to the induction of hydrogen or biogas at the concentrations described earlier.

The sensitivity[9] of the legislation was determined based on a review of the document and any associated guidance materials. Historical case studies, for example an Environmental Impact Assessment document for a pipeline upgrade, were also used to confirm how legislation is applied by government bodies and industry.

3.1 SPREADSHEET DATABASE

The database accompanying this report is in the form of an Excel spreadsheet that lists Australian legislation and standards that are relevant to the governance of existing gas infrastructure across the supply chain.

Legislation for each state and territory is listed on a separate worksheet within the spreadsheet. Commonwealth level legislation and Australian Standards are also listed on separate worksheets. These worksheets can be navigated by selecting the tabs at the bottom of the Excel window.

Within each worksheet, legislation is listed in rows and can be sorted using the headings in Row 1. Document type (i.e. Act or regulation), title, year and jurisdiction are listed in columns A to D. With the exception of the "Standards" worksheet, the primary headings (in Row 1) include:

- Infrastructure stage;
- Supply chain stage;
- Composition/fuel type considered;
- Regulatory function; and

[9] Sensitivity means that the terms set out in the regulation may restrict or stop the introduction of hydrogen or biogas fuel within existing networks or change regulatory processes and triggers with a change from natural gas to hydrogen or biogas.

— Impacted by (impacts on) a change in fuel type/mix.

These primary headings contain subcategories (in Row 2) that specify what infrastructure and supply chain stage and what composition/fuel type is considered by each regulation, the regulatory function that each regulation serves and if the regulation is impacted by, or impacts on, a change in fuel type/mix from natural gas to hydrogen or biogas. The implications for different blends of hydrogen are also listed under this primary heading.

For columns E to W, if a category (in Row 2) is applicable to the listed item, then a “Y” will be present in the aligning cell to indicate that this category is applicable. If the category is not applicable, then the aligning cell is left blank.

Columns X to AE show if, and how, each item is impacted by (or impacts on) a change in fuel type/mix from natural gas to hydrogen or biogas. If the regulation is impacted by (or impacts on) a change in fuel type/mix, then a “Y” is present in the aligning cell. If the regulation is not impacted by a change fuel mix or there are no regulatory implications, then an “N” is present in the aligning cell. Further explanatory detail is provided for the selection of either a “Y” or an “N” in the cell directly to the right of these columns (in columns X, Z, AB and AD).

Further detail about the impacts on or applicability of each regulation is provided in column AF and potential actions that can be taken for regulation that is sensitive to a change in fuel, as well as references to relevant sections of the report, are listed in column AG.

For the “Standards” worksheet, similar headings are used to categorise each relevant standard listed in the rows. There are, however, differences in the column headings in order to capture data specific to Australian standards. Columns V to AC detail the suitability of each standard for the gas composition/type. If the standard is suitable for the gas composition/type, then a “Y” is placed in the relevant column for the gas composition/type. An “N” is placed in the aligning cell for gas composition/type that are not suitable for the standard.

4 Research Findings

4.1 LEGISLATED DEFINITIONS OF GASEOUS FUELS

One of the key issues in considering whether or not future fuels and future fuel / natural gas blends fall within the scope of existing legislation lies in the various definitions of petroleum / natural gas. Before discussing the detailed findings of the review, it is instructive to set out the interpretations that have been used in relation to key definitions.

Many legislative instruments rely on the definition of natural gas used in the National Gas Law, either by reference to it, or by reproducing this definition. Section 2 of the NGL provides that:

> Natural gas means a substance that—
>
> d) is in a gaseous state at standard temperature and pressure; and
> e) consists of naturally occurring hydrocarbons, or a naturally occurring mixture of hydrocarbons and non-hydrocarbons, the principle constituent of which is methane; and
> f) is suitable for consumption.

Of particular note is the requirement that natural gas be 'naturally occurring' or 'a naturally occurring mixture'. The interpretation used in this report is that neither hydrogen nor (generally speaking) biogas is naturally occurring and so biogas, hydrogen or blends of these gases with natural gas are not currently covered by legislation that uses this definition. It is acknowledged that this may be conservative, but we believe this is appropriate for a review such as this to highlight.

Other legislation does not reproduce the NGL definition but rather uses a uniquely crafted definition of natural gas. In some of these, the term 'naturally occurring' is used idiosyncratically e.g. 'naturally occurring or processed mixture'. These have been evaluated on a case by case basis and are detailed in the spreadsheet.

The only legislation identified in this review that addresses this issue directly does not provide definitive clarification, The National Greenhouse and Energy Reporting Regulations 2008 (under the *National Greenhouse and Energy Reporting Act 2007*) includes the following definitions:

> **Primary fuel** or energy commodity means a fuel or energy commodity **extracted or captured from natural sources** with minimal processing ….

and

> **Secondary fuel** or energy commodity means a fuel or energy commodity **produced** by converting energy from one form (usually a primary fuel or energy commodity) to another form for consumption ….

Schedule 1 of this legislation lists landfill biogas and sludge biogas as primary fuels and so, referring back to the definitions above, they are seen to be coming from natural sources. This may provide a model to follow but other aspects of the same set of definitions create other problems. Natural gas conveyed through a pipeline is considered a secondary fuel in Schedule 1 of the Regulations and by implication biogas in a pipeline would be considered similarly. This source is therefore not a clear guide as to how biogas (blended with natural gas or otherwise) is defined in legislation. In these regulations, hydrogen still requires nomination.

Several industry advisers have advised us informally that they are of the view that biogas is naturally occurring. In any case, the aim of this report is not to make a case one way or another regarding the extent to which biogas is naturally occurring, but rather to point out the implications of uncertainty around this issue when it comes to potential regulatory barriers to further future fuels development.

A second definitional issue relates to usage of the terms 'production' and 'produced'. In some legislation these terms are used to mean extracted from a geological reservoir. In other legislation, the terms refer to substances that have been manufactured. Biogas and hydrogen have been treated in the analysis as manufactured products. Cases where it has been interpreted that 'production' means 'extraction', and so biogas / hydrogen are potentially excluded, have been highlighted in the spreadsheet.

The final definitional issue relates to the level of future fuel gases that can be blended into natural gas according to gas definitions. Many definitions include gas mixtures provided they are 'primarily' or 'predominantly' methane (or hydrocarbon in other cases) or have methane as their 'principle constituent'. The analysis assumes that all such wording precludes gas blends of 50% or more of non-methane constituents (such as hydrogen) but that a 10% hydrogen blend would be acceptable. In practice, technical issues may determine the desired blending concentration, but from a legal perspective the limit may be somewhere between 10% and 50% depending on the composition of the gas it is blended with, such that the required 50% methane is maintained.

4.2 SAFETY AND TECHNICAL REGULATION

4.2.1 Production

The primary legislation related to technical safety matters relevant to manufacturing of future fuels are the requirements for major hazard facilities and dangerous goods. These regulations are designed to cover multiple chemicals and are broadly fit for purpose for hydrogen or biogas manufacturing as they are for natural gas processing.

Major hazard facilities requirements

The most hazardous chemical facilities fall under the scope of what is generally known as major hazard facility (MHF) regulations in each state and territory. Whether or not a facility falls under this regime is determined by the quantity of various hazardous chemicals present on a given site. The threshold quantity of stored hydrogen is 50 tonnes as shown in Table 1 which also lists the relevant regulations in each state or territory. It should be noted that this is only 25% of the threshold quantity for methane (which applies to either natural gas or biomethane).

Preliminary design data indicates that some proposed hydrogen production facilities may exceed this trigger (more than 50 tonnes of hydrogen) and hence fall under this regulatory regime. As can been seen in Table 1, the threshold quantities are common across all states and territories; other MHF requirements have also been almost entirely harmonised based on the model WHS act and regulations produced by the Commonwealth.

Major hazard facilities require a safety case submission addressing requirements for formal risk assessment and safety management systems. These requirements are well established, and no hydrogen-specific regulatory issues are anticipated in these regimes.

Table 1: Major hazard facilities threshold quantities and regulations by state/territory

Jurisdiction	Regulation that governs MHF	Threshold quantity of HYDROGEN	Threshold quantity of METHANE or NATURAL GAS
Commonwealth	*Model Work Health and Safety Regulations*, Schedule 15 – Hazardous chemicals at major hazard facilities (and their threshold quantity)	50 tonnes	200 tonnes
NSW	*Work Health and Safety Regulation 2017*, Schedule 15 – Hazardous chemicals at major hazard facilities (and their threshold quantity)	50 tonnes	200 tonnes
QLD	*Work Health and Safety Regulation 2011*, Schedule 15 – Hazardous chemicals at major hazard facilities (and their threshold quantity)	50 tonnes	200 tonnes
VIC	*Occupational Health and Safety Regulations 2017*, Schedule 14 – Materials at major hazard facilities and their threshold quantities	50 tonnes	200 tonnes

Jurisdiction	Regulation that governs MHF	Threshold quantity of HYDROGEN	Threshold quantity of METHANE or NATURAL GAS
ACT	*Work Health and Safety Regulation 2011*, Schedule 15 – Hazardous chemicals at major hazard facilities (and their threshold quantity)	50 tonnes	200 tonnes
SA	*Work Health and Safety Regulations 2012*, Schedule 15 – Hazardous chemicals at major hazard facilities (and their threshold quantity)	50 tonnes	200 tonnes
TAS	*Work Health and Safety Regulations 2012*, Schedule 15 – Hazardous Chemicals at Major Hazard Facilities (and their threshold quantity)	50 tonnes	200 tonnes
WA	*Dangerous Goods Safety (Major Hazard Facilities) Regulations 2007*, Schedule 1 – Threshold quantity for Schedule 1 substances	50 tonnes	200 tonnes
WA	*Gas Standards (Gas Supply and System Safety) Regulation 2000.* Where the requirements of *Part 5 – Gas plant safety* apply to gas plants constructed after the commencement of these regulations, the requirements of the *Dangerous Goods Safety Act 2004 and Dangerous Goods Safety (Major Hazard Facilities) Regulations 2007* do not apply. Part 5 applies where the *gas plant* is directly connected to and supplies gas into a gas distribution system. The plant operator is required to prepare a safety case in accordance with Part 5.	N/A	N/A
NT	*Work Health and Safety (National Uniform Legislation) Regulations 2011*, Schedule 15 – Hazardous chemicals at major hazard facilities (and their threshold quantity)	50 tonnes	200 tonnes

Dangerous goods requirements

There are different regulatory requirements for facilities with smaller quantities of stored chemicals. Hydrogen is classified as a flammable gas (category 1) under the Globally Harmonised System of Classification and Labelling of Chemicals (GHS). Consequently, under the general requirements of the model work health and safety regulations, facilities with more than 5000 L of stored hydrogen trigger a range of requirements including notification to the regulator. These requirements apply in SA, NSW, ACT, Tasmania, Queensland and NT. Table 2 below shows the relevant legislation.

Table 2: Dangerous goods requirements in NSW, ACT, TAS, QLD and NT

State	Regulations	Hazardous chemical	Category	Placarding quantity	Manifest quantity
SA	Schedule 11 of the *Work Health and Safety Regulations 2012*	Flammable gases	1	200 L	5000 L
NSW	Schedule 11 of the *Work Health and Safety Regulation 2017* (see also Schedule 12 for Manifest requirements)				
ACT	Schedule 11 of the *Work Health and Safety Regulation 2011* (see also Subdivision 7.1.3.2 Manifest of Schedule 11 hazardous chemicals for Manifest requirements)				
TAS	Schedule 11 of the *Work Health and Safety Regulations 2012*				
QLD	Schedule 11 of the *Work Health and Safety Regulation 2011*				
NT	Schedule 11 of the *Work Health and Safety (National Uniform Legislation) Regulations 2011*				

Victoria and WA still operate under pre-existing arrangements for storage and handling of dangerous goods. In both states, storage of more than 5000 L of compressed or refrigerated hydrogen triggers similar requirements to those of the model work health and safety legislation. Table 3 shows the relevant legislation.

Table 3: Dangerous goods requirements in VIC and WA

State	Regulations	Dangerous goods class	Fuel type	Packing group	Placarding quantity	Manifest quantity	Fire protection quantity
VIC	Schedule 2 of the *Dangerous Goods (Storage and Handling) Regulations 2012*	Class 2.1	Compressed hydrogen and refrigerated liquid hydrogen Biogas (methane) in compressed or liquid refrigerated form Natural gas	N/A	500 L	5000 L	5000 L
WA	Schedule 1 of the *Dangerous Goods Safety (Storage and Handling of Non-explosives) Regulations 2007*	Division 2.1 except aerosols	N/A	N/A	500 L	5000 L	N/A
WA	*Gas Standards (Gas Supply and System Safety) Regulation 2000.* Where the requirements of *Part 5 – Gas plant safety* apply to gas plants constructed after the commencement of these regulations.		N/A	N/A	As per Safety Case	As per Safety Case	As per Safety Case

For all states except Victoria and WA, regulations specify a placarding quantity of 200 L for hydrogen. A stored quantity above this triggers a requirement for signage aimed to inform emergency services of the presence of hazardous chemicals on the site. In Victoria and WA, signage is triggered with a stored quantity above 500 L.

All these systems have been designed with multiple chemicals in mind and so present no particular problems when applied to manufacturing, storage and handling of hydrogen or biogas as a future fuel.

4.2.2 Transmission, distribution and end-use

The safety and technical legislative framework that governs the gas transmission and distribution networks along with the end-users of natural gas is complex and varies significantly from state to state. In some states a single Act covers gas transmission, distribution and end-use, while in others separate legislation applies to each element of the supply chain.

Across all states' safety and technical legislation applicable to these supply chain areas, general themes emerging from consideration of how legislation is impacted by the introduction of hydrogen or biogas include the following reasons for precluding the substance:

- Object of the Act precludes alternate fuels such as hydrogen or biogas;
- Definition of petroleum may preclude hydrogen or biogas;
- Definition of natural gas may preclude hydrogen or biogas; or
- The substance is not contemplated under the legislation.

The following sections summarise the implications for each state's safety and technical legislation of the introduction of hydrogen or biogas. See the spreadsheet of all legislation for further detail.

New South Wales

In NSW, separate Acts govern gas transmission, distribution networks and end-users. The key pieces of legislation covering transmission and distribution pipelines preclude hydrogen or biogas due to the definitions of *petroleum* and *natural gas* within the legislation. A complexity within the Gas Supply (Safety and Network Management) Regulation 2013 however, is that Part 4 prescribes natural gas standards, and defines *compliant natural gas* as natural gas that complies with the standards set out in AS 4564-2011. The scope of AS 4564 includes natural gas that is sourced from biogas, and so Part 4 could be interpreted to apply to biogas. Table 4 summarises the key findings.

Table 4: Summary of NSW safety and technical legislation

Document	Transmission	Distribution	Installations/ Appliances	Summary
Pipelines Act 1967	X			Act and regulation would not apply to hydrogen or biogas in petroleum due to the application of the definition of *petroleum*. The Act would, however, apply to a pipeline conveying any other 'substance' (including hydrogen and biogas), and therefore the Act and regulation would apply to these substances. The conditions of an existing petroleum licence would be impacted by the addition of hydrogen or biogas to the petroleum being conveyed.
Pipelines Regulation 2013	X			
Gas Supply Act 1996		X		Act and regulation would not apply to hydrogen or biogas due to not fitting within the definition of *natural*

Document	Transmission	Distribution	Installations/ Appliances	Summary
Gas Supply (Safety and Network Management) Regulation 2013		X		*gas* under the Act, which is as per the *National Gas (NSW) Law*. Hydrogen or biogas would need to be declared by regulation to be a gas for the purposes of the Act. However, Part 4 of the Regulation outlines natural gas standards, and defines *compliant natural gas* as natural gas that complies with the standards set out in AS 4564-2011. The scope of AS 4564 includes natural gas that is sourced from biogas, and so Part 4 could therefore be interpreted to apply to biogas.
Gas and Electricity (Consumer Safety) Act 2017			X	Act and regulation would not apply to hydrogen or biogas due to not fitting within the definition of *natural gas* under the Act, which is as per the *National Gas (NSW) Law*. Hydrogen or biogas would need to be declared by regulation to be a *gas* for the purposes of the Act.
Gas and Electricity (Consumer Safety) Regulation 2018			X	
Work Health and Safety Act 2011			X	Act and regulation would apply to hydrogen or biogas.
Work Health and Safety Regulation 2017			X	

Queensland

In Queensland, a single Act governs gas transmission, distribution networks and end-use. The legislation generally covers hydrogen and biogas, via regulation prescribing hydrogen to be *fuel gas* under the Act, and prescribing biogas to be both *petroleum* and *fuel gas.* However, gaps exist in the coverage of the legislation in relation to hydrogen production, as hydrogen is not considered *petroleum* for the purposes of the Act, and also in relation to gas quality, which is not specified for fuel other than processed natural gas and LPG. Therefore, quality specifications under the Petroleum and Gas (Safety) Regulation 2018 would not apply to hydrogen blends greater than 50%, as these would not fit within the definition of *processed natural gas.* It is uncertain whether the gas quality specifications would apply to biogas if biogas is interpreted not to be naturally occurring and therefore not to fall within the definition of *processed natural gas* under the Act. The Regulation prescribes gas quality requirements for *processed natural gas* to comply with AS 4564 'Specification for general purpose natural gas'; the scope of AS 4564 itself includes biogas as a source of natural gas, and therefore the quality requirements could be interpreted to apply to biogas. This is summarised in Table 5.

Table 5: Summary of QLD safety and technical legislation

Document	Transmission	Distribution	Installations/ Appliances	Summary
Petroleum and Gas (Production and Safety) Act 2004	X	X	X	Act and regulation apply to hydrogen as the regulation prescribes hydrogen as fuel gas under the Act. However, hydrogen is not considered petroleum under the Act, and therefore the Act is not applicable to hydrogen for the purposes of regulating petroleum, including production facilities, safety management systems and abandonment. Act and regulation are applicable to biogas as biogas is prescribed by regulation to be petroleum and fuel gas.
Petroleum and Gas (General Provisions) Regulation 2017	X	X	X	
Petroleum and Gas (Safety) Regulation 2018	X	X	X	Regulation is applicable to hydrogen as hydrogen is prescribed by regulation to be fuel gas under the Act, however at blends of 50% or more the gas would no longer be considered *processed natural gas*. The regulation prescribes gas quality specifications for processed natural gas and LPG but not for other fuel gas. Regulation is applicable to biogas as biogas is prescribed by regulation to be petroleum and fuel gas, however, it is uncertain whether it would be applicable under the definition of *processed natural gas* if biogas is interpreted not to be naturally occurring, which has implications for specification of gas quality. The Regulation prescribes gas quality requirements for *processed natural gas* to comply with AS 4564 'Specification for general purpose natural gas'; however the scope of AS 4564 itself includes biogas as a source of natural gas, and therefore the quality requirements could be interpreted to apply to biogas.

Victoria

Amongst the safety and technical legislation in Victoria, one key set of legislation covers transmission pipelines, and another covers gas distribution and installations. The legislation covering gas transmission is applicable to hydrogen, which falls within the stated application of the Act. The Act is applicable to biogas as biogas falls within the meaning of *petroleum* under the Act. Both hydrogen and biogas are regulated under the Victorian legislation covering gas distribution and installations, however, due to the application of the definition of *natural gas* in this legislation, the specified quality requirements do not cover blends of 50% hydrogen or more in natural gas. See Table 6 for a more detailed summary of the findings outlined in the spreadsheet.

Table 6: Summary of VIC safety and technical legislation

Document	Transmission	Distribution	Installations/ Appliances	Summary
Pipelines Act 2005 (VIC)	X			The Act and regulation apply to hydrogen as hydrogen falls within the application of the Act. The Act and regulation apply to biogas as biogas falls within the meaning of *petroleum* under the Act.
Pipelines Regulations 2017 (VIC)	X			
Gas Industry Act 2001 (VIC)	X	X	X	Act is applicable to both hydrogen and biogas according to the definition of gas for the purposes of the Act. However, the Act would not be applicable to hydrogen or biogas where 'natural gas' is referenced due to the definition of natural gas. As a result, Parts 3 and 4 of the Act would not apply to the blended gas, meaning (1) a gas distribution licence would not be required, and (2) if a company does not have a gas distribution licence under the Act, they are automatically not a gas company under the *Gas Safety Act*. In this case the company would need to be declared a gas company under Section 5 of the *Gas Supply Act*.
Gas Safety Act 1997 (VIC)		X	X	Act and regulations are applicable to hydrogen and biogas as both fit within the definition of gas under the Act. However, the gas quality requirements under the *Gas Safety (Safety Case) Regulations* would not apply to concentrations of hydrogen at blends of 50% or more due to the implied definition of natural gas, to which the gas quality specifications apply (blends of hydrogen this high would also not meet the quality requirements of AS 4564, as prescribed by the regulation).
Gas Safety (Safety Case) Regulations 2018 (VIC)		X	X	
Gas Safety (Gas Installation) Regulations 2018 (VIC)			X	
Building Act 1993 (VIC)			X	Act and regulation are applicable to hydrogen and biogas as they rely on application of and reference the same meaning of gas as in the *Gas Safety Act 1997*.
Plumbing Regulations 2018 (VIC)			X	

Western Australia

In WA, there is separate legislation covering safety and technical regulation of transmission lines, gas distribution and downstream installations and appliances, with some overlap. The Petroleum Pipelines set of legislation is not applicable to hydrogen or biogas due to the definition of *petroleum* under the Act, as well as the objects of that Act relating to drawing petroleum from natural reservoirs. Similarly, the related Gas Supply set of legislation draws on the definition of *petroleum* from the *Petroleum Pipelines Act 1969*, and so does also not apply to hydrogen or biogas.

The key sets of legislation covering distribution and downstream installations would apply to hydrogen and biogas due to their inclusion in the definition of *gas*, with the exception that the subordinate Gas Standards legislation is applicable to *natural gas*, the definition of which would preclude blends of 50% hydrogen or above. Despite the legislation being applicable to blends of less than 50% hydrogen, in reality the application of the prescribed Australian standards would further limit the amount of hydrogen able to be blended under this legislation, as outlined in Table 7.

Table 7: Summary of WA safety and technical legislation

Document	Transmission	Distribution	Installations/ Appliances	Summary
Petroleum Pipelines Act 1969	X			Act and regulations would not apply to hydrogen or biogas due to the definition of petroleum under the Act.
Petroleum Pipelines (Occupational Safety and Health) Regulations 2010	X			
Petroleum Pipelines (Management of Safety of Pipeline Operations) Regulations 2010	X			
Gas Supply (Gas Quality Specifications) Act 2009	X	X		Act and regulations would not apply to hydrogen or biogas due to the reference in the Act to the *Petroleum Pipelines Act 1969*, and the definition of petroleum within that Act.
Gas Supply (Gas Quality Specifications) Regulations 2010	X	X		
Gas Standards Act 1972		X	X	Act is applicable to hydrogen and biogas as both fit within the definition of *gas* under the Act. The Act does not define *natural gas* whereas the subordinate regulations do.
Gas Standards (Gas Supply and System Safety) Regulations 2000		X	X	The regulations would apply to biogas, and to hydrogen at blends of less than 50% according to the definition of *natural gas* in the *Gas Standards (Gas Supply and System Safety) Regulation 2000*. At higher hydrogen blends the definition of natural gas would no longer apply. The requirement to comply with the quality specifications of AS 4564 means that whilst this regulation applies to biogas and to hydrogen at blends of less than 50%, in practice, the technical limitation would occur at a blend of considerably less than 50% hydrogen.
Gas Standards (Gasfitting and Consumer Gas Installations) Regulations 1999		X	X	

Document	Transmission	Distribution	Installations/ Appliances	Summary
				Similarly, the technical requirements of AS/NZS 5601.1, prescribed by the *Gas Standards (Gasfitting and Consumer Gas Installations) Regulations 1999* must also be met, including in relation to definitions of the gas families.
Energy Safety Act 2006		X	X	Acts and regulations apply to hydrogen and biogas as both substances fit within the definition of *gas* for the purpose of both Acts.
Energy Coordination Act 1994		X	X	
Energy Coordination (General) Regulations 1995		X	X	
Energy Coordination (Higher Heating Value) Regulations 2008		X	X	
Energy Coordination Exemption Order 2009		X	X	

Northern Territory

In NT, a single set of legislation covers transmission pipelines and distribution networks, while the *Dangerous Goods Act 1998* covers downstream installations and appliances, as outlined in Table 8.

Under the *Energy Pipelines Act 1981* covering transmission and distribution, the definition of *energy-producing hydro-carbon* could be interpreted to apply to biogas and possibly to hydrogen blends in natural gas, however this is uncertain in relation to hydrogen, and it would not apply to 100% hydrogen.

Table 8: Summary of NT safety and technical legislation

Document	Transmission	Distribution	Installations/ Appliances	Summary
Energy Pipelines Act 1981	X	X		Whilst it is uncertain whether blends greater than 50% hydrogen in a hydrocarbon such as natural gas would fit within the definition of *energy-producing hydro-carbon* under the Act, the Act and regulation can be interpreted to apply to lesser blends of hydrogen in natural gas, and to biogas.
Energy Pipelines Regulations 2001	X	X		
Dangerous Goods Act 1998			X	Act and regulation apply to hydrogen and biogas as both substances fit within the definition of *fuel gas* referenced in the regulation.
Dangerous Goods Regulations 1995			X	

Australian Capital Territory

In the ACT, two related Acts both cover gas transmission and distribution, while a separate Act covers installations and appliances. None of the legislation in ACT would apply to hydrogen or biogas, due to the definition of *natural gas*, derived from the National Gas (ACT) Law, being applied to the legislation. See Table 9.

Table 9: Summary of ACT safety and technical legislation

Document	Transmission	Distribution	Installations/ Appliances	Summary
Utilities Act 2000	X	X		The Acts and regulations would not apply to hydrogen or biogas due to the application of the definition of *natural gas* as defined under the *National Gas (ACT) Law*. For hydrogen and biogas to be regulated under these Acts and regulations, consideration would need to be given to enacting legislation that applies to these substances.
Utility Networks (Public Safety) Regulation 2001	X	X		
Utilities (Gas Restrictions) Regulation 2005	X	X		
Utilities (Technical Regulation) Act 2014	X	X		
Gas Safety Act 2000			X	
Gas Safety Regulation 2001			X	

Tasmania

In Tasmania, separate sets of legislation cover transmission lines, distribution and downstream installations and appliances. Generally, the legislation is applicable to hydrogen and biogas as both substances fall within the definition of *gas* as applied by the legislation. An exception is under the Occupational Licensing legislation, where undefined terms *natural gas* and *calorific gas* are employed, however the legislation is interpreted to be applicable to both substances. See Table 10 for details.

Table 10: Summary of TAS safety and technical legislation

Document	Transmission	Distribution	Installations/Appliances	Summary
Gas Pipelines Act 2000	X	X		Act and regulation apply to hydrogen and biogas as both substances fit within the definition of *gas*, which is a regulated substance under the Act.
Gas Pipelines Regulations 2014	X	X		
Gas Act 2000		X	X	

Document	Transmission	Distribution	Installations/Appliances	Summary
Gas (Safety) Regulations 2014		X	X	Act and regulations apply to hydrogen and biogas as both substances fit within the definition of *gas* under the Act.
Gas (Exemption) Order 2006			X	
Occupational Licensing Act 2005			X	Act and regulation apply to hydrogen as hydrogen is included under the Act Schedule 2, Part 2. The Act and regulation would apply to biogas if biogas is interpreted to fall under the terms *natural gas* or *calorific gas* under the terms referenced in the Act.
Occupational Licensing (Gas-fitting Work) Regulations 2010			X	

South Australia

In South Australia, separate legislation applies to transmission lines, to distribution networks and to downstream installation and appliances. The Petroleum and Geothermal Energy legislation applicable to transmission pipelines would not apply to hydrogen or biogas due to the definition of *petroleum*, and to the objects and interpretation of the Act, which is limited to production associated with natural reservoirs.

The legislation applicable to distribution networks and to downstream installations and appliances all utilises a definition of *gas* that would include biogas, and blends of up to 50% hydrogen. The legislation would be applicable to these substances provided the requirements of the legislation can be met. The findings are summarised in Table 11 below.

Table 11: Summary of SA safety and technical legislation

Document	Transmission	Distribution	Installations/ Appliances	Summary
Petroleum and Geothermal Energy Act 2000 (SA)	X			Act and regulation would not apply to hydrogen or biogas due to the definitions of *petroleum* and *regulated substance* under the Act, unless hydrogen or biogas were declared to be regulated substances under the Act. Regardless, the Act would not apply to hydrogen or biogas production, due to the definitions of *produce* and *natural reservoir* under the Act.
Petroleum and Geothermal Energy Regulations 2013 (SA)	X			
Gas Act 1997 (SA)	X	X	X	Act and regulation would apply to hydrogen in natural gas at blends below 50% hydrogen, and to biogas, provided the requirements of the Act and regulation can be met. Beyond 50% hydrogen the legislation would no longer apply according to the definition of *gas*, as the gas would no longer consist predominantly of hydrocarbons.
Gas Regulations 2012 (SA)		X	X	
Energy Products (Safety and Efficiency) Act 2000 (SA)			X	Act and regulation would apply to hydrogen in natural gas at blends below 50% hydrogen, and to biogas, as the definition

Document	Transmission	Distribution	Installations/ Appliances	Summary
Energy Products (Safety and Efficiency) Regulations 2012			X	of *gas* referenced in the Act is the same as defined in the Gas Act 1997. Beyond 50% hydrogen, the gas would no longer consist predominantly of hydrocarbons.
Plumbers, Gas Fitters and Electricians Act 1995 (SA)			X	Act and regulation would apply to hydrogen in natural gas at blends less than 50% hydrogen, due to the interpretation of *gas* in the Act. Beyond 50% hydrogen the gas would no longer consist predominantly of hydrocarbons. Act and regulation would apply to biogas, provided the requirements of the Act and regulation can be met.
Plumbers, Gas Fitters and Electricians Regulations 2010			X	

4.2.3 Technical and safety standards

Standards are documents that set out specifications, procedures and guidelines that aim to ensure products, services, and systems are safe, consistent, and reliable. Standards, which are an accumulation of industry experience and are occasionally out-paced by the development of technology, are commonly accepted as a current definition of "best practice".

There are three categories of standards:

- International standards are developed by the International Standards Organisation (ISO), International Electrotechnical Commission (IEC), and International Telecommunication Union (ITU) for any country to adopt for national use.
- Regional standards are prepared by a specific region, such as the European Union's EN standards, or joint Australian/New Zealand standards (AS/NZS).
- National standards are developed by an accredited body such as Standards Australia. Any standard developed under the "AS" name may have been created in Australia or be an adoption of an international standard.

This review identified key safety and technical standards that are applied in the design, construction and operation in the natural gas, hydrocarbons and oil industry across the whole supply chain (production through to end-use). A high level review of the suitability for the following gas compositions was then completed:

- 10% hydrogen blended with 90% natural gas;
- 50% hydrogen blended with 50% natural gas;
- 100% hydrogen; and
- 100% biogas/biomethane (within the quality limits of AS 4564).

This review considered the performance, safety and integrity impacts of the change in fluid composition above. Details are included in the 'Standards' tab of the spreadsheet.

Mandatory safety and technical standards referenced in legislation

Standards do not automatically carry legal force in Australia. That is, mandatory compliance with standards is not an automatic requirement by law, except in the following instances:

a) Some standards are made mandatory by Australian law where they are referenced in state or federal legislation; and

b) Where a legal duty of care would require someone to follow best practice, failure to comply with standards may be difficult to defend in court.

Where legislation does not comprehensively capture safety and technical requirements, it may refer directly to one or more standards. When a standard is referred to in legislation, unless otherwise stated, this standard is mandatory and must be complied with. Note that the spreadsheet includes data to cross reference each standard to the legislation that refers to it, demonstrating the interlinkage between these two sets of requirements.

It is common for state and Commonwealth governments of Australia to refer to Australian Standards (AS) or joint Australian/New Zealand Standards (AS/NZS) in their legislation. In this context, compliance with standards becomes mandatory.

It is important to remember that standards may also refer to a number of other reference standards. Where a standard called on by legislation references requirements of another standard, the referenced standard also becomes mandatory in order to comply with the legislation referencing the original standard. Note that for this review only primary referenced standards have been reviewed in the spreadsheet.

Additionally, non-mandatory standards provide guidance or informative commentary on the technical and safety aspects of a particular topic. Whilst this may mean there are no direct legal implications of non-compliance with these standards, they provide valuable guidance on current “best practice” to designers.

Summary and themes of varying fuel compositions to Australian Standards

From the standards reviewed as part of this study, generally, three approaches for fluid composition are used:

- A specific composition(s) – The standard prescribes a specific fluid composition (or composition range with upper or lower limits) that are within the scope of the standard. The definitions for the composition(s) are generally provided in the standard but in certain cases can reference another standard.10
- A general fluid class – The standard does not reference a specific composition, but includes fluid classes in general terms, such as ‘natural gas’, ‘hydrocarbon fluids’, ‘liquefied petroleum gas’, ‘liquid petroleum’ and ‘carbon dioxide’. These fluid classes can be defined within the standard or referenced standard, or rely on the plain English interpretation.
- No specific composition or fluid class – The standards do not prescribe a composition but rather place the responsibility on the person applying the standard to ensure that the technical and safety performance requirements are met.

For the majority of the standards reviewed, varying fluid composition, or the introduction of a ‘manufactured’ fluid outside the composition range normally expected from a petroleum reservoir was either not considered or addressed; consequently, many of the standards either currently limit or prohibit unusual or non-naturally occurring components such as hydrogen, or, due to the absence of any guidance or considerations for this fluid, do not provide confidence in their application.

Where these standards are expected to be used in hydrogen service, the standard should be reviewed and updated with consideration of (but not limited to) the following:

- Materials related issues including the impact of embrittlement, high temperature hydrogen attack (HTHA), leakage and permeation;
- Changes to safety due to the different properties including wider flammability limits, lower minimum ignition energy, faster flame speed, etc.;
- Changes to performance including variations in energy density; and
- Impacts to integrally linked equipment/systems such as downstream appliances in a gas distribution network.

In some cases, it may be determined that the current standard is either unsuitable for use or will require substantial modification or rework in order to cover the application of hydrogen. In these cases, a suitable standard (international or regional) could be adopted or a new Australian standard developed to cover the specific fluid application.

[10] An example of this is the definition for natural gas which is *generally* referred back to *AS 4564 – Specification for general purpose natural gas.*

Where standards do not specifically refer to a particular composition(s) or fluid class, generally, these will be acceptable for varying compositions or uncommon fluids in new applications. An example of this is *AS 3814 – Industrial gas fired appliances,* which currently allows a new appliance to be designed to operate on hydrogen, providing it achieves the requirements defined in AS 3814.

For applications that wish to convert from one type of fuel to another, e.g. natural gas to hydrogen, many standards give a method for changeover.

Where gaps in safety and technical standards are identified

Where a standard is unsuitable for a prospective future gas composition(s) or general fluid class, several solutions exist:

a) Update the existing standard;
b) Adopt an internationally recognised standard to supplement or replace the existing standard; or
c) Develop a new Australian Standard.

Development of new Australian Standards or updating existing standards to be suitable for a new gas composition or fluid class requires the standard to go through a Standards Australia development process. This process requires a project proposal to be developed by a proponent (member of the Australian community) and assessed through Standards Australia's project prioritisation and selection process.

The new standard or a revised existing standard requires the content or proposed changes to be developed, reviewed and approved by the nominated Standards Australia technical committee and associated working groups. Review, update, approval and publication of an existing standard can take several years from project initiation and requires agreement from a wide range of stakeholders of the standard, often including periods of public consultation, which means the process may be difficult to expedite. For standards referenced in multiple legislative instruments, across multiple jurisdictions, e.g. *AS 4654 - Gas Quality Specification,* this process would require a high level of consultation and coordination. In some cases, the technical committees and working groups include representatives of the key stakeholders including representatives of state government bodies responsible for associated legislation, such as the AS 2885 suite of standards. In this case the development and consultation process is more streamlined.

Where current standards cannot be modified, or it is impractical to do so, adoption of an international standard or development of a new standard may be required. This will likely be most relevant for standards that are written with a particular gas composition in mind, e.g. *AS 5263 – Gas Appliances*. For mandatory standards, this will require consultation and coordination with state and federal agencies as it would require amendment to the legislation to adopt the new standard.

Recent activity for standards development and adoption of international standards for hydrogen

Standards Australia held a forum in October 2018 to discuss how standards can support the further development of the hydrogen industry in Australia. Specifically, Australian involvement in international standards development and adoption was a key consideration. The forum identified a number of existing natural gas related standards covering areas of transportation and distribution that may require review for their relevance for hydrogen, including AS 2885 and AS 4645. The technical committee for AS 2885, ME-038, is convening in early 2020 to determine the timeframe and process for adoption of hydrogen and other future fuels into the AS 2885 series.

The outcome of the forum also led Standards Australia to establish a committee of Australian experts to mirror the work of international experts on "ISO/TC 197, Hydrogen Technologies". This committee, known as "ME-093 Hydrogen Technologies", has completed a standards mapping project to identify gaps in the current Australian standards, and which international ISO standards developed under ISO/TC 197 may be adopted to bridge these gaps. Consequently, a number of applicable ISO standards are being adopted for use in Australia as "AS/ISO" standards.

4.3 Environmental and land use planning

Environmental legislation is generally consistent in approach across Australia. Each jurisdiction has environmental protection-based legislation that generally manages environmental risks and impacts from wastes and pollutants originating from human activity. Legislation draws on national policy, however, also contains local content. In addition, each state has its own set of legislation minimising/preventing impacts on certain areas of environmental significance and resources such as water. At a Commonwealth level, legislation exists to minimise/limit impacts on biodiversity and national heritage as well as providing an Australia-wide framework for managing carbon emissions. This framework of environmental legislation interconnects with state-based land use planning systems. In each state, dedicated planning legislation that calls on other environment or work health and safety legislation is in place. Environmental and land use planning legislation influences the construction and upgrade of gas infrastructure through mechanisms such as environmental impact assessments, environmental management plans, licencing of works and permits to generate pollution and waste (including gas), and mechanisms such as zoning to control land uses.

This section presents the key findings regarding environmental and planning legislation, which is impacted by, or impacts on, a change in fuel from natural gas to hydrogen or biogas across the supply chain. This section addresses:

- whether regulatory decisions in environment and planning are significantly impacted by changes to gas composition; and
- what gaps or barriers exist that require regulatory changes in order to ensure that future fuels are appropriately included in existing regulatory frameworks.

These findings are inclusive of the legislation that exists in each state and territory and at Commonwealth level that impact natural gas infrastructure. The findings also address the parts of the relevant legislation specific to different gas composition, type and source. The detailed findings are captured in the associated accompanying spreadsheet.

The following findings, which include identified legislative gaps, barriers or other considerations with implications for future fuels, have been presented according to the key themes identified:

- Gas definitions in safety and technical legislation and the impacts these have on environmental and planning decision-making processes;
- Perception of risk in planning and environmental impact assessment processes; and
- Management of risk in environment and planning mechanisms with a change of fuel from natural gas to hydrogen.

4.3.1 Gas definitions in safety and technical legislation: Impacts on environmental and planning decision-making processes

Changes to environmental management processes under pipeline legislation

In some states and territories, transmission and distribution pipeline legislation functions as the primary instrument to manage the environmental impacts associated with gas infrastructure. Where hydrogen or biogas as a fuel source is precluded by the existing definition of gas, it is not covered by the legislative framework. In different technical legislative definitions of gas in different locations within Australia, hydrogen and biogas is either included entirely, excluded entirely or only included to certain blend thresholds. It is important to note that these legislative definitions exist outside environmental and planning based legislation, however, have implications when they are called on by environment and planning legislation. Table 12 presents the states where definitional issues have resulted in the preclusion of hydrogen and biogas from the transmission and distribution legislation, and associated environmental management frameworks. In each state and territory additional environmental legislation exists that also influences environmental management of gas infrastructure which is discussed in other sections of the report.

Table 12: Hydrogen and biogas as related to definitions of gas and associated implications for environmental impact management under transmission and distribution pipeline legislation

Transmission				
Jurisdiction	**Act**	**Blends of hydrogen included in the definition of gas** (not by AS/NZS requirements under the Act).	**Blends of biogas included in the definition of gas** (not by AS/NZS requirements under the Act).	**Implications for environmental impact management under the pipeline legislation**
ACT	*Utilities Act 2000*	Not included at any percentage blend	Not included at any percentage blend	The definition of gas under the Act precludes licensed transmission pipelines from conveying any blend of hydrogen or biogas as a regulated activity under the Act. If the activity were to be enabled under separate legislation, the relevant environmental impact and associated management requirements of that separate legislation would apply.
NT	*Energy Pipelines Act 1981*	10% and 50% hydrogen, but not 100% hydrogen	Up to 100% Biogas	The definition of gas under the Act precludes licensed transmission pipelines from conveying 100% hydrogen as a regulated activity under the Act. Biogas however would be a regulated activity under the Act as it fits within the current definition of gas. If the activity were to be enabled under separate legislation, the relevant environmental impact and associated management requirements of that separate legislation would apply.
SA	*Petroleum and Geothermal Energy Act 2000*	Not included at any percentage blend	Not included at any percentage blend	The definition of gas under the Act precludes licensed transmission pipelines from conveying any blend of hydrogen or biogas as a regulated activity under the Act. If the activity were to be enabled under separate legislation, the relevant environmental impact and associated management requirements of that separate legislation would apply.

Distribution				
State	**Act**	**Blends of hydrogen included in the definition of gas** (not by AS/NZS requirements under the Act).	**Blends of biogas included in the definition of gas** (not by AS/NZS requirements under the Act).	**Implications for environmental impact management under the pipeline legislation**
ACT	*Utilities Act 2000*	Not included at any percentage blend	Not included at any percentage blend	The definition of gas under the Act precludes licensed distribution pipelines from conveying any blend of hydrogen or biogas as a regulated activity under the Act. If the activity were to be enabled under separate legislation, the relevant environmental impact and associated management requirements of that separate legislation would apply.
NSW	*Gas Supply Act 1996*	Not included at any percentage blend	Not included at any percentage blend	The definition of gas under the Act precludes licensed distribution pipelines from conveying any blend of hydrogen or biogas as a regulated activity under the Act. If the activity were to be enabled under separate legislation, the relevant environmental impact and associated management requirements of that separate legislation would apply.
SA	*Gas Act 1997*	Less than 50% hydrogen	Up to 100% Biogas	The definition of gas under the Act precludes licensed distribution pipelines from conveying 50% or more hydrogen as a regulated activity under the Act. Biogas however would be a regulated activity under the Act as it fits within the current definition of gas. If the activity were to be enabled under separate legislation, the relevant environmental impact and associated management requirements of that separate legislation would apply.

To illustrate the problems arising from the definitional issues of gas in Table 12, for example, in the Northern Territory, a pipeline licenced under the *Energy Pipelines Act 1981* is required to comply with environmental objectives such as minimising impacts to land, air, water, organisms and ecosystems. The definition of gas, however, would only include 10% and 50% blends of hydrogen in licenced transmission pipelines, therefore, this environmental management framework no longer applies to pipelines conveying 100% hydrogen. Similarly, in the ACT, transmission and distribution pipelines are regulated and licensed under the *Utilities Act 2000* which aims, among other things, to *'promote ecologically sustainable development in the provision of utility services'*. Protection of the environment and reporting on this is required as part of licencing conditions under the Act. However, under the Act, gas means natural gas that is naturally occurring and therefore licensing of transmission and distribution pipelines containing hydrogen and biogas, or blends of hydrogen and biogas with natural gas, are not covered by this legislation. This is also the case for transmission pipelines regulated under the *Petroleum and Geothermal Energy Act 2000* in South Australia, and distribution pipelines regulated under the *Gas Supply*

Act 1996 in New South Wales. As a result and without amendment, the above existing environmental management processes, suitable to pipelines, would not be applied to hydrogen pipelines and some percentage blends with natural gas. Where these definitions preclude these activities from being conducted under the relevant pipeline legislation, and indeed for existing licensed pipelines may preclude blends from being conveyed without breach of license conditions, amendments would be required to enable the activity itself and associated management of environmental impacts. For 100% hydrogen pipelines where these are identified to be precluded from existing pipeline legislation, the activity approval process would be likely to default to planning legislation and associated environmental management either within that framework or through a separate environmental regulatory regime. A similar situation arises with the other states listed in Table 12 above.

Changes to environmental legislation processes

Definitions of gas which preclude or limit high percentage blends of hydrogen or biogas in gas pipelines also have an effect on environmental based legislation, in some states, where the environmental legislation refers to pipeline legislation to provide exemptions or conditions. Examples of this include the Northern Territory's *Waste Management and Pollution Control Act 1998* which does not apply in relation to a contaminant or waste released from a pipeline during the conduct of an activity authorised under the *Energy Pipelines Act 1981*. However, if conveyance of 100% hydrogen is precluded under the *Energy Pipelines Act 1981*, then this exemption under the *Waste Management and Pollution Control Act 1998* may no longer apply. Likewise, native vegetation clearing exemptions in WA, under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*, only apply to activities authorised under the *Mining Act 1978*, the *Petroleum and Geothermal Energy Resources Act 1967* and the *Petroleum Pipelines Act 1969* or the *Petroleum (Submerged Lands) Act 1982*. However, any blend of hydrogen and biogas with natural gas is precluded by the definition of gas under the *Petroleum Pipelines Act 1969* which governs gas transmission pipelines.

For biogas manufacturing, licences are required by environmental protection acts in all states and territories, although threshold amounts and terms differ from state to state. Licences relate to the collection and processing of organic waste, the production of gas (including biogas) and also the burning or flaring of biogas. This latter activity, however, applies to biogas energy generation facilities, rather than injection into gas networks. No environmental protection legislation, however, prohibits the production of biogas.

Changes to planning processes

Australian planning legislation often calls on safety and technical legislation governing gas infrastructure to define gas and associated transmission and distribution pipelines. Processes and triggers in planning legislation which call upon these definitions are affected where the definitions preclude biogas or hydrogen. An example can be given in South Australia where, under the *Planning, Development and Infrastructure Act 2016* (and associated *Planning, Development and Infrastructure (General) Regulations 2017*), the construction, alteration, extension, repair or maintenance of gas infrastructure is not categorised as development, therefore development approval is not required. These arrangements are in place as these activities and their licensing and approval would be conducted under the *Gas Act 1997* or the *Petroleum and Geothermal Energy Act 2000*. Gas infrastructure is defined in the same way as seen in the *Gas Act 1997* and therefore this clause may not be applied to distribution networks conveying 50% or more hydrogen. As a result, under the current legislation, these pipelines carrying 50% or more hydrogen would not be regulated under the *Gas Act 1997* or *Petroleum and Geothermal Energy Act 2000* and would require a development permit.

A similar situation arises in Queensland for manufacturing facilities. The development of manufacturing facilities and transmission and distribution pipelines licenced under the *Petroleum and Gas (Production and Safety) Act 2004* are exempt from approval processes under Schedule 6 of the Planning Regulation 2017. Due to the definition of petroleum, facilities manufacturing blends of 50% or more hydrogen would not be regulated by the *Petroleum and Gas (Production and Safety) Act 2004* and therefore this planning exemption would no longer apply. Development of such manufacturing facilities would need to follow planning processes as required by the *Planning Act 2016* and subordinate Planning Regulation 2017.

Table 13 highlights the states where changes to planning processes result from a change in the use of hydrogen as a fuel in distribution pipelines.

Table 13: Changes to planning processes as a result of a change in fuel in distribution pipelines

State	Safety and technical legislation	Blends of hydrogen included in the definition of gas (not by AS/NZS requirements under the Act).	Blends of biogas included in the definition of gas (not by AS/NZS requirements under the Act).	Implications for planning processes
SA	*Gas Act 1997*	Less than 50% hydrogen	Up to 100% biogas	Gas infrastructure under the ***Planning, Development and Infrastructure Act 2016*** is defined using the definition from the *Gas Act 1997*. As a result, gas distribution infrastructure carrying 50% or more hydrogen would require a development permit.
TAS	*Gas Act 2000*	Up to 100% hydrogen	Up to 100% biogas	Safety and technical legislation referred to in **Section 57 of the *Land Use Planning and Approvals Act 1993***, however, as definition includes 100% hydrogen and biogas this does not have any implications.
WA	*Energy Coordination Act 1994*	Up to 100% hydrogen	Up to 100% biogas	Safety and technical legislation referred to in **Control Policy 4.3: Planning for High-Pressure Gas Pipelines (DC 4.3)**, however, as definition includes 100% hydrogen and biogas this does not have any implications.

A change in fuel also has implications for planning processes and triggers in transmission pipelines. Table 14 outlines the changes to planning processes as a result of a change in fuel to hydrogen in transmission pipelines.

Table 14: Changes to planning processes as a result of a change in fuel in transmission pipelines

State	Safety and technical legislation	Blends of hydrogen included in the definition of gas (not by AS/NZS requirements under the Act).	Blends of biogas included in the definition of gas (not by AS/NZS standard requirements under the Act).	Implications for planning processes
NSW	*Pipelines Act 1967*	Up to 100% hydrogen	Up to 100% biogas	Safety and technical regulation referred to in ***Environmental Planning and Assessment Act 1979***, however, definition includes 100% hydrogen and biogas, and therefore this does not have any implications.

State	Safety and technical legislation	Blends of hydrogen included in the definition of gas (not by AS/NZS requirements under the Act).	Blends of biogas included in the definition of gas (not by AS/NZS standard requirements under the Act).	Implications for planning processes
TAS	*Gas Pipelines Act 2000*	Up to 100% hydrogen	Up to 100% biogas	Safety and technical legislation referred to in **Section 57 of the *Land Use Planning and Approvals Act 1993***, however, as definition includes 100% hydrogen and biogas this does not have any implications.
WA	*Petroleum Pipelines Act 1969*	Not included at any percentage blend	Not included at any percentage blend	Statutory planning policy, **Control Policy 4.3: Planning for High-Pressure Gas Pipelines (DC 4.3)**, designed to manage land uses adjacent to pipelines may be affected based on reference only to pipelines under the *Petroleum Pipelines Act 1969* and the *Energy Coordination Act 1994*.

In WA, under the *Petroleum Pipelines Act 1969* and associated *Petroleum Pipelines (Environment) Regulations 2012* which governs the licencing of transmission pipelines, both hydrogen and biogas, at any blend with natural gas, are precluded from the definition of gas under the Act. This may have implications for land use planning policy, as the current draft Control Policy 4.3: Planning for High-Pressure Gas Pipelines (DC 4.3) which aims to reduce the conflict in land uses surrounding transmission pipelines in land use planning decisions applies to pipelines under the *Petroleum Pipelines Act 1969*.

Gasfitting work

Gasfitting work is not licenced under existing legislation for appliances and installations using any blend of hydrogen or biogas in the Australian Capital Territory and New South Wales, or 50% or more hydrogen in South Australia. This has implications for building occupancy permits issued by local councils if gasfitting work is not licenced under existing legislation. Table 15 outlines the states where there are implications for gasfitting licences or licensing of gasfitting work as a result of a change in fuel to hydrogen in gas appliances and installations.

Table 15: Implications for gasfitting licences or licensing of gasfitting work as a result of a change in fuel to hydrogen in gas appliances and installations

State	Act	Blends of hydrogen included in the definition of gas (not by AS/NZS requirements under the Act).	Blends of biogas included in the definition of gas (not by AS/NZS requirements under the Act).	Implications for gasfitting licences or licensing of gasfitting work
ACT	*Gas Safety Act 2000*	Not included at any percentage blend	Not included at any percentage blend	Gasfitting work is not licenced under existing legislation for appliances and installations using any blend of hydrogen or any blend of biogas.

State	Act	**Blends of hydrogen included in the definition of gas** (not by AS/NZS requirements under the Act).	**Blends of biogas included in the definition of gas** (not by AS/NZS requirements under the Act).	**Implications for gasfitting licences or licensing of gasfitting work**
NSW	*Gas Supply Act 1996*	Not included at any percentage blend	Not included at any percentage blend	Gasfitting work is not licenced under existing legislation for appliances and installations using any blend of hydrogen or any blend of biogas.
NT	*Dangerous Goods Act 1998*	Up to 100% hydrogen	Up to 100% biogas	Hydrogen and biogas are covered by the legislation and therefore gasfitting work for hydrogen and biogas installations and appliances is regulated.
QLD	*Petroleum and Gas (Production and Safety) Act 2004*	Up to 100% hydrogen	Up to 100% biogas	Hydrogen and biogas are covered by the legislation and therefore gasfitting work for hydrogen and biogas installations and appliances is regulated.
SA	*Plumbers, Gas Fitters and Electricians Act 1995*	Less than 50% hydrogen	Up to 100% biogas	Gasfitting work is not licenced under existing legislation for appliances and installations using 50% or more hydrogen. Biogas would be regulated up to 100%.
TAS	*Occupational Licensing Act 2005*	Up to 100% hydrogen	Up to 100% biogas (if biogas is considered to be natural gas or calorific gas)	Hydrogen and biogas are covered by the legislation and therefore gasfitting work for hydrogen and biogas installations and appliances is regulated.
VIC	*Plumbing Regulations 2018 / Gas Safety Act 1997*	Up to 100% hydrogen	Up to 100% biogas	Hydrogen and biogas are covered by the legislation and therefore gasfitting work for hydrogen and biogas installations and appliances is regulated.
WA	*Gas Standards Act 1972*	Up to 100% hydrogen	Up to 100% biogas	Hydrogen and biogas are covered by the legislation and therefore gasfitting work for hydrogen and biogas installations and appliances is regulated.

4.3.2 Perception of risk in planning and environmental impact assessment processes

Where there is the potential for environmental impact associated with development on land with “significant” flora, fauna, ecological communities, cultural heritage etc., Ministerial or other responsible authority discretion is a legislative trigger for environmental impact assessment legislation across Australia. Perceptions and tangible risk associated with hydrogen as a fuel source will influence the environmental impact assessment as well as land use planning legislation and processes associated with the construction or upgrade of gas infrastructure across the supply chain. These perceptions of tangible risk can either work in favour or against hydrogen infrastructure, with research indicating that while hydrogen is a low emissions fuel source and has general support as part of transitioning to a low carbon economy, community and local government opposition to infrastructure siting can run contrary to broader socio-political sentiment with people supporting “renewable energy as long as it is not in

their own backyard".[11] Examples where Ministerial discretion to call in a project for an environmental impact statement (EIS) includes:

- Victoria's Environmental Effects Act 1978 (dependent on the impact of the project and at the discretion of the Minister);
- Queensland's State Development and Public Works Organisation Act 1971 (for projects deemed coordinated projects by the Minister);
- South Australia's Planning, Development and Infrastructure Act 2016 (for major projects);
- Tasmania's State Policies and Projects Act 1993 (for projects deemed 'state significant' by the Minister);
- Western Australia's Environmental Protection Act 1986 (for projects that will have a significant effect on the environment and recommended by an authority or proponent to the EPA who determines if an EIS is required);
- Northern Territory's Environment Assessment Act 1982 (actions that may have a significant impact on the environment are to be referred to the NT EPA to determine whether the proposed action requires an EIA); and
- New South Wales' Environmental Planning and Assessment Act 1979 (the Act) (for projects deemed as state significant whereby the Planning Minister has assessed the potential impacts "and the perspectives of regulatory agencies, specialists, the community and other stakeholders".12

If an EIS is required for the construction or upgrade of gas infrastructure, this may trigger other environmental and planning legislation. The EIS process may coordinate the environmental, social and/or economic requirements of multiple pieces of legislation triggered by the EIS of the proposed project. Further investigation into the perspectives of hydrogen fuel infrastructure from regulatory agencies, specialists, the community and other stakeholders that influence decision-making under environmental and planning legislation and if this differs to natural gas is warranted.

4.3.3 Management of risk with a change of fuel from natural gas to hydrogen

Hydrogen has a different risk profile with regards to technical and safety risk. In this context, the different risk profile of hydrogen compared with natural gas may challenge the safety and environmental objectives of planning and environment legislation with regards to environmental management plans, EISs, and pipeline corridor planning (such as overlays and industrial buffer distances). This risk can arise from the increased potential for hydrogen leakage in manufacturing, transmission and distribution and third party interference and also the changed measurement lengths for pipelines (where acknowledged in environment and planning legislation). These are examples of how hydrogen may impact on the current objectives and decision-making criteria for such planning and environmental management instruments. Further investigation is warranted to determine the implications the different risk profile of hydrogen has on environment and planning decisions.

4.4 ECONOMIC REGULATION[13]

The focus of this section is Australia's current economic regulatory regime as it applies to gas transmission pipelines and distribution networks. If future fuels, such as hydrogen and biogas (blended with natural gas or otherwise), are to be transmitted through these pipelines and networks, a number of issues arise because of the nature of existing economic regulation.

We first consider the existing, and quite complex, economic regulatory regime context in which these issues arise. This consideration indicates the extent of potential impact for owners and operators of regulated gas transmission pipelines and distribution networks to transmit future fuels—if there is amendment to the current definition of natural gas that applies within Australia's economic regulatory regime to permit the transmission of

[11] Wüstenhagen, R., Wolsink M., and Bürera, M.J. (2007). Social acceptance of renewable energy innovation: An introduction to the concept, Energy Policy, 35 (5), 2683-2691, p. 2685.
[12] NSW Planning and Environment (2017) Preparing an Environmental Impact Statement, NSW Government https://www.planning.nsw.gov.au/~/media/Files/DPE/Guidelines/guideline-4-draft-preparing-an-environmental-impact-statement-2017-06.ashx
[13] Samuel Naylor (University of Sydney) provided research assistance for this section.

blends of hydrogen or biogas with natural gas.[14] The implications of existing economic regulation are considered for new and existing gas transmission pipelines and existing distribution networks. Insights from the European Union (EU) regulation of hydrogen energy are also discussed given parallels with the Australian energy sector.

4.4.1 The Australian economic regulatory regime

Legislative framework and economic regulators

The *National Gas Law* (NGL) and the *National Gas Rules* (NGR) determine if a gas transmission pipeline or distribution network is subject to economic regulation. The NGL is enacted as a law of South Australia—*National Gas (South Australia) Act 2008.* Mirror legislation has been enacted in other jurisdictions implementing the NGL in all Australian states and territories.

Section 23 of the NGL sets out the National Gas Objective (NGO), namely:

> The objective of this Law is to promote efficient investment in, and efficient operation and use of, natural gas services for the long term interests of consumers of natural gas with respect to price, quality, safety, reliability and security of supply of natural gas.

Section 2 of the NGL provides that:

> Natural gas means a substance that—
>
> a) is in a gaseous state at standard temperature and pressure; and
> b) consists of naturally occurring hydrocarbons, or a naturally occurring mixture of hydrocarbons and non-hydrocarbons, the principle constituent of which is methane; and
> c) is suitable for consumption.

At the state level, further legislative instruments regulate the supply of gas which overlap with the NGO. Many of these instruments refer to natural gas as having the same meaning as it has in the NGL and/or as compliant with the natural gas standards as set out in relevant Australian Standards.

Introduction of either hydrogen or biogas into the network poses definitional problems given that they are most likely to be seen as manufactured, rather than naturally occurring, substances. Hydrogen is further limited by the requirement for any blended mixture to be principally methane. Thus, greater definitional specificity in the NGL is required for future fuels like hydrogen to be transmitted through regulated gas transmission pipelines and distribution networks.

Should greater definitional specificity be introduced into the NGL, the definitions of many related state legislative instruments and Australian Standards would also require amendment given the functional impact of inconsistent specifications.

The NGL also provides for the functions and powers of the Australian Energy Market Commission (AEMC), the Australian Energy Regulator (AER) and the Economic Regulation Authority of Western Australia (ERAWA). The AEMC is the rule maker for Australian gas and electricity markets and thus responsible for making and amending the NGR. The AER is responsible for economic regulation in all states and territories except WA which falls within the jurisdiction of the ERAWA.

Gas infrastructure subject to economic regulation

The framework of the NGL and NGR, commencing from 1 July 2008, is a refinement of the access regime set out in the *Gas Pipeline Access (South Australia) Act 1997* and the National Third Party Access Code for Natural Gas

[14] In October 2019, the COAG Energy Council issued a consultation Regulation Impact Statement on 'Options to improve gas pipeline regulation'. This consultation concerns the regulatory coverage test for gas pipelines (and the information disclosure and arbitration framework), and not the economic regulation of gas transmission pipelines and distribution networks. This is an important distinction. See Section 4.4.1 below.

Pipelines Systems, commonly referred to as the Gas Code.[15] Access regulation applies only to 'covered' pipelines or networks.[16]

A gas transmission pipeline or distribution network is deemed to be 'covered' for economic regulation if:

- the pipeline or network was covered under the previous Gas Code;
- the pipeline or network is developed through an AER approved tender process;
- an unregulated pipeline or network voluntarily submits an access arrangement to the AER; or
- an application is made for coverage and the relevant Australian State government Minister is satisfied the pipeline or network meets all the coverage criteria.

There are four prescribed coverage criteria:

a) that access (or increased access) to pipeline services provided by means of the pipeline would promote a material increase in competition in at least 1 market (whether or not in Australia), other than the market for the pipeline services provided by means of the pipeline;

b) that it would be uneconomic for anyone to develop another pipeline to provide the pipeline services provided by means of the pipeline;

c) that access (or increased access) to the pipeline services provided by means of the pipeline can be provided without undue risk to human health or safety;

d) that access (or increased access) to the pipeline services provided by means of the pipeline would not be contrary to the public interest.[17]

In making a decision about whether each criterion is met, the relevant Australian state government Minister must have regard to the NGO.

Coverage may be revoked by the relevant Minister if at least one of the coverage criteria is no longer met.[18] Coverage status of a pipeline or network may also change over time due to changed circumstances and a greenfields pipeline may be granted a 15-year coverage exemption if one or more of the coverage criteria will not be met.

If a pipeline or network is deemed to be covered under the NGL the next threshold issue is which form of economic regulation applies—full or light. Covered pipelines and networks are subject to full regulation until a light regulation determination, upon application, is made by the National Competition Council (NCC). The only exception to this applies to 'designated' gas pipelines and networks which are subject to full economic regulation; a light regulation determination cannot be made for designated gas pipelines and networks.[19]

Nearly 32% of existing gas transmission pipelines and more than 91% of existing gas distribution networks are subject to full economic regulation (see Table 16). More than 70% of fully regulated gas transmission pipelines have been operating—since commissioning—for more than 30 years, and nearly 28% for 46-50 years. These 'older' pipelines are predominantly located in WA, the Northern Territory and Victoria.

[15] The objective of the Gas Code was:
> the establishment of a framework for third party access to gas pipelines that would, amongst other things, prevent the abuse of monopoly power by pipeline operators and provide rights of access on fair and reasonable terms for both the pipeline operator and users (Australian Competition and Consumer Commission. 2016. *Inquiry into the East Coast Gas Market,* April 2016, Canberra: ACCC, p. 121).

[16] Access to 'uncovered' pipelines and networks is through commercial negotiation and arrangements.

[17] *National Gas (South Australia) Act 2008,* s. 15.

[18] Coverage has been revoked for nearly 22% of gas transmission pipelines. This figure was calculated from data in the Australian Energy Market Commission's *Gas Scheme Register*, and Vertigan's 2016 *Examination of the Current Test for the Regulation of Gas Pipelines* for the COAG Energy Council.

[19] *National Gas (South Australia) Act 2008,* s. 2. A designated pipeline is one classified by the Regulations (permitted under s. 3) or in the application Act of a participating jurisdiction.

Table 16: Economic regulatory status of gas infrastructure

Transmission pipelines				
Jurisdiction	**Length (km)**	**Full regulation**	**Light regulation**	**No regulation**
WA	6,039	54.3%	0.7%	45.0%
QLD	6,502	8.6%	14.5%	76.9%
NSW	3,379[20]	8.9%	38.0%	53.1%
VIC	2,614	77.9%	-	22.1%
SA	2,217	-	-	100.0%
TAS	734	-	-	100.0%
NT	3,074	53.9%	-	46.1%
Australia	**24,559**	**31.9%**	**14.8%**	**53.3%**
Distribution networks				
Jurisdiction	**Length (km)**	**Full regulation**	**Light regulation**	**No regulation**
WA	12,800	100.0%	-	-
QLD	6,199	-	97.5%	2.5%
NSW	26,668	97.4%	-	2.6%
VIC	31,190	99.7%	-	0.3%
SA	7,950	100.0%	-	-
TAS	712	-	-	100.0%
ACT	4,720	100.0%	-	-
NT	38	-	-	100.0%
Australia	**90,277**	**91.4%**	**6.7%**	**1.9%**

Application of economic regulation

Full economic regulation determines the revenue a business needs to cover 'efficient costs' and sets a revenue 'cap' based on a cost of capital (debt and equity), and forecast capital expenditure (investment) and operating costs. Consequently, economic regulation is a significant influence on the profitability of a regulated business.

Full economic regulation means direct regulatory control of the prices charged to consumers and the conditions of supply to consumers. A reference tariff (price) is set for a service that will be sought by a significant part of the market. Reference tariffs must be submitted by the service provider for approval—within an access arrangement—to the economic regulator (AER or ERAWA).[21]

Light economic regulation is focused around commercial negotiation between the service provider and shipper with economic regulatory intervention used to arbitrate disputes. The requirement to submit a full access arrangement to the economic regulator for approval is the key difference between the obligations on a service provider under full and light economic regulation.[22]

Fully regulated businesses periodically submit proposed access arrangements—generally for a five-year period—for the approval of the economic regulator. A proposed access arrangement details the forecast revenue and expenditure requirements of the regulated business for the regulatory period and a reference tariff, i.e. a price for a 'reference service'—a pipeline or network service—sought by a significant proportion of the market.

[20] A further 450km is planned for NSW (APA Group – Western Slopes Pipeline).
[21] Users (shippers) may be willing to accept the reference tariff or can negotiate a price with the service provider. If commercial negotiations break down, the user can seek arbitration.
[22] A 'service provider' is any person who owns, controls or operates the pipeline or network (*National Gas (South Australia) Act 2008,* s. 8).

Section 24 of the NGL sets out revenue and pricing principles which the economic regulator must take into account when reviewing a proposed access arrangement, namely:

(2) A service provider should be provided with a reasonable opportunity to recover at least the **efficient costs** the service provider incurs in—
  (a) providing reference services; and
  (b) complying with a regulatory obligation or requirement or making a regulatory payment.
(3) A service provider should be provided with **effective incentives** in order to promote economic efficiency with respect to reference services the service provider provides. The economic efficiency that should be promoted includes—
  (a) **efficient investment** in, or in connection with, a pipeline with which the service provider provides reference services; and
  (b) the **efficient provision** of pipeline services; and
  (c) the **efficient use** of the pipeline.
(4) Regard should be had to the capital base with respect to a pipeline adopted—
  (a) in any previous—
    (i) full access arrangement decision; or
    (ii) decision of a relevant Regulator under section 2 of the Gas Code;
  (b) in the Rules.
(5) A reference tariff should allow for **a return commensurate with the regulatory and commercial risks** involved in providing the reference service to which that tariff relates.
(6) Regard should be had to the **economic costs and risks of the potential for under and over investment** by a service provider in a pipeline with which the service provider provides pipeline services.
(7) Regard should be had to the economic costs and risks of the potential for under and over utilisation of a pipeline with which a service provider provides pipeline services.[23]

The NGR, in giving effect to the NGL, indicate the criteria the economic regulator will apply in assessing forecast revenue requirements to meet the 'efficient costs' of the regulated business.[24] Total revenue for each year is assessed by the economic regulator using the building block approach in which the 'blocks' are forecasts of operating expenditure (opex), depreciation of the projected capital base, corporate income tax, revenue adjustments from incentive schemes, and a return on capital.[25]

> In assessing operating expenditure forecasts, the AER considers cost drivers that include customer growth, expected productivity improvements, and changes in real input costs for labour and materials. Operating cost increases may also reflect step change factors arising from external drivers such as **changes in government regulation**.[26]

Proposed capital expenditure (capex) by the regulated business is also assessed by the economic regulator. Capex will influence the size of the business' capital base and therefore the revenue generated from the return on capital, i.e. the capital base x the rate of return on capital. The assessment of capex involves a number of relevant aspects to this discussion—the assessed value of the capital base at the beginning of the regulatory period (opening 'conforming' capital base) and the projected capital base at the end of the regulatory period which depends on the assessed value of proposed new 'conforming capex'.[27]

---

[23] *National Gas (South Australia) Act 2008,* s. 24 (emphasis added).
[24] See: Part 9 of the NGR.
[25] For regulated gas businesses, the economic regulator does not set a maximum cap on revenue for the regulatory period. Instead, weighted average price caps are set. This means that different tariffs for different reference services apply within an overall revenue ceiling. The reference tariffs are derived from the total revenue requirement after considering the forecast demand for each reference tariff category. The tariffs determined by the economic regulator act as a revenue constraint for the regulatory period rather than the total revenue requirement set by the economic regulator's decision. If actual demand is greater than forecast demand, actual revenue will be greater than forecast revenue and the converse applies.
[26] Australian Energy Regulator. 2017a. *State of the Energy Market May 2017.* Melbourne: AER, p. 115 (emphasis added).
[27] See: NGR Rule 79.

In assessing proposed capex:

> the AER approves **prudent** and **justifiable** investment forecasts, based on criteria in the National Gas Rules. The underlying investment drivers include rising connection numbers, the replacement of ageing networks, and the maintenance of capacity to meet customer demand.[28]

The AER has also expressed the view that:

> We **do not approve funding for an energy network business' specific projects or programs**, but rather a total forecast for capex and opex. Once a total forecast is set, it is for the business to decide which suite of projects and programs are required to meet their service and reliability requirements.[29]

Nevertheless, the economic regulator does review the proposed delivery and arrangements for 'specific projects and programs' which comprise the expenditure forecasts within a proposed access arrangement as part of the regulatory approval process, and the economic regulator directly comments on the scale and provision of specific projects and programs. So, although the economic regulator's approval is for 'global' amounts (opex, capex, return on capital etc.), the approved amounts for each of the 'blocks' is based upon a somewhat forensic assessment by the economic regulator of all the elements which comprise the proposed access arrangement in order to form a view of 'efficient costs'.

The return on capital is the largest component of revenue for a regulated business and has been estimated at 50% of total revenue for SA gas distribution and 52% for Victorian gas transmission.[30] Operating expenditure is estimated to be 40% of total revenue for South Australian gas distribution and 33% for Victorian gas transmission.[31] Consequently, the economic regulator's assessments and decisions about opex, capex and the weighted average cost of capital (rate of return on equity and debt costs) are quite critical for a regulated business, and even more so if there is considerable difference between a proposed access arrangement and the regulator's determination.

4.4.2 Implications of the economic regulatory regime for different scenarios

This section considers a range of economic regulation issues for the transmission of future fuels through gas pipelines and distribution networks—under different scenarios—given the nature of the supply chain infrastructure required for hydrogen and biogas as described in the Introduction.

Gas specifications in the NGL

The first threshold issue is the current natural gas definition in the NGL noted earlier; namely, the levels to which hydrogen blends with natural gas, pure hydrogen, or biogas blends could be transported in regulated gas transmission pipelines and distribution networks are limited by the current definition.

This is a significant issue on a number of counts. The commercial decisions for owners and operators of regulated pipelines and distribution networks will be constrained, and thus the role of future fuels in decarbonising Australia's energy sector, until there is greater scope within the specifications of gas to include the transmission within the gas supply infrastructure of future fuels.

Hydrogen or biogas transport—blended or pure—will have capital and operating expenditure implications as well as impacting pricing structures and revenue levels, all of which are subject to the economic regulator's approval.

New gas transmission pipelines?

New gas pipelines may be required:

- to transport hydrogen from production points to export hubs;

[28] Australian Energy Regulator. 2017a. *State of the Energy Market May 2017.* Melbourne: AER, p. 115 (emphasis added).
[29] Australian Energy Regulator. 2014. *Overview of the Better Regulation Reform Package,* April 2014, Melbourne: AER, p. 6 (emphasis added).
[30] Australian Energy Regulator. 2017a. *State of the Energy Market May 2017,* Melbourne: AER, p. 103.
[31] Australian Energy Regulator. 2017a. *State of the Energy Market May 2017,* Melbourne: AER, p. 103.

— to transport hydrogen or biogas to a processing facility for mixing and subsequent insertion into transmission systems or reticulated distribution networks; or

— to inject hydrogen into reticulated distribution networks.

A 'greenfields' pipeline may be granted a 15-year exemption from economic regulation if one or more of the coverage criteria will *not* be met (refer to Section 4.3.1).

Should an exemption not be granted, full economic regulation would apply—unless the NCC determines that light economic regulation applies—and assuming an amendment to the NGL to include the carriage of hydrogen or biogas above small blended amounts. This scenario raises a set of issues given the nature and processes of Australian economic regulation as outlined previously. The economic regulator would review and make a determination on these issues which include:

— What is prudent and justifiable (conforming) capex for the new transmission pipeline?

— What are the efficient operating costs for the new pipeline?

— Is safety expenditure—for the purposes of transmitting hydrogen/biogas—prudent and justifiable capex and opex costs of the new pipeline?

— If a blend of hydrogen/biogas is to be transported, should the capex and opex costs of safety expenditure—for the purposes of transmitting hydrogen/biogas—be distinguished from other safety expenditure for the new pipeline?

— Are the assets connecting the production facility and/or storage tanks to the new pipeline included or excluded from the regulated asset base of the new pipeline?

The notions of 'prudent and justifiable' expenditure and 'efficient' costs, the amount expended on safety, the distinction between types of safety expenditure pertaining to different fuels transported in the same pipeline, and the definition of where the regulated asset starts when connected to a production facility and storage tanks, are matters about which it is highly likely that a regulated business and the economic regulator will hold different views about the drivers and justification of expenditure.

Location of new gas transmission pipelines?

New gas pipelines could be located within an existing transmission pipeline corridor of an existing regulated gas transmission business. If this occurs, a threshold question is: Are the assets of the new pipeline treated as assets of the existing regulated business and thus subject to full economic regulation?

If the answer to this question is in the affirmative, a similar set of economic regulatory issues arise as outlined above for the scenario of a new transmission pipeline.

If the answer to this question is in the negative, then the following questions will arise:

— Is the new pipeline covered by full economic regulation?

— If the pipeline is covered by full economic regulation, what processes will the economic regulator adopt to review and assess these pipeline assets independently of the owner's other pipeline assets in the same corridor?

— If the new pipeline is not covered by full economic regulation, what should be the determination by the relevant authority?

Use of existing gas transmission pipelines?

The use of existing gas transmission pipelines to transmit future fuels will depend on, in addition to NGL definitional amendment, the following: [a] the proximity of these pipelines to future fuels production facilities, storage tanks and export locations; and [b] the susceptibility of these pipelines to potential embrittlement from hydrogen due to factors such as pipe condition, material and thickness.

As noted earlier, nearly 32% of existing transmission pipelines are subject to full economic regulation, and more than 70% of these regulated pipelines have been operating—since commissioning—for more than 30 years, and nearly 28% for 46-50 years.

Should existing—and fully regulated—gas transmission pipelines require upgrading or replacement for the purpose of transmitting future fuels, this raises a number of issues upon which the economic regulator would

make a determination for each regulatory period. These issues are similar to those outlined above for new transmission pipelines about prudent and justifiable capex, efficient operating costs, safety expenditure and the inclusion or not within the regulated asset base of capital assets required to connect production facilities, export hubs and storage tanks to transmission pipelines.

Use of existing gas distribution networks?

The use of existing gas distribution networks to transmit blends of future fuels and natural gas will similarly depend on proximity to future fuels production facilities and network susceptibility to potential embrittlement and leakages. As noted earlier, more than 90% of current distribution networks are subject to full economic regulation.

The 2019 *Australian Hydrogen Hubs Study,* for the COAG Energy Council Working Group, noted that the mains replacement programs of Australia's gas distribution networks have deployed high density polyethylene (HDPE) pipe to replace cast iron or steel pipes. HDPE is suitable for transmitting up to 100% hydrogen, and thus eliminating the risk of pipe embrittlement. Nevertheless, the forecast expenditure and proposed timelines for mains replacement have been a significant point of contention over past regulatory periods between the distribution networks and the economic regulator.

Despite the suitability of existing gas distribution networks with HDPE pipes to transmit hydrogen, the economic regulatory issues common to the above discussed scenarios remain: What are the amounts of prudent and justifiable capex, efficient operating costs, and safety expenditure? Which assets are included or not in the regulated asset base required to connect production facilities (e.g. electrolysers) and storage tanks to distribution networks?

4.5 INSIGHTS FROM EU HYDROGEN ENERGY REGULATION

This discussion of insights from EU future fuels energy regulation focuses primarily on the regulatory issues for the blending of hydrogen into gas networks. The discussion draws upon findings of the HyLaw project to remove the legal barriers to integrate hydrogen into the EU energy network. This 2017-2018 project involved industry and research partners across 23 countries.

4.5.1 EU regulation and other relevant instruments

Currently, hydrogen injection into EU gas networks is generally considered on a case-by-case basis and is through electrolysers which use surplus electricity from the grid to produce hydrogen ('Power to Gas' or PtG) and are generally time-limited and for demonstration.[32] The PtG process involves a distribution network operator to blend and deliver the hydrogen-rich natural gas although the process may also involve a transmission operator and interface with multiple network gas grid connections. Thus, there are considerable parallels with the potential introduction of hydrogen transmission through Australia's gas supply infrastructure which is covered by the NGL.

EU gas grids have been open to market competition for over 20 years as provided for in EU Directive 2009/73/EC and subsequent regulations. However, these EU-level Directives are primarily framed around the storage, transmission, distribution and customer-based supply of natural gas, and do not facilitate network access for hydrogen injection. Nevertheless, the EU regulatory model, in some areas, is more hydrogen-friendly than the Australian regulatory regime.

For example, EU Directive 2009/73/EC—the key instrument pertaining to the gas grid—provides an open-ended definition of gas. Article 1(2) states:

> … the rules established by this Directive for natural gas, including LNG, shall also apply in a non–discriminatory way to biogas and gas from biomass or other types of gas in so far as such gases can technically and safely be injected into, and transported through, the natural gas system.

Thus, the EU regulatory framework, although centred on natural gas provides for the inclusion of other fuels, including hydrogen, and limited only by technical and safety requirements.

[32] HyLaw Horizontal Position Paper, pp. 5-6.

This is also evidenced elsewhere such as the EU Directive 2014/94/EU on the deployment of alternative fuels infrastructure (AFID). Article 2 of AIFD defines alternative fuels as:

> … fuels or power sources which serve, at least partly, as a substitute for fossil oil sources in the energy supply to transport and which have the potential to contribute to its decarbonisation and enhance the environmental performance of the transport sector. [this includes hydrogen]

In addition, EU Directive 2018/2001 on the promotion of the use of energy from renewable sources (RED II), replacing Directive 2009/28/EU, establishes a common framework for the promotion of energy from renewable sources. Article 2.36 defines renewable liquid and gaseous transport fuels of non-biological origin as:

> … liquid or gaseous fuels which are used in the transport sector other than biofuels or biogas, the energy content of which is derived from renewable sources other than biomass.

This Directive also requires that an emissions reduction target be reached through use of such fuels.

ISO standards specifically relating to hydrogen energy have also been adopted. This is particularly evident in the EU Directive 2014/94/EU AFID which seeks to minimise dependence on oil and to mitigate the environmental impact of transport through the deployment of alternative fuels infrastructure. For example, the technical specifications for hydrogen refuelling points for motor vehicles are underpinned by compliance with the technical specifications with multiple ISO standards.

The 2018 National Hydrogen Roadmap issued by the CSIRO, apart from documenting current regulations and standards applicable to hydrogen use in Australia, lists at length the relevant ISO standards pertaining to hydrogen energy although not adopted in the Australian regulatory framework.

National legislation of some EU member countries has also mandated ‘acceptable’ hydrogen levels for use in gas networks. These range from minimal (0.1-0.5%), low (1.0-4.0%), mid (6%), and high (up to 10%). In other member countries there is no legally mandated concentration rule although safety limits operate by default. Notably a 2018 amendment to AS/NZS4645 covers gas blends of up to 15% hydrogen in gas distribution networks.

The use of open, and non-discriminatory, fuel definitions, and the explicit adoption of ISO standards, and legally mandated acceptable hydrogen blend levels are three ways in which the EU regulatory framework is hydrogen-friendly.

4.5.2 Calorific value

A live issue raised by the European HyLaw project concerns the impact of hydrogen blends on the ‘calorific value of gas’. The calorific value of gas refers to the amount of energy contained within given the volume of a given gas. It is calculated according to ISO6976 (Natural gas – Calculation of calorific values, density, relative density).

As in Australia, the calorific value forms the basis of the transport, supply, pricing and billing of natural gas within EU instruments. Hydrogen blends will change the calorific value of the gas flow and thus will impact upon the operation of the EU gas market. In addition, the change in energy content will have repercussions for operational and safety processes particularly concerning end-user appliances.

5 Conclusions

The review has shown that much of the legislation that applies to use of natural gas as a fuel does not contemplate injection of future fuels into existing gas infrastructure. This may not be deliberate, but rather that injection of non-hydrocarbon gases and hydrocarbons from non-geological sources was not contemplated when legislation was drafted.

A common problem relates to definitions of natural gas (or sometimes hydrocarbon) covered by existing legislative frameworks. These often preclude future fuels. In some cases, government Ministers have deeming powers which may allow some legislative coverage to be put in place. Relying on this approach clearly comes with project risks.

Another issue is that many regulations either contain technical requirements (such as gas quality) or refer to Australia Standards that have technical requirements. In many cases, biogas or hydrogen are not effectively covered by this material. This potentially leaves a legislative trail that could, for example, require a hydrogen facility to comply with a methane standard which would clearly not be appropriate.

In the case of environment and land use planning legislation, definition problems could lead to future fuels facilities triggering new planning process requirements instead of existing processes for natural gas pipelines, where these existing processes did not contemplate the future fuel or blend. They would no longer be subject to various exemptions that are granted to natural gas facilities and would be required to seek approval under the planning process.

When it comes to economic regulation, there are also potential issues. The NGL currently does not contemplate addition of future fuels to the natural gas system. Without amendment to the NGL's gas definition, the scope for future fuels injection into Australia's 'covered' natural gas infrastructure will likely be limited thus preventing a considerable opportunity to accelerate decarbonisation of the energy sector. The EU gas sector provides an example of requirements that are not fuel-discriminatory and which would permit future fuels such as hydrogen and biogas to play a far more prominent role.

Nearly one third of gas transmission pipelines are subject to full economic regulation which seeks to deliver the supply of gas at the lowest possible cost. Over 72% of these gas transmission pipelines were commissioned more than 30 years ago, and 27% more than 46-50 years ago. This age profile suggests that regulated businesses would need to raise expenditure levels to maintain pipeline integrity and reduce the risks of leakages and embrittlement with the injection of hydrogen in particular. Biogas presents no such limitation.

More than 90% of distribution networks are subject to full economic regulation. These networks have undertaken considerable mains replacement programs with pipes that are highly suitable to transmit either hydrogen or biogas.

Nevertheless, the nature of Australia's economic regulatory regime means that a significant set of issues will occur for the development and location of new gas transmission pipelines, and the use of existing regulated gas pipelines and transmission networks, for transporting future fuels. These issues arise from the processes of economic regulation structured by the NGL and the NGR, and potentially include contention about levels of prudent and justifiable capex, efficient operating costs, safety expenditure for future fuels transport, and the inclusion or not within the regulated asset base of capital assets required to connect future fuels production facilities, export hubs and storage tanks to transmission pipelines and distribution networks.

The economic regulator seeks to establish expenditure levels that would be incurred by a prudent service provider acting efficiently, in accordance with accepted good industry practice, to achieve the lowest cost of providing services. It is this level of expenditure (along with an agreed rate of return) that fixes allowable charges. The NGR, as currently written, contain a number of terms which are very open to interpretation. These terms include: 'reasonable', 'prudent', 'accepted good industry practice', 'necessary', 'maintain and improve', 'integrity', and 'comply'. This means that the economic regulator can form a view which may be at odds with that of a gas transmission pipeline or distribution network business.

There is scope for the economic regulatory process to not accept an operator's assessment of the risk posed by their gas transmission or distribution assets. This scope is provided by the discretion within the NGR for the economic regulator to determine what is a regulatory obligation or requirement. It is also provided by the authority

of the economic regulator to prescribe ‘micro’ expenditure solutions notwithstanding the claim that only ‘global’ amounts for capex and opex forecasts are approved and not funding for specific projects or programs.

The issue of which assets—due to future fuels transmission—are included in the regulated asset base poses a particular challenge for the economic regulatory regime. This issue applies equally to the transmission of 100% hydrogen or to a blend of hydrogen or biogas with natural gas although is more complex in the case of a blend. For future fuels transmission to occur, a connection with a production facility, export hub and/or storage tank will be necessary. It is this connection which poses a potential issue. Is the connection—from the regulated pipeline—classified as part of the pipeline’s regulated asset base? Future fuels transmission cannot occur without these connections. This suggests that the capital assets denoted as the regulated assets of a gas transmission pipeline or distribution network will need to include the assets which form the connection to the production facility, export hub or storage tank.

6 Implications and Recommendations for industry

The review highlights the extent to which future fuel blends with natural gas are not robustly addressed by current legislative instruments. The current arrangements pose a wide range of project risks for development of future fuels infrastructure projects.

There are three primary ways in which this could be addressed:

- Existing legislation could be broadened in scope to include future fuels;
- New legislation could be introduced to cover aspects of future fuels usage; and/or
- Alternate approval pathways could be developed through existing legislative instruments.

In each case, and especially where broadening the scope of existing legislation or definitions within the legislation to include future fuels, the potential implications for existing activities, and associated co-regulations, will need to be carefully considered.

7 Next steps and future works

This is the final report on the subject project. Next steps relate to the practical implications, rather than more research.

8 APPENDICES

8.1 APPENDIX 1: STANDARDS USED IN LEGISLATIVE DATABASE SEARCH

Standard	Number	Year	Title
AS	1425	2013	LP Gas fuel systems for vehicle engines
AS	1210	2010	Pressure vessels
AS	1375	2013	Industrial fuel-fired appliances
AS	2473.3	2007	Valves for compressed gas cylinders
AS	2613	2005	Safety devices for gas cylinders
AS	2885	Series	Transmission pipelines
AS	3645	2017	Essential requirements for gas equipment
AS	3814	2017	Industrial and commercial gas fired appliances
AS	4552	2005	Gas fired water heaters for hot water supply and/or central heating
AS	4554	2016	Gas laundry dryers
AS	4555	2013	(AG 105) Domestic gas refrigerators
AS	4563	2016	Commercial catering gas equipment
AS	4575	2019	Gas appliances - quality of servicing
AS	4618	2019	Gas appliance regulators
AS	4619	2004	Gas appliance thermostats
AS	4624	2005	Combination controls for gas
AS	4627	2017	Quick-connect devices for gas
AS	4647	2018	Diaphragm gas meters
AS	4041	2016	Pressure piping
AS	4564	2011	Natural gas
AS	4617	2018	Manually operated gas valves
AS / NZS	1869	2012	Hose and hose assemblies for liquefied petroleum gases (LP Gas), natural gas and town gas
AS / NZS	2739		Natural gas (NG) fuel systems for vehicle engines
AS / NZS	3509	2009	LP Gas fuel vessels for automotive use
AS / NZS	4645.1	2018	Gas distribution networks: Network management
AS / NZS	4645.2	2018	Gas distribution networks: Steel pipe systems
AS / NZS	4645.3	2018	Gas distribution networks: Plastic pipe systems
AS / NZS	5263.0	2017	Gas appliances - general requirements
AS / NZS	5263.1.1	2016	Domestic gas cooking appliances
AS / NZS	5263.1.10	2019	Gas direct fired air heaters
AS / NZS	5263.1.12	2019	Gas pool heaters
AS / NZS	5263.1.2	2016	Gas fired water heaters for hot water supply and/or central heating
AS / NZS	5263.1.3	2016	Gas space heating appliances
AS / NZS	5263.1.4	2017	Radiant gas heaters
AS / NZS	5263.1.5	2019	Domestic gas refrigerators
AS / NZS	5263.1.6	2016	Indirect gas-fired ducted air heaters
AS / NZS	5263.1.7	2016	Domestic outdoor gas barbecues
AS / NZS	5263.1.8	2016	Decorative effect gas appliances
AS / NZS	5263.1.9	2019	Gas laundry dryers
AS / NZS	5601.1	2013	Gas installation
AS / NZS	60079	Series	Requirements for the design, selection and installation of electrical equipment in hazardous areas
AS / NZS	1596	2014	The storage and handling of LP Gas
AS / NZS	1826	2008	Electrical equipment for explosive gas atmospheres - special protection - type of protection

THIS PAGE SHOULD BE LEFT BLANK

Future Fuels CRC

Enabling the Decarbonisation of Australia's Energy Networks

www.futurefuelscrc.com

info@futurefuelscrc.com

Australian Government
Department of Industry, Science, Energy and Resources

Business Cooperative Research Centres Program