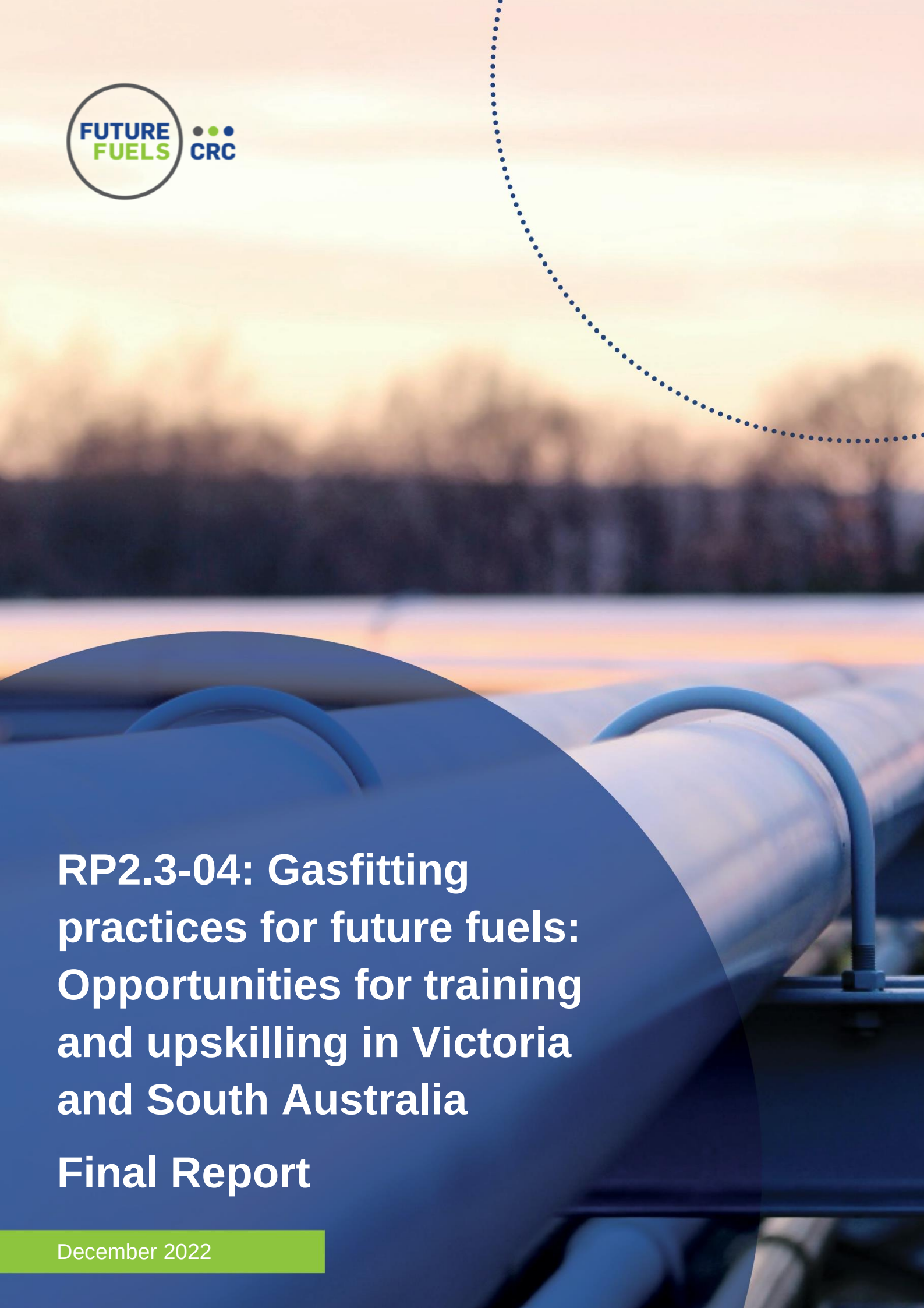

RP2.3-04: Gasfitting practices for future fuels: Opportunities for training and upskilling in Victoria and South Australia

Final Report

December 2022

Project number: RP2.3-04

Gasfitting practices for future fuels: Opportunities for training and upskilling in Victoria and South Australia

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AusIndustry
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.

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Acknowledgement

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

The authors would like to acknowledge the insight and advice provided by the Industry Advisory Group and the time and knowledge generously volunteered by our research participants.

Project Information	
Project number	RP2.3-04
Project title	Gasfitting practices for future fuels
Research Program	Research Program 2 – Social Acceptance, Public Safety and Security of Supply
Milestone Report Number	Final Report
Description	Practical delivery of future fuels to the public requires that appropriate trade resources (i.e. gasfitters) are available. This project assesses the current state of the gasfitting trade in terms of numbers, registration and continuing professional development, identifies the evolving knowledge base to develop the necessary skills for future fuels and assesses the capacity of the existing training, certification, registration and reregistration of gasfitters in Victoria and South Australia to deliver the necessary workforce capabilities and capacity for a successful transition and ongoing sustainability of a future fuel economy.
Research Provider	RMIT University
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Related Commonwealth Schedule	This work is part of Output 2.3. It does not relate to a specific milestone.
Project start/completion date	Nov 2020/ Nov 2022
IP Access	**Open** – available publicly to all parties outside the CRC.
Approved by	Paul Harris (ESV)
Date of approval	15 December 2022

Table of Contents

Project Information **4**

Table of Contents **5**

1. Introduction **6**

2. Hydrogen and the gasfitting trade **7**

3. Upskilling needs for hydrogen **8**

4. Approaches to develop and maintain competency **10**

5. Gasfitters learning needs and training practices **11**

6. Providing leadership to engage key stakeholders **13**

7. Supporting the VET sector **13**

8. Regulating competency for hydrogen practice **14**

9. Principles for hydrogen training and upskilling **15**

10. Implications and Recommendations for industry **17**

12. References **18**

1. Introduction

Significant changes are facing Australia's domestic energy sector in the transition to a low carbon energy future. *Australia's Gas Vision 2050* and the CSIRO's *National Hydrogen Roadmap* state that hydrogen can be used in the existing gas supply networks to heat, cool, cook, and generate electricity in the home (Bruce et al., 2018; Energy Networks Australia, 2018). Numerous trials are currently being undertaken in Australia to test domestic Type A appliances with hydrogen and inject hydrogen into the natural gas supply for use in homes[1].

Hydrogen as a future fuel will require skilled professionals and practitioners across the hydrogen supply chain. The potential use of hydrogen as a future fuel in Australian households means that gasfitters working downstream of the meter on household gas appliance installations, servicing, maintenance and conversion, are essential skilled practitioners in the transition process. Further, hydrogen provides an opportunity for the long-term viability of the gasfitting trade in a low carbon energy future.

Despite the opportunity presented by the transition to a decarbonised gas, the required skills for gasfitters are largely absent from government policies regarding green, clean or low carbon skills. Within the low carbon skills space more broadly, federal and state governments are investing in green skills. The Federal Government has recently announced plans to train 10,000 'New Energy Apprentices' and fund a New Energy Skills Program as an outcome of the 2022 Jobs and Skills Summit. While the Victorian Government has announced that it will build skills to support Victoria's clean economy as part of the Victorian Skills Plan and is developing a Clean Economy Workforce Development Strategy. Moves to a zero-carbon energy supply and a focus on renewable *electricity* in government energy and built environment policy and associated training initiatives, means that the use of natural gas and the gasfitting trade is at risk of becoming obsolete in the future energy economy. It is important that gasfitting skills for hydrogen are considered in such initiatives, as renewable electricity and transport related skills currently dominate this space.

As such, the skills and associated learning and training needs of domestic gasfitters in the transition to hydrogen have been the focus of this two-year study which sought to:

> 1) investigate the capacity of gasfitters to support a transition to hydrogen in Australian households in terms of numbers and existing skills,
>
> 2) identify the emerging knowledge and skills required for gasfitters and potentially other trades in a transition to hydrogen in Australian households and
>
> 3) assess the capacity of the existing training, certification, registration and licensing frameworks for gasfitters in Victoria and South Australia to deliver these skills for a successful transition to future fuels.

This final report summarises the key research findings presented in Interim Reports 1 through to 4 and highlights key learnings and principles that can facilitate the training and upskilling of gasfitters in Australia to work with hydrogen, along with recommendations to assist the gas industry to engage with stakeholders in the gasfitter training and regulatory space.

The summary of findings presented in this report are based on research methods which included:

1. A desktop review of academic and non-academic literature (reports, websites, policy) to determine the existing training frameworks and the advantages and challenges these present for hydrogen training and upskilling.
2. Sixty-seven semi-structured interviews with a variety of stakeholders including engineers, technicians and researchers working on hydrogen pilot projects (n=6), industry regulators (n=4), gasfitters (n=40), Vocation Education and Training (VET) sector trainers (n=11), and plumbing industry associations (n=6). Data from which provided insight into these stakeholder perspectives on current training and licensing requirements and practices, and views on opportunities and challenges with regards to supporting the development of competencies to work with hydrogen.
3. A review of training and associated regulatory frameworks in 10 occupations outside of gasfitting.

[1] For example see Deakin University's Hycel facility in Wollongong, Victoria (Deakin University, 2021), AGIG's Hydrogen Park in Tonsley, South Australia (AGIG, n.d), ATCO's Clean Energy Innovation Hub (CEIH) in Jandakot, Western Australia (ATCO, 2020), Evoenergy and the Canberra Institute of Technology's Hydrogen Test Facility in the Australian Capital Territory (Evoenergy, 2021) and Jemena's Western Sydney Green Gas Project (Jemena, n.d-b).

4. A national survey of 1001 plumbers/gasfitters to determine their training behaviours and ways to support training and upskilling for hydrogen.

2. Hydrogen and the gasfitting trade

In Australia, gasfitting is a specialisation within the plumbing trade. Australia-wide, gasfitting accounts for 23 per cent of the total revenue generated by plumbing (Kelly, 2021). According to the most recent labour force data from the ABS, there were 79,900 people working as plumbers in Australia in 2021 (ABS, 2022) but no public data has been identified regarding the number of people with gasfitting qualifications specifically. Almost all gasfitters are self-employed and/or work as part of a small business (50 per cent sole traders/partnerships, 48.6 per cent with less than 20 employees) (Kelly, 2020). Plumbing, including gasfitting, is regulated at a state level and qualification requirements for licensing or registration, along with licensing classifications and terminology, vary across states and territories. Regardless, all state based qualification requirements rely on the national training framework and its certificate level qualifications for plumbing and/or gasfitting practices delivered by the VET sector's registered training organisations (RTOs) including TAFEs.

The implications for gasfitting for working with hydrogen differ depending on the approach taken to transition away from natural gas. A sample of Australian Type A appliances have been shown to be compatible with natural gas that is enriched with up to 10 per cent hydrogen[2] (Smith, Ashman, Bogers, & Alfonsetti, 2020, p. 11), however, higher percentage blends of hydrogen will require new appliances or significant upgrades to existing appliances specifically in relation to their burner designs (Bruce et al., 2018). In Interim Report 1, three potential end use hydrogen scenarios were established based on existing research and industry and government plans. The implications of each scenario for gasfitting practice were identified. These scenarios are:

1. Low percentage hydrogen blend of up to 10 per cent in existing reticulated gas networks
2. 100 per cent hydrogen in reticulated networks
3. Home electrolysers and fuel cells

The three scenarios have differing implications for the type of training or upskilling required to be completed by gasfitters to prepare them for work with an alternative gaseous fuel. Upskilling involves the attainment of additional skills and/or knowledge to work with new technologies or practices in one's existing occupation. In other words, upskilling 'is an increase in skill level resulting from technical change or job redesign and the associated training' (Heery & Noon, 2017). This differs to initial training that provides the foundational competencies for entry level practice in an occupation. Both initial training and upskilling are important for hydrogen.

In the first hydrogen scenario, the impact on gasfitting work will likely be small as existing Type A appliances, fittings and materials can generally accommodate low percentage blends of hydrogen. Type A appliances are those that are 'off the shelf' such a hot water heaters, warm air heaters (space heating) and cooking appliances that are produced in volume. In this scenario, awareness of the properties of hydrogen gas would be advantageous for those working with hydrogen blends. In the second scenario, gasfitting practice will broadly remain the same because hydrogen will replace natural gas as the domestic combustion fuel. However, knowledge of hydrogen properties and their impacts on associated gasfitting practices will be critical. Required areas of expertise will include, but are not limited to, working safely with hydrogen, suitable materials and fittings, knowledge and skills for installation, maintenance, and conversion of Type A appliances. In the third scenario, traditional gasfitting work is expanded to include working with new technology such as electrolysers and fuel cells. This emergent field is likely to require multidisciplinary knowledge and skills across areas such as chemistry, electrolysis, electrical, and water and gas plumbing. This in and of itself may represent a new area of work practice and associated certification. The associated implications for training and upskilling for each of these scenarios are shown in Table 1.

2 This study was based on a sample of Australian appliances. Further testing is required for hydrogen compatibility with older appliances.

Table 1: Training Implications of different hydrogen end use scenarios

Scenario 1: ***Up to 10 per cent hydrogen blend with natural gas***	Based on education research, increasing knowledge of hydrogen properties can be achieved through a transmissive training approach such as an information session, video, short online course or other materials that can be studied by gasfitters to achieve the required knowledge outcomes.
Scenario 2: ***100 per cent reticulated hydrogen***	In this scenario, hydrogen would need to be included in initial gasfitter training and also in upskilling training for gasfitters working with hydrogen fuel. This training would ideally be nationally accredited to ensure consistency of learning outcomes across jurisdictions. Depending on the approach taken to the roll out of hydrogen, additional training can be completed on an as needs basis until the entire network is converted. If 100 per cent hydrogen was supplied to all homes, then all gasfitters would need to upskill. This raises the question of the number of existing gasfitters that would be required to upskill. These numbers are summarised in Section 3.
Scenario 3: ***Fuel cells***	Based on the interviews and desktop review, those undertaking work with residential electrolysers/fuel cells will need specific training/upskilling in areas traditionally outside of gasfitting units of competency. Multidisciplinary knowledge and skills requirements for working with electrolysers/fuel cells may also necessitate upskilling in other trades or the creation of new electrolysers/fuel cell certification. As fuel cells are installed at the discretion of the developer or home owner, it is not necessary for all gasfitters to be trained in such work, however upskilling is likely required for existing gasfitters who wish to undertake work with fuel cells.

In addition to hydrogen, another future low carbon fuel proposed for use in existing gas networks is biomethane, a purified biogas that contains at least 95 vol per cent of methane (Vrbová & Ciahotný, 2017, p. 9393). Under Australian regulations, biogas that is upgraded to biomethane must meet natural gas specifications to be injected into the gas network. Currently, there are plans to blend biomethane with natural gas in the reticulated gas network or blend biomethane with renewable hydrogen to displace natural gas (ARENA, 2020; Jemena, n.d-a). This study takes the position that injection of biomethane that meets natural gas specifications into reticulated gas networks will have no notable effect on gasfitting practices[3]. As such, this research has focused on hydrogen as a future fuel which, even at low percentage blends of 10 per cent can have implications for gasfitting practices and associated knowledge and skills requirements for gasfitters.

3. Upskilling needs for hydrogen

Interim Report 2 presented the training and upskilling needs for gasfitters in Victoria and South Australia to transition the gas network and associated domestic appliances to hydrogen by 2030. Based on the percentage of current gas connections in Victoria, by 2030, when the National Hydrogen Strategy plans for 'large-scale and rapid deployment of hydrogen technologies' driven by government and industry investment, there will likely be an additional 805,000 dwellings in Victoria, with a total 668,150 new households connected to gas in addition to the

[3] There are technical considerations for biomethane that need to be addressed including the potential for increased corrosion due to an increase in oxygen which could lead to fouling of copper piping. This issue however can be addressed if biogas is upgraded to required specifications for natural gas. Another issue is the potential for the combustion of biomethane to cause a build-up of silica at the point of combustion also leading to fouling. This however would occur in appliances after years using biomethane. It is likely that regulations regarding siloxane levels will be introduced to ensure that this impact is minimal. Therefore, this is not viewed as a significant issue that would affect appliances or their installation from a gasfitting perspective. The impact of biomethane on appliances has been studied as part of FFCRC Program 1. See in particular RP1.4-07 Biomethane injection into the gas network: impact of impurities on the performance of end-use appliances.

approximately 2,089,000 households connected to gas based on the Deloitte data. With these estimates, there will be between 2.5 and 3 million households connected to mains gas in Victoria (assuming the number of gas connections will remain consistent over time) all of which may require appliance conversion or the installation of hydrogen ready appliances and associated fittings to support 100 per cent hydrogen in the home. Assuming conversion work takes on average 4 hours per household and an average work time of 1750 hrs per year, conversion of 2.5 million households would require approximately 5700 gasfitters working full time for a year. As of June 2021, in Victoria there are a total of 20,262 plumbers, of which 8,676 are licensed as gasfitters. A transition to 100 per cent hydrogen across the Victorian gas network would require that around two thirds of these licensed gasfitters to upskill in order to undertake appliance conversion over a one year period. It is possible or perhaps even likely that such a transition would extend over a longer period of time but this indicative calculation provides a comparison between the scale of the task and the available workforce.

Similarly, in South Australia, according to Deloitte Access Economics (2019) cited in Energy Networks Australia (2021), there are 450,000 gas connections in South Australia. Based on these current estimations, and assuming conversion work takes on average 4 hours per household and an average work time of 1750 hrs per year, conversion of 450,000 households would require around one thousand gasfitters working full time for a year. As of October 2021, in South Australia there are a total of 1886 unrestricted gasfitters. A transition to 100 per cent hydrogen across the South Australian gas network would require more than half of these registered gasfitters receive upskilling in order to undertake appliance conversion over a one year period and for them to work consistently on the transition in preference to other gasfitting work.

Neither of these estimates include Type A appliances in commercial settings. The scenarios also assume conversion of all appliances in a one-year period, whereas it is not likely that all networks immediately switch to 100 per cent hydrogen but nevertheless the demand on the gas fitting trade will be significant. In addition, if 100 per cent hydrogen was supplied across the gas network, all practitioners undertaking gasfitting work would require upskilling to work with hydrogen and install and maintain new hydrogen appliances. If a staged roll out were to occur over a number of years, a similar approach to training and development could be implemented as is being done in the UK, with existing gasfitters who wish to be licensed in hydrogen gasfitting work, able to choose to undertake additional units of competency and assessment to gain this licensing. These scenarios do not include industrial applications of hydrogen as it is beyond the scope of this research.

While this project focuses on Victoria and South Australia, it provides an idea of the extent of upskilling required in other states that use natural gas, particularly Western Australia and New South Wales. Given the number of gas connections across Australia shown in Table 2, the need for suitably trained and qualified gas fitters to install, service and maintain domestic hydrogen equipment across most jurisdictions is clear.

Table 2 Australian gas use by region

	Australia	ACT	NSW	QLD	SA	TAS	VIC	WA
Homes connected to gas (‘000)	**5,163**	153	1,491	211	450	13	2,089	757
Percentage of homes connected to gas	**48%**	73%	43%	10%	56%	5%	76%	68%
Average household gas consumption (GJ pa)	**32**	33	20	9	17	30	54	13
Percentage of total jurisdictional household energy from gas	**45%**	54%	30%	4%	36%	5%	71%	35%
Percentage of energy from gas for average electricity and gas connected household	**63%**	62%	50%	31%	51%	49%	76%	44%
Length of distribution gas mains (km)	**97,646**	4,933	27,566	7,123	8,420	839	34,203	14,362
Estimated residential gas network-connected appliances* (‘000)	**12,169**	286	3,302	643	1,003	33	5,233	1,669

(Deloitte Access Economics (2019) cited in Energy Networks Australia, 2021)

4. Approaches to develop and maintain competency

Pathways into plumbing and gasfitting typically involve the completion of a Certificate III level qualification accompanied by a four year workplace apprenticeship. Additional qualifications can be obtained for specific or more advanced forms of work. Ongoing training is only required for ongoing licensing in the state of Tasmania as part of their trades continuing professional development (CPD) regulations. In other states, plumbers and gasfitters are responsible for their own ongoing learning to maintain their 'industry currency' to perform work to standard or upskilling, to develop new or additional skills in plumbing and gasfitting as markets and technologies evolve. The large percentage of plumbers and gasfitters working as sole traders or in small businesses, as opposed to working in large organisations with their own systems of training and continuing professional development, highlights the autonomy gasfitters have in deciding if and how they will undertake any ongoing training or upskilling.

While this is the case for plumbers/gasfitters, there is a variety of regulatory and non-regulatory approaches to help support practitioners and professionals in other areas to be adequately qualified for their roles and support ongoing competency and capability. This broader experience may have useful lessons for the successful transition of gasfitter competencies to include hydrogen.

It is important to highlight that work-related training can be categorised into three different types:

- **Accredited training** that refers to a program of training leading to vocational qualifications and credentials that are recognised by the attainment of a formal qualification or award. This can include whole courses or selected modules of a course.
- **Unaccredited training** that refers to a program of structured training or instruction that does not lead to the attainment of a formal qualification or award, for example, short courses, product-specific training and industry or organisation-specific training.
- **Informal training** that refers to unstructured training that usually occurs on the job through interactions with coworkers as part of the day-to-day work, for example, on-the-job coaching, mentoring or reading on the internet' (White & Rittie, 2022, p. 11).

Accredited training usually forms a large part of initial qualifications for entry into an occupation, while accredited and non-accredited training are used as part of ongoing learning after initial entry qualification has been attained. Accredited and non-accredited training in ongoing learning can take many forms including being a part of:

- a licensing or regulatory requirement for a 'one off' training activity;
- a standalone training requirement to upskill practitioners or ensure that existing practitioners are up to date with changes in regulations and so on; or,
- ongoing requirements, often referred to as continuing professional development (CPD).

Informal training is also often documented as part of CPD requirements for a range of occupations, however, because of the 'informal' nature of this training, this research refers to this type of training as 'informal learning' in recognition that a range of *non-intentional* experiences (such as chatting with colleagues over lunch, learning by doing) can also support ongoing learning.

For hydrogen, Interim Reports 1 and 2 established that initial training for apprentices as well as upskilling and ongoing training for existing plumbers and gasfitters would be required, particularly for the introduction of hydrogen blends greater than 10 per cent and also for fuel cells. Formal accredited training is strongly recommended to ensure gasfitters are adequately skilled for working with hydrogen, however, as survey and interview data have shown, this can be complimented with informal learning from a range of stakeholders that make up a plumber/gasfitter's learning environment. Interim Reports 1, 2 and 3 also noted the importance of some form of CPD requirement for ongoing licensing to support ongoing learning as the hydrogen industry evolves. To understand what approaches to initial training, upskilling and ongoing CPD requirements would be suitable for gasfitting and hydrogen, this project looked to ten other occupations that provide services to the public[4].

[4] Case studies included: Electricians; Nurses; Financial advisers; Architects; Aircraft engineers; Refrigeration mechanics; Aged care workers; Automotive trades (mechanics); Builders; Building surveyors.

Findings from the review of other training frameworks identified that accredited training is important for initial training and upskilling. Accredited training is usually provided through national training packages. There are currently 55 training packages designed to deliver competencies for different industries. Training packages can be updated to include additional competency units (subjects) or to update existing units. Updating training packages allows certificate, diploma and advanced diploma level qualifications to meet changing competency needs as technologies and markets evolve. Updated training packages also provide single competency units that can be undertaken by existing qualified trades practitioners to upskill. In such cases, practitioners can complete one or more single competency units for their own development or to meet ongoing licensing requirements. The national system of accreditation offered by the training packages can also support workforce mobility, depending on state regulations. Updates to the gasfitting training package (the Construction, Plumbing and Services Training Package) to include hydrogen are underway. However, the case studies illustrate that such updates are often implemented in response to the introduction of new technologies which differs to the pre-emptive update to the plumbing training package for hydrogen. The absence of market driven training presents challenges for incentivising gasfitters to pursue training opportunities; however, this also allows time to consider and assess the best approaches to implement hydrogen training. There are examples of industry playing a role in driving changes to training packages in the past, and therefore strong industry involvement in such changes for hydrogen could be advantageous in this case.

The case studies also indicate that specialist training and adequately qualified trainers must be available in the regions where the skills will be needed. Additionally, it is important that there is a consistent delivery of standardised training across the country and that national, state and association training requirements align to avoid conflicting or diverse training pathways and support transferability of skills between states which may be particularly important in the early stages of a transition from natural gas to hydrogen.

For ongoing training and upskilling, an absence of formal CPD for gasfitters in most states does not preclude upskilling as hydrogen training can be required as part of licensing renewal as needed. However, CPD is advantageous for ongoing updates as the industry evolves. The case studies reflect various approaches to CPD requirements with differing learning outcomes.

The case studies also showed how initial and ongoing training must be supported by regulatory frameworks. In all case studies, regulation requires completion of initial qualifications to begin practicing in the occupation and some also require formal upskilling for undertaking certain types of work. The case studies show that this regulation can be at a national level and/or state level and highlights the ways in which a national framework of regulation or a national association to assist in managing training requirements across the states and territories can be used. Such frameworks can also be used to serve the purpose of supporting workforce mobility. While implementing a national regulatory framework for plumbing/gasfitting has been the subject of much debate across the jurisdictions, some case studies show how a specific aspect of work practice can be nationally regulated or coordinated. In the context of gasfitting, nationally regulating or coordinating hydrogen work and associated training/training requirements may be useful for ensuring consistency of competency and workforce mobility as well as being more feasible than nationally regulating the broader scope of all plumbing/gasfitting work.

5. Gasfitters learning needs and training practices

The research shows that gasfitters are interested in learning more about hydrogen and had a strong positive attitude towards undertaking any future training to work with hydrogen. In fact, plumber/gasfitters' intention to undertake training is driven by their attitudes towards training and associated perceived benefits of training (rather than by any social or structural considerations e.g. regulatory compliance). As a result, plumber/gasfitters are independently interested in undertaking training because of a variety of benefits this provides, in particular, the development of their skills and knowledge of their gasfitting practice and using their skills and knowledge to undertake safe work that protects their customers. This interest in training is consistent with the reported strong perception that a transition to hydrogen would support the long term viability of their trade and provide business opportunities. In the interviews, participants also emphasised their role in influencing consumer behaviour in recommending appliances. These positive beliefs and attitudes towards future hydrogen training are important given these were the most significant impact on gasfitters intention to undertake training, compared with social pressure or external behavioural controls, according to the survey data. Despite the positive attitudes towards undertaking hydrogen training in the future, currently plumber/gasfitters have limited awareness of hydrogen and associated industry plans.

Another important insight from the interview and survey data is that gasfitters learn from a range of sources in their ongoing practice and consider themselves as 'ongoing learners'. Most gasfitters interviewed described their learning approach as 'learning by doing' and noted they were active in seeking out information to inform their day-to-day work. This reflects the academic literature on how small businesses learn where informal learning dominates over the uptake of formal training opportunities. Suppliers/manufacturers, insurers, colleagues/peers, regulators and customers are all stakeholders whose encouragement to undertake training was felt by gas fitters. The research shows that gasfitters also learn from a similar variety of stakeholders including regulators, employers, peers, colleagues, manufacturers/suppliers and associations. As a result, these stakeholders are critical in shaping plumber/gasfitters learning and encouraging further training practice.

The findings reinforce a need for a holistic approach to communicating changes to industry given that gasfitters learn from a range of sources. Any formal training can be supported by the network of stakeholders that make up a gasfitters' learning environment. For example, as described in the interviews, suppliers that offer informal information sessions and demonstrations along with breakfast or lunch BBQs are also a key site for new information to assist in getting gasfitters on board. Regulators and industry associations were seen as important sources of information and learning to support the transition in skills to work with hydrogen. The range of influential stakeholders noted in the interviews and survey data are shown in Figure 1.

Figure 1 Key stakeholders that inform and influence gasfitters' ongoing learning and practice

According to interviewees, the VET sector is a suitable place to learn competencies relevant to working with hydrogen, and to educate apprentices. While formal training for hydrogen is broadly supported by gasfitters interviewed, consideration must be given to different age demographics, business roles, time availability and costs when delivering any upskilling packages. The interview data showed that gasfitters preferred several different delivery approaches for hydrogen training, including both formal and informal options shown in Table 3.

Table 3 formal and informal learning preferences for hydrogen

Formal	Face to face in a classroom with a registered training provider (RTO course)
	Online with a registered training provider (RTO course)
	Workplace/on-site training with a training provider
	Face to face training by manufacturers on specific products
Informal	Employer led workplace information sharing and discussion
	Supplier information sessions about appliances, such as a trades lunch
	Face to face association led information sessions
	Online association led information sessions

This preference for different learning deliverables was supported by the survey data. However, learning face-to-face with support from regulators and industry associations was preferable to other options presented in the survey. While not opposed to online learning, in the context of upskilling for hydrogen, survey respondents noted the importance of face-to-face training. As domestic hydrogen is new, the regulator and industry association's involvement in training for hydrogen was perceived as important for this new fuel source in the domestic setting. Consequently, any training programs offered by VET providers and other organisations will be more likely to be widely accepted if they are strongly supported by the regulator and industry associations.

6. Providing leadership to engage key stakeholders

Stakeholders interviewed and surveyed as part of this project were largely very supportive of the prospect of transitioning to hydrogen in the domestic gas sector provided it was done with adequate training and was affordable for gasfitters, the VET sector and end users. Despite this enthusiasm for hydrogen, the research has identified a lack of certainty regarding skills required for a future hydrogen economy, specifically related to gasfitting practices. However, both gasfitters and trainers felt that this presented an issue of timing and the industry's ability to respond to the transition, rather than an issue for working with the gas itself. All interviewees from all stakeholder groups indicated a lack of clarity about the future of the hydrogen market and the implications for gasfitting work. Actions required to ensure sufficient competent gasfitters are available to support the sector cannot be clearly defined until the sector itself develops a clearer forward plan. This is constrained by other factors and yet unless some broad parameters can be established, lack of trade resources may become a significant limiting factor in the development of a hydrogen economy going forward.

Stakeholders interviewed perceived a lack of leadership, planning, coordination and policy direction at a national level to encourage the development of the hydrogen industry including the investment and training. Stakeholders, including gasfitters themselves, felt they are not receiving enough information about transition plans from government or industry to adequately prepare themselves for hydrogen. Meeting skills needs for the transition to hydrogen would benefit significantly from national leadership and coordination. There are several components of hydrogen industry development for which the Federal Government is responsible and are necessary to inform skills requirements and training at a state level including National Training Package(s), National Standards development, and product certification schemes. Progress is being made in all three of these areas, as well as a state level, however there is no one national body or agency taking a holistic or overarching role, or coordinating the various initiatives, trials, reviews, and projects being progressed around the country. An existing national group such as the Gas Technical Regulators Committee, could assist in driving national consistency and supporting coordination between initiatives and stakeholders. Macro level coordination is also essential to also ensuring that hydrogen skills are included in national and state policies and programs to invest in 'green' or 'clean' skills as renewable energy evolves.

Across all stakeholders, there was an appetite for more information about industry developments now or in the near future before more formal training is offered. Given the interest of gasfitters in hydrogen and a growing awareness of transition plans but no formal information provided, along with the concerns gasfitters interviewed raised about safety, it would appear advantageous that consultation, or informal training to raise awareness of hydrogen prior to the roll out, takes place. Such information could help address the questions held by all stakeholders interviewed about hydrogen properties and the hydrogen roll out and prepare gasfitters for hydrogen into the future.

7. Supporting the VET sector

It is apparent that training of gasfitters is informed by a complex mix of national and state actors from the training sector, industry, government and state regulators of gas, gasfitting and training. The state based licensing systems are largely dependent on completion of units of competency that are designed as part of the National Training Package. This means that registration and licensing with regards to hydrogen will need to consider the competencies for hydrogen developed at a national level and ensure these are adequate to achieve the safety outcomes required for hydrogen. Recent updates to the Construction, Plumbing and Services Training Package have responded to existing industry challenges and changes. In the case of hydrogen, the skills required and the market need are evolving in parallel with updates to the training itself. Developing initial and ongoing training for hydrogen, therefore, differs significantly from the usual factors that prompt professional development sessions or updates to National Training packages. Several participants used the 'chicken and egg' metaphor to describe the

current situation where training is dependent on standards, which are dependent on technologies, which are dependent on markets, which are dependent on training, and so on. In the context of training, the VET sector in Australia is designed to respond to market and industry needs, which presents a key challenge in the undefined hydrogen market. Given that the inclusion of hydrogen into the Construction, Plumbing and Services Training Package is classified as a ‘complex project’, coordination of stakeholders is important to support the update and ensure training package delivery aligns with the establishment of the hydrogen market.

The process and organisations involved in updating the national training package, since this research commenced, have undergone significant change in 2022. The Skills Service Organisation that was tasked with presenting the Case for Change to update the Construction, Plumbing and Services Training Package to include hydrogen, are no longer responsible for this work and the updates have been put on hold to be reassessed by a soon to be developed 'industry skills cluster' which will commence in 2023. This further extends the duration of an already complex updating process and underscores the need for clear knowledge about hydrogen standards and associated competency requirements and coordination of stakeholders to ensure the timely addition of hydrogen related competencies to the national training package.

Adequate support and training for trainers delivering hydrogen courses and the provision of resources for RTOs to effectively delivery such training was also identified as critical in the development of effective training. When the training package is updated to include hydrogen there is further work to be undertaken to ensure that delivery via the RTOs is done in a well-resourced and effective manner to ensure that gasfitter competencies are effectively developed for safe practices with hydrogen. RTOs are interested in offering training in hydrogen and expressed a keen interest in being involved in industry developments and updates to training packages. RTOs saw this as important for keeping their trainers informed of changes as the industry evolves. It was also noted that physical changes to training equipment might be required in order to give students practical experience with hydrogen facilities. Such changes take time and come with an associated cost that would need to be covered by industry.

The diversity of RTO organisation types and their associated competing objectives, coupled with the time duration for updated training packages to be endorsed and delivered, raised concerns from participants about the quality of future training and the ability for it to be delivered to the industry in a timely manner. This is where manufacturers and regulators play a role in standardising the quality of delivery across the sectors, for example, all RTOs being able to access emerging technologies for training purposes and also to upskill trainers in hydrogen. Some RTO’s are better placed than others in regard to access to resources to deliver hydrogen training. PICAC are already planning for provision of initial and ongoing gasfitter training for hydrogen and collaborative work is underway between Deakin’s Hycel Pilot Project in Warrnambool and SouthWest TAFE. These RTOs are at an advantage with funding to provide dedicated hydrogen training and industry connections to support such training delivery.

8. Regulating competency for hydrogen practice

Gasfitting is a specialisation of plumbing in all Australian jurisdictions and requires an occupational license or registration that permits the license holder to undertake gasfitting work. There are different license categories (also referred to as 'classes' or 'endorsements' depending on the state) for different types of gasfitting work. For initial licensing/registration, plumbers must demonstrate the appropriate level of qualification for the license category they are seeking to work in. Ongoing licensing requirements usually require the periodic payment of a license renewal fee and evidence of ongoing insurance, with the exception of Tasmania, that also requires evidence of the completion of CPD activities for license renewal.

Based on the desktop review, Victoria and South Australia both have a training and licensing system in place that can accommodate a transition to future fuels through licensing requirements, associated training and regulatory oversight of work undertaken; however, the research has identified a number of potential considerations that arise when transitioning to hydrogen. For existing gasfitters, the current licensing system can accommodate the addition of a hydrogen licence endorsement/class as part of gasfitter registration/licensing for those wishing to work with hydrogen. Completion of hydrogen training can be a requirement for the added endorsement. The effectiveness of these mechanisms for competency development via the licensing system is dependent on RTOs to deliver relevant units effectively with adequate assessment of students’ competency to receive the qualifications used in the licensing process. Effective regulation of competency is inextricably linked to the

provision of adequate support and development for trainers delivering hydrogen training and the provision of resources for RTOs to effectively delivery such training.

For ongoing gasfitter competency, there is currently no requirement for CPD in Australia, except for Tasmania. While a review into CDP for building professionals and plumbers is underway in Victoria. Previous attempts to introduce CPD for building trades have not been successful but the public profile of problems with non-compliant building design and materials, such as cladding, may provide further impetus for change on this occasion. Given the voluntary nature of CPD options available for gasfitters, there may be gaps in gasfitter knowledge and skills as standards and technology evolve. Non-compliant work may go unnoticed unless there is an audit of the work by the state regulators, an accident case or an issue is reported. In addition to the need for ongoing CPD requirements to ensure the maintenance of industry currency as the sector transitions, there is also a need for regulatory oversight of work completed. Such oversight is important for identifying areas of non-compliance that can inform further training programs. Auditing by the regulator has the potential to provide an important check on the effectiveness of any future hydrogen skills training. Regulatory audits aim to identify and rectify non-compliant practice through one-on-one consultation with those gasfitters identified as doing non-compliant work. Problems identified in audits also have the potential to become learning opportunities for the sector at large via newsletters and other communications, however effort in this area is resource constrained within the regulators.

Currently, audits are undertaken on a small percentage of gasfitting work, and so only partly address the potential need to closely monitor the skills and workmanship of hydrogen based gasfitting work during and immediately post such a transition. Participants identified that regulation of practice currently fails to adequately capture non-compliant work due to poor practice and lack of skills and that this situation could be exacerbated when transitioning to hydrogen fuel. This is important for ongoing learning because regulatory oversight was identified as key to maintaining skills amongst gasfitters and regulators themselves were seen as an important source of learning for those surveyed and interviewed. Ensuring that there is adequate oversight is therefore essential to ensuring work practice currency in an emerging market. As is the case with trainers, regulators would also need to be to be trained in these new skills. Regulators expressed a keen interest in gaining more information about hydrogen as the industry develops so they can then guide gasfitters through the transition. It is important therefore that the regulator be informed, and staff trained in hydrogen as a soon as possible to provide advice to industry as hydrogen evolves. This need is underscored by the fact the RTOs and licensing regulator also look to the technical regulator for advice on training package delivery and licensing requirements.

Based on anecdotal evidence there are also those undertaking gasfitting work without the licencing or registration endorsement to do so. This has implications for understanding what the existing qualifications of practitioners are and how many are practicing. Such data is important for establishing a clear understanding of any potential skills gaps for hydrogen and what the existing knowledge and experience base of gasfitters in Victoria is. A stronger auditing program is also likely to go some way towards addressing this issue.

Given that gasfitting is a specialisation of plumbing which is a building trade, there is a wide group of stakeholders active in building trades regulation. Regulatory reform of qualification, licensing and CPD requirements due to high profile quality and safety issues identified in the new buildings is being considered or undertaken in a number of states. At the same time, there are also suggestions to simplify requirements for occupational licensing across Australia, including plumbers, and to regulate service outputs through consumer law, rather than qualifications and competencies of trades people (CEDA, 2022). It is critical that in such discussions, the importance of ensuring safe gasfitting practices through regulation of the occupation now and for working with hydrogen is known to these stakeholders outside of the gas and energy industry.

9. Principles for hydrogen training and upskilling

Interim reports 1 through to 4 have each presented considerations and implications for training and upskilling gasfitters based on the research findings. The following is a summary of the key principles that can be used to focus and guide decisions regarding hydrogen training and upskilling based on the research findings. Overall, the research results show that training and upskilling must be:

Coordinated	The complexity of multiple stakeholders involved in hydrogen training, upskilling and ongoing learning highlights the importance of engaging with and coordinating key stakeholders to support training and upskilling. Leadership is needed at the macro level to guide and signal key stakeholders identified in

	this research and support collaboration for the delivery of timely and well informed training programs.
Affordable and accessible	Gasfitters are supportive of undertaking hydrogen training provided it is accessible and affordable. Therefore training design must consider when and where this training is delivered and its affordability. If training is not a mandatory license requirement, these factors are critical to ensuring maximum uptake of training. If training is mandatory, these factors are vital in the acceptance by the industry of any training programs.
Well informed and timely	There are currently many gaps in stakeholders' awareness and knowledge of hydrogen. Ensuring that those providing training and information to gasfitters are well informed is essential for supporting the development of practitioners that are competent to safely work with hydrogen and to also increase the uptake of formal training through greater awareness of implications and benefits amongst stakeholders. Training itself must be based on developed hydrogen standards and appliance information so that it is well informed and adequate to build competencies.
Well resourced	The VET sector must be well resourced to train trainers about the materials, appliances, and facilities to deliver such training. Training facilities and adequately qualified trainers must be available in the regions where the skills will be needed. In addition, regulators and industry associations must also have the resources to communicate, provide technical support and seminars for gasfitters through the transition.
Hands on	While online learning has provided opportunities to engage more practitioners in training opportunities during COVID-19 lockdowns, in the context of upskilling for hydrogen, gasfitters and other industry stakeholders noted the importance of face-to-face hands on training for working with a new fuel such as hydrogen, provided it was affordable and accessible.
Communicated effectively	Stakeholders' limited awareness of hydrogen and transition plans indicates training is essential and has a dual purpose of upskilling to work with hydrogen and educating the sector about the transition to hydrogen. There is merit in immediately commencing communications that increase awareness amongst gasfitters that there may be a transition to hydrogen, foreshadowing the future need for broad training/upskilling. Such communication should highlight the role hydrogen plays in the viability of plumbing/gasfitting and that the associated skills and knowledge are vital to future practice.
Supported by regulation	Training for working with blends of hydrogen of 10 per cent or more will require formal accredited training and should be associated with licensing requirements of those that will be undertaking such work.
Consistent	It is important that there is a consistent delivery of standardised training across the country and that national, state and association training requirements align to avoid conflicting or diverse training pathways. This also supports workforce mobility. While implementing a national regulatory framework for plumbing/gasfitting has been the subject of much debate across the jurisdictions, some case studies show how a specific aspect of work practice can be nationally regulated or coordinated. There is the potential for establishing a national coordinating body if national regulatory frameworks are not viable for hydrogen work in gasfitting.
Ongoing	The research has shown there is a clear role for supporting existing informal ongoing learning practices by informing and supporting key stakeholders such as suppliers, manufactures, regulators and industry associations with

information and resources to guide gasfitters in day-to-day practice. The absence of formal CPD for gasfitters does not preclude upskilling, however, CPD is advantageous for ongoing updates as the industry evolves. As CPD programs vary in delivery and outcomes, it is important that regulations use more of an 'output' approach to CPD by setting prescriptive content when needed; requiring the completion of accredited courses as needed; requiring CPD be delivered by adequately qualified trainers, and; ensuring that the content and structure allows for meaningful learning to occur.

10. Implications and Recommendations for industry

While the transition to hydrogen is being pursued by the gas industry and members of the Future Fuels CRC, much of the work regarding training and upskilling of gasfitters for domestic hydrogen work sits outside the industry in the training sector and associated government bodies. As such, while the gas industry is not responsible for updating training package materials or regulating or licensing domestic gasfitting work, it does have a key role to play in order to ensure there is adequate competency and capability within the domestic plumbing and gasfitting trade to support the roll out of hydrogen. As such, this research recommends that the gas industry take the following steps:

- Continue to develop standards and ensure that updates are communicated to relevant stakeholders such as RTOs, Industry Skills Councils and Skills Service Organisations (soon to be replaced by industry clusters) in the training sector.
- Maintain engagement in updates to the national training package to ensure they are progressing and assist in any coordination of stakeholders and knowledge sharing that is required.
- Provide regular communications about hydrogen trial projects and technologies to key stakeholders.
- Engage key stakeholders for input into any future training plans and initiatives.
- Support regulators, manufacturers and suppliers to provide ongoing information about hydrogen, associated technology and training opportunities to gasfitters.
- Communicate the research findings and principles outlined in Section 9 above to key relevant stakeholders in the gas industry and training sector.
- Maintain a 'watching brief' over trades training more generally to ensure that the gas sector's interests are front of mind for any changes that can impact gasfitter licensing or training requirements.

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