

BETTER WAYS TO WORK



UNDERSTANDING THE BARRIERS TO SKILLS
DEVELOPMENT FOR ENERGY EFFICIENCY IN
COMMERCIAL BUILDING HVAC

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ABOUT THIS REPORT

Title: Understanding the barriers to skills development for energy efficiency in commercial building HVAC

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EXECUTIVE SUMMARY

Improving energy efficiency in the built environment represents a substantial opportunity to meet Australia's global climate change commitments, while also lowering energy costs for owners and enhancing everyday life for building occupants. A key pathway for realising energy transitions in the built environment is through the development of a robust, skilled workforce that is equipped to identify and deliver potential energy savings. This report addresses the potential for capacity-building in the workforce responsible for managing and maintaining commercial buildings.

This workforce is well-positioned to work with building owners and tenants to improve the energy performance of Australia's existing building stock. In commercial buildings, Heating, Ventilation, Air-Conditioning and Refrigeration systems (HVAC&R) are typically the largest end-use of energy. HVAC&R contractors and Facilities Managers are on the front line of energy transitions in Australia's built environment, with responsibility for managing and maintaining these energy-intensive systems.

Quantifying this largely invisible and diverse workforce is a challenge. Growth projections for HVAC&R contractors more broadly provide an insight into potential workforce shortage issues. As of August 2020, 30,200¹ people worked as Refrigeration and Air Conditioning Mechanics in Australia. Projections indicate future growth in employment of four percent to 34,800 by 2025. The Facilities Management workforce is more dispersed, directly and indirectly employing approximately 200,000 people across relevant positions. Signs of skills and workforce shortages are already evident across the HVAC&R workforce servicing commercial buildings. Continued investment in energy transitions without accompanying workforce planning has the potential to create critical skilled workforce deficits that will impact on Australia's ability to meet the *Trajectory for Low Energy Buildings*.

This report addresses fundamental questions about the HVAC&R workforce, the skills, knowledge and professional networks required to meet the *Trajectory*, and how to strengthen training and professional development pathways for those working on commercial buildings.

1. Based on ANZSCO occupation 3421 Airconditioning and Refrigeration Mechanic. This includes those working on applications outside of the built environment, including cold chain and industrial sectors.

The research found seven key issues impacting on the sector's capacity to deliver on energy transitions in the built environment:

WORKFORCE SHORTAGES AND PIPELINE ISSUES

ISSUE 1: ATTRACTION, RETENTION AND ATTRITION OF HVAC CONTRACTORS

National workforce figures mask pressing challenges for the HVAC&R workforce that services the commercial built environment. The research found that attracting people to train in the sector is challenging and, once trained, enterprises experience difficulties in retaining employees. Additional attrition is likely due to an ageing workforce.

ISSUE 2: THE PROFESSIONALISATION OF FACILITIES MANAGERS

Facilities Management is vital to managing increasingly complex buildings, however it remains an emergent profession in Australia. The workforce has tended to migrate into the sector from other property roles, which means FMs hold diverse qualifications and levels of experience.

BARRIERS TO NEW SKILLS DEVELOPMENT

ISSUE 3: OBDURATE VET TRAINING REGIMES FOR HVAC CONTRACTORS

HVAC&R trade qualifications have evolved over time to cover the diversity of applications a contractor may encounter. Opportunities to extend the trade curriculum further are very limited. Industry plays an important role in filling gaps around energy efficiency training and upskilling in building performance.

ISSUE 4: LIMITED CAPACITY FOR RESPONDING TO NEW TECHNOLOGIES FOR HVAC CONTRACTORS AND FACILITIES MANAGERS:

Technical skills needed within the HVAC&R sector constantly change with the emergence of new technologies. With overcrowded curricula and dispersed pathways in to the workforce, there is limited capacity within the sector to respond with appropriate training. Failure to keep up with changing skills needs will further compound the impact of workforce shortages.

ISSUE 5: MISALIGNMENT OF ROUTINE TASKS WITH SKILL LEVELS OF HVAC CONTRACTORS

Regular maintenance on HVAC&R systems ensures that equipment performs efficiently and is operating safely. However preventative maintenance involves routine tasks that do not require the technical and diagnostic skills held by HVAC&R contractors. In a lowest-cost contracting environment like the mid-tier, there is a need to explore ways in which routine tasks might be undertaken more cost-effectively.

ISSUE 6: LACK OF RECOGNITION FOR SOFT SKILLS FOR HVAC CONTRACTORS AND FACILITIES MANAGERS

Technical skills alone are not sufficient to lift building energy performance. Interpersonal and negotiation skills and the capacity to illustrate the value proposition for energy efficiency will be vital in the delivery of net-zero ready buildings by 2030. Soft skills are not adequately addressed in existing training regimes for HVAC&R contractors or Facilities Managers.

CHALLENGES OF GOVERNING SKILLS AND TRAINING FOR ENERGY EFFICIENCY

ISSUE 7: COMPLEX REGULATORY ENVIRONMENT ACROSS STATES FOR HVAC CONTRACTORS

HVAC&R exists in a complex regulatory environment that sits across both federal and state departments, and with different stakeholder groups – including the ARC. This complexity has direct impact on skills and training, and the energy performance of buildings in the mid-tier.

Three key opportunities provide a framework for fostering the development of this workforce:



1. SHAPING A WORKFORCE ON THE FRONT LINE OF ENERGY TRANSITIONS IN THE BUILT ENVIRONMENT

Governments and industry should work together to develop attraction and retention strategies for this critical workforce.



2. BUILDING CAPACITY FOR SKILLS AND TRAINING TO MEET THE TRAJECTORY

Capacity-building includes working with the sector to provide training opportunities that build on existing ways of acquiring knowledge, including up-skilling for technological change, and developing soft skills.



3. SUPPORTING THE DEVELOPMENT OF SKILLS AND TRAINING THROUGH A MULTI-SCALAR, CROSS-SECTORAL APPROACH

Developing a skilled workforce capable of delivering energy transitions is beyond the scope of a single agency. A ‘training eco-system’ approach recognises the many different stakeholders who have a role to play in capacity-building for future energy transitions.

CONTENTS

ABOUT THIS REPORT	2
EXECUTIVE SUMMARY	3
1. THE HVAC MAINTENANCE OPPORTUNITY	7
1.1 The Challenge	9
1.2 About the Project	10
2. CHARACTERISING THE COMMERCIAL BUILDING HVAC MAINTENANCE WORKFORCE	11
2.1 Overview of the National Licencing and Training Regime for the Building HVAC Workforce	12
3. METHODOLOGY	14
3.1 Data Collection for Work Packages 1 and 2	15
3.2 Data Collection for Work Packages 3 and 4	15
4. IDENTIFYING BLOCKAGES TO IMPLEMENTING HVAC REPAIR AND MAINTENANCE IN LINE WITH THE TRAJECTORY	17
4.1 Workforce shortages and pipeline issues.....	17
4.2 Barriers to new skills development.....	22
4.3 Challenges of Governing Skills and Training for Energy Efficiency.....	29
5. DEVELOPING HVAC SKILLS AND TRAINING TO ADDRESS ENERGY EFFICIENCY	30
5.1 Opportunity 1: Shaping a workforce on the frontline of energy transitions in the built environment	31
5.2 Opportunity 2: Enhancing capacity for skills and training to meet the <i>Trajectory for Low Energy Buildings</i>	32
5.3 Opportunity 3: Supporting the development of skills and training through a multi-scalar, cross-sectoral approach	34
6. REFERENCES	37

1. THE HVAC MAINTENANCE OPPORTUNITY

Decarbonising Australia’s building stock is critical to meeting commitments to global climate agreements and creating more liveable built environments. Through existing low-cost technologies, addressing energy efficiency in buildings has the potential to contribute over 50 per cent of Australia’s 2030 energy productivity target, and over 25 per cent of the 2030 emissions reduction target.

Two key Australian Government policy measures provide the governance roadmap to address this potential:

- The Climate Solutions Package: a \$3.5 billion package announced in the 2019 Budget to deliver on Australia’s 2030 international climate commitments;
- The National Energy Productivity Plan (NEPP) agreed by the Council of Australian Governments Energy Council in 2015, which aims to improve Australia’s energy productivity by 40 per cent.

As part of the Climate Solutions Package, the *Climate Solutions Fund* was designed to secure over 100 million tonnes of greenhouse gas reductions by 2030. Within this envelope, the package aims to deliver 48 million tonnes of greenhouse gas emissions through targeting energy efficiency in buildings.

Under NEPP Measure 31, the *Trajectory for Low Energy Buildings* was developed in December 2018 in collaboration with State and Territory Governments to identify opportunities for improving building energy efficiency for new buildings. In November 2019, the *Addendum to the Trajectory for Low Energy Buildings – Existing Buildings* was released, outlining a plan for improving the energy performance of the existing residential and commercial building stock. This project was developed in response to the following Phase 1 initiative of the *Trajectory*:

Investigate the feasibility of mechanisms for achieving the optimisation of maintenance and performance of Heating, Ventilation and Air-Conditioning (HVAC) equipment and controls.

In 2020-21, Australia consumed 188.6 terawatt hours of electricity.² In the year to March 2021, Australia produced 494.2 million tonnes of greenhouse gas emissions.³ The commercial building sector is responsible for approximately 25 per cent of Australia’s total electricity consumption, and around 10 per cent of total carbon emissions in Australia.⁴ This means the current share of national electricity consumption attributed to commercial buildings is 47 terawatt hours, contributing in the order of **49 million tonnes** of greenhouse gas emissions.

2. Australian Energy Regulator (2021) Annual electricity consumption. <https://www.aer.gov.au/wholesale-markets/wholesale-statistics/annual-electricity-consumption-nem>

3. Department of Industry, Science, Energy and Resources (2021) Commercial buildings <https://www.energy.gov.au/government-priorities/buildings/commercial-buildings>

4. DISER (2021)



In commercial buildings, HVAC equipment is typically the highest end use of electricity. Approximately 40 per cent of total energy use (70 per cent of base building energy use) is attributed to HVAC.⁵ This means the share of national electricity consumption attributed to HVAC in commercial buildings is around 18.8 terawatt hours.

Using an alternative lens, CSIRO modelling estimates that HVAC is responsible for an average of 20 per cent of Australia's total electricity consumption across both residential and commercial building applications.⁶ Using these figures, the current share of national electricity consumption attributed to building HVAC is in the order of 37.7 terawatt hours. The potential share of greenhouse gas emissions associated with all building HVAC is approximately **35.8 million tonnes**.

It is challenging to put a single definitive figure on improvements that can be achieved through enhancing the energy efficiency of HVAC in buildings, with estimates varying from 5 per cent to 40 per cent. Industry sources suggest 20 per cent might be used as an average estimate of the contributions improved HVAC maintenance could make to building energy consumption. Thus, the potential national energy savings associated with improved HVAC maintenance in buildings is in order of 7.5 terawatt hours. The potential national greenhouse gas emissions savings from HVAC maintenance improvements is approximately **7.16 million tonnes**.

The value proposition for addressing HVAC maintenance in Australia's building stock is substantial. Using currently accepted emissions offset guides of \$20 per tonne CO₂, the opportunity cost of fully offsetting greenhouse gas emissions due to a lack of maintenance is in the order of **\$143.2 million**. The more compelling value proposition however is the opportunity cost of excess electricity consumption due to lack of HVAC maintenance. Using an average price of \$0.30 per kilowatt hour, the opportunity cost of not addressing HVAC energy efficiency in the built environment is in the order of **\$2.25 billion**.

5. Department of Environment and Energy (2013) Factsheet: HVAC Energy Breakdown <https://www.environment.gov.au/system/files/energy/files/hvac-factsheet-energy-breakdown.pdf>

6. CSIRO (2021) Net-zero energy HVAC Roadmap <https://www.csiro.au/en/research/technology-space/energy/net-zero-energy-hvac-roadmap>

1.1 THE CHALLENGE

Addressing energy efficiency in the built environment clearly represents a substantial opportunity for meeting Australia's global climate change commitments, while lowering energy costs for owners, and enhancing the liveability of buildings for occupants. Ensuring the optimal operation of technologies that already exist presents some of the lowest cost opportunities for delivering net zero buildings by 2050.

Within the commercial building sector, Australia is a global leader in the design and construction of Premium and A-grade office buildings. Australian property market leaders have invested significantly in portfolio energy performance over the last two decades, producing some of the most energy efficient buildings in the world. However, energy efficiency is not a priority in other segments of the market. The gap between Premium and A-Grade assets and those at a lower-grade (B, C and D-grade using the PCA grading scheme) is significant and widening.

Lower-grade buildings (generally referred to as the 'mid-tier') represent 85% of Australia's commercial building stock, and as such, are a significant barrier to Australia's capacity to meet net zero targets by 2050. Mid-tier buildings are smaller, older, and poorer quality. They are located predominantly in metropolitan fringe and suburban locations, and major regional centres. They typically have a mixed ownership and tenancy profile, with limited levers available for incentivising retrofit and upgrade activity. The HVAC plant installed in these buildings tends to be an original system that has never been upgraded, with very limited controls and little to no as-built documentation.⁷ These systems are often run to failure, where decisions to install more efficient equipment might be compromised by the urgency of the replacement. The complexity of these issues means that mid-tier buildings have become something of a 'wicked problem', in terms of improving energy performance.

The *Trajectory for Low Energy Buildings* outlines a roadmap for Australia to meet its global commitments to address emissions reductions. But the *Trajectory* will not be delivered through 'business-as-usual' practices. Especially in the mid-tier, a range of policy, regulation and market changes will be necessary to drive innovation and reform in industry standard practices and to grow market demand for delivering energy-efficient buildings. For the HVAC&R sector, developing the skills necessary for this transformation requires effective future planning to identify and address gaps in the existing training regime.

A mix of education and skills, capabilities and collaborations across the maintenance procurement supply and innovation chains are required to address energy performance in the mid-tier. Signs of skills and workforce shortages are already evident across the HVAC&R workforce servicing commercial buildings, and demand exceeds the sector's ability to respond. Existing skills demands will be compounded by the task of delivering the energy transitions required to meet the *Trajectory for Low Energy Buildings*. In order to meet the *Trajectory* significant effort will be required to understand the new skills and occupations involved, as well as the underpinning training and professional development pathways required. **Regulatory and market changes must be aligned with skills and capabilities, to ensure returns on investment in either domain are not compromised.**

7. Carr, C, Stanes, E, Daly, M, Daly, D, McGuirk, P (2021) *Better Ways to Work: HVAC management, repair and maintenance in the mid-tier commercial office sector*. Final report, March 2021. ISBN: 978-1-74128-359-4.

1.2 ABOUT THE PROJECT

Multiple commissioned studies have examined a range of policy levers for addressing energy efficiency in mid-tier buildings.⁸ However, limited attention has been directed towards the workforce that will be required to upgrade and maintain Australia's existing building stock with respect to energy performance. This project addresses this research gap. Commissioned by DISER in December 2020, the project uses mixed-method (primarily qualitative) empirical research to identify and examine the workforce-related barriers to improving commercial building energy performance via enhancements to HVAC&R. The project addresses the following research questions:

- How does the current skills and training regime shape the potential of the HVAC&R workforce to deliver the *Trajectory for Low Energy Buildings*?
- What new skills, knowledge, training, and networks will be needed to deliver the *Trajectory for Low Energy Buildings*?
- What are the structural barriers to skills and training development in this sector, and what kinds of policy responses might be pursued to address these?

The project focuses on the context and pathways for skills and training development across two key constituents of the HVAC&R sector workforce: building service technicians and facilities managers (FMs); that is, those directly responsible for the management and maintenance of HVAC in commercial office buildings.

This project sits within a broader program of work being delivered for DISER by researchers from the University of Wollongong (UOW). Since March 2020, the team has delivered a large-scale survey focussed on management and maintenance practices in the mid-tier commercial office sector, followed by three additional projects collectively aimed at better understanding the barriers to energy productivity improvement in HVAC systems in the mid-tier commercial building sector.

The first phase of the project delivered the largest national survey of the HVAC&R sector to date, targeting facilities managers, HVAC contractors, systems specialists and engineering consultants. The ***Better Ways to Work*** (BWW) survey provided a substantial new empirical data source for understanding how the HVAC repair and maintenance workforce engages with buildings and technologies, building owners and tenants, governance authorities and regulators, and with each other through formal institutions and informal, everyday working relationships.⁹

The survey findings highlighted the need for a mix of policy approaches to lift the energy performance of mid-tier office buildings. These include empowering stakeholders through better training, information and capacity building; carefully targeted incentive programs that recognise geographical disparities in building stock, ownership profiles and workforce characteristics; and lifting energy performance through a range of regulatory pathways. The second phase of the project delivered three additional empirical datasets and analyses that address:

1. Mapping the decision-making process of HVAC maintenance lifecycle across the mid-tier sector;
2. Identifying common issues in mid-tier HVAC maintenance from the Better Ways to Work survey (commercial office focus) across other commercial building types; and
3. **Understanding the barriers to skills development for energy efficiency in commercial building HVAC&R.**

This report presents the findings from the third and last research project connected with *Better Ways to Work* program of work.

8. EY. 2015. Mid-tier commercial office buildings in Australia: Research into improving energy productivity. EY; Green Building Council of Australia. (2015). *Mid-tier commercial office buildings in Australia: A national pathway to improving energy productivity (Issue November)*.; GBCA, PCA, AIRAH, EEC, FMA, City of Sydney, & CitySwitch. (2017). *Opportunity knocks: Accelerating energy efficiency for mid-tier buildings*.; Sustainability Victoria. (2016). *Energy efficient office buildings: Transforming the mid-tier sector*. Sustainability Victoria.

9. Details and analysis of the Better Ways to Work survey, as well as a review of previous work in the mid-tier sector can be found in Carr et al. (2021), and the [Better Ways to Work website](#).

2. CHARACTERISING THE COMMERCIAL BUILDING HVAC MAINTENANCE WORKFORCE

The HVAC&R sector employs a diverse range of workers, including trades and technicians, professionals and engineers. The most recent figures estimate direct employment in the Refrigeration and Air Conditioning Industry in Australia as between 59,000 and 85,000 people (including those working in commercial and split system air-conditioning <18kW).¹⁰ Definitive data on the size of the workforce servicing the mid-tier commercial sector is not available.

The Australian Industry and Skills Committee (AISC) provides annual information for Air-Conditioning and Refrigeration Mechanics. Combining data from the Commonwealth Department of Employment predictions, the ABS Survey of Employed Persons (cat. no. 6291.0), and customised ABS data of VET-related occupations, AISC determined that, as of August 2021, 30,200 people worked as Refrigeration and Air Conditioning Mechanics.¹¹ Projections indicate future growth in employment for Refrigeration and Air-conditioning Mechanics of four percent to 34,800 by 2025. A large proportion of HVAC Contractors are employed in the Construction Services, and Repair and Maintenance industries (c. 37% and 35% respectively).

Australian Government workforce figures indicate that 17,000 workers are currently employed as Facilities Managers (ANZSCO 149913) and 2,900 as Facilities Administrators (ANZSCO 599916). According to the Facilities Management Association (FMA), the sector directly and indirectly employs approximately 200,000 people in relevant roles.¹² This larger figure highlights the highly dispersed nature of roles connected with facilities management, including property managers, facilities administrators and account managers. Not all these roles have responsibility for the energy performance of commercial space or the procurement and maintenance of HVAC systems.

These figures present a limited view of the commercial building workforce, and specifically, of those servicing the mid-tier sector. The BWW survey provided the first Australian sector-wide snapshot of the commercial building HVAC&R maintenance workforce in terms of its training qualifications, technical skills and workplace knowledge and experience. The survey found that the trade certificate is the dominant qualification currently held (68% of participants).¹³ A different story emerges for post-trade qualifications. Across the participant cohort, 27% (n=250) held Cert IV qualifications, 24.5% (n=227) held Diploma qualifications and 21.0% (n=195) held a Bachelor Degree.

10. Brodribb, P. and McCann, M. (2018) *Cold Hard Facts 3*. Prepared for the Department of Environment and Energy.

11. Australian Industry Skills Commission (2021) Refrigeration and Air-conditioning overview. <https://nationalindustryinsights.aisc.net.au/industries/electrotechnology/refrigeration-and-air-conditioning>

12. Facilities Management Australia (2020) Facility Perspectives. Executive Media. <https://www.fma.com.au/common/Uploaded%20files/Facility%20Perspectives%20MK%202021.pdf>

13. Carr et al. (2021)



Alongside formal education credentials and training qualifications, building management, repair and maintenance work benefits from the depth and breadth of on-the-job experience. The BWW survey indicated that more than 45% of contractors reported working in the sector for 20+ years.

The combination of the under-utilisation of post-trade training in the Australian HVAC&R sector and an aging cohort of HVAC&R contractors is problematic for an industry at the front line of increasingly rapid environmental, technological and economic change.¹⁴ Nevertheless this broad scope of experience is seen as beneficial. A challenge however, is how to prioritise the skills that are needed to meet targets for net zero ready buildings.

2.1 OVERVIEW OF THE NATIONAL LICENCING AND TRAINING REGIME FOR THE BUILDING HVAC WORKFORCE

The nationally accredited Certificate III in Air-Conditioning and Refrigeration provides the trades training required to install, maintain and repair complex electro-mechanical systems. In Australia, HVAC&R Contractors are covered by two separate licensing regimes:

1. The Australian Refrigeration Council (ARC) host a Refrigerant Handling Licence for handling fluorocarbons, which are harmful to the environment as potent greenhouse gases if emitted to the atmosphere. This licence supports regulations under the Ozone Protection and Synthetic Greenhouse Gas Management Act 1989, a responsibility held by the Department of Agriculture, Water and Environment (DAWE). There are more than 110,000 licence holders in Australia.¹⁵ Licences are mandatory to purchase, handle and work on systems that use synthetic refrigerants (HFCs/CFCs/HCFCs). To date, the licence does not cover alternate refrigerants increasingly being used with the phasedown of HFCs.
2. State-based occupational electrical licences for disconnecting and reconnecting HVAC systems (restricted electrical licence), plumbing licences for hydronic systems and condensate management, and/or air-conditioning and refrigeration trade licences.

Once a license has been gained, neither licencing regime requires further training of HVAC&R Contractors. Peak organisations in the sector have long advocated for better recognition of specialist refrigeration trade qualifications. There is concern among peak organisations¹⁶ and the workforce that a failure to improve licencing via mandatory ongoing training will result in poorer outcomes for meeting future energy targets and significant health, safety and environmental risks.

Sector engagement in post-trade training suffers from geographic hurdles (training not offered outside of Sydney and Melbourne) and general lack of market demand. As a result, few Registered Training Organisations (RTOs) that provide post-trade training exist, though there are some notable partnerships between RTOs and industry peak organisations e.g. the Holmesglen HVAC Centre of Excellence (Victoria), established by Holmesglen

14. Carr et al. (2021)

15. Australian Refrigeration Council (2021) Cool Change Newsletter https://www.arctick.org/media/17502/arc4918-coolchangenewsletter62_web.pdf

16. AIRAH (2020) HVAC&R licensing in Australia: Now and towards 2050. <https://www.airah.org.au/licensing>

and the Air-Conditioning and Mechanical Contractors' Association (AMCA), and a collaboration between the Facilities Management Association (FMA) and University of New England Professional. Peak organisations are also providing industry-led professional diplomas, such as Australian Institute of Refrigeration, Air conditioning and Heating's (AIRAH) Professional Diploma in Sustainable HVAC Design and Operation (Table 2.1).

No current post-trade providers offer training specifically in energy efficiency nor any relevant qualification at a Cert IV or Diploma level. Instead, some courses have aimed to embed energy efficiency or energy performance principles within degree programs. This is particularly the case for courses developed via industry and training provider collaboration.

Continuing professional development (CPD) is an additional route to upskilling the existing workforce to ensure ongoing skills currency. The BWW survey found a mixed uptake of CPD training, with Facilities Managers and Engineers more likely to undertake CPD than HVAC Contractors. Mandatory CPD training for this cohort is gaining some traction in some states and territories, with a program for Air-Conditioning and Refrigeration contractors due to start in 2022 in Victoria, supported by the Department of Environment, Land, Water and Planning (DELWP).

Table 2.1: Summary of the HVAC&R licencing and training regime

	NSW	VIC	ACT	SA	NT	QLD	WA	TAS
Mandatory requirements to work on building HVAC systems								
HVAC&R trade qualification	•	•	•	•	•	•	•	•
Restricted Electrical licence or permit	•	•		•	•	•		•
Air-Conditioning and Refrigeration Trade licence	• *	• **	• ***			• ****	• ****	
Refrigeration Handling Licence	•	•	•	•	•	•	•	•
Compulsory CPD		From 2022						
Available training cutting across energy efficiency in building HVAC systems								
AIRAH Professional Diploma in Sustainable HVAC Design								Designed for online delivery through AIRAH
FMA Professional Diploma in Facilities Management								Designed for online delivery through University of New England Partnerships
Previously offered targeted training for energy efficiency in building HVAC systems								
AIRAH Graduate Certificate in Energy Efficient HVAC design								Not run since 2013
Cert IV Air-conditioning Systems Energy Management and Control								Not currently offered via RTO
Certificate IV in Energy Efficiency and Assessment								Not currently offered via RTO
Certificate IV in Energy Management Control								Not currently offered via RTO

*Airconditioning and refrigeration licence or certificate.

** Licence managed under the Victorian Plumbing Regulations 2018.

***Electrotechnology Systems Refrigeration and Airconditioning licence.

****Refrigeration and Airconditioning work licence. The licence is part of the Mechanical Services Licensing Framework.

*****Refrigeration and Airconditioning mechanics licence.

3. METHODOLOGY

To explore barriers to skills and training development for energy efficiency in commercial building HVAC, this research deployed a mixed-method approach to generate a suite of qualitative and quantitative data. The mixed-methods approach was necessary to enable a holistic view of skills and training pathways for the diverse role types that constitute the HVAC&R workforce.¹⁷ This section provides an overview of the research work packages, their aims, and the data sources that inform this report.

The research was comprised of four work packages:

WORK PACKAGE	AIMS
1. Review and mapping of HVAC trade certification and state licencing regimes	<ul style="list-style-type: none"> To map the skills and competencies of trade-certified HVAC&R technicians and how this differs across jurisdictions. To understand the trade registration and licencing regimes in Australian states and territories, how they vary, and the implications for skills mobility across Australia.
2. Detailed stocktake of existing tertiary and vocational post-trade training courses for HVAC&R Contractors and Facilities Managers	<ul style="list-style-type: none"> To understand the existing offerings across vocational education and training (VET), industry accreditation, industry webinars, university courses and continuing professional development (CPD).* To identify gaps in the training eco-system around energy efficiency and energy performance.
3. Interviews with industry and education stakeholders	<ul style="list-style-type: none"> To define the scope of education and training available in the sector. To gain insights into critical gaps within the broader training eco-system.
4. Career pathway interviews with HVAC&R Contractors and Facilities Managers**	<ul style="list-style-type: none"> To understand the diverse pathways through which people enter the HVAC&R workforce and progress through their careers. To identify skills and training gaps observed by those tasked with delivering improved HVAC&R energy performance.

*As this work was undertaken in a year dominated by state and territory border closures and lockdowns, short courses and webinars may have featured more heavily as a form of outreach to the sector.

** A pool of potential interviewees was purposefully sampled to ensure that a diversity of experiences were captured in the interviews, including geographic location, context and time spent in the industry.

17. This project was reviewed and approved by the University of Wollongong Human Research Ethics Committee (ref: HREC 2020/171).

3.1 DATA COLLECTION FOR WORK PACKAGES 1 AND 2

Work package 1 and 2 used online industry and government databases and websites to obtain information about education and training programs, short courses and webinars offered in Australia. The databases used to obtain information on different education and training programs offered across Australia for skills development include:

- Industry peak organisations (including AIRAH, FMA, AREMA)
- Training.gov.au
- www.ncver.edu.au
- Nationalskillscommission.gov.au

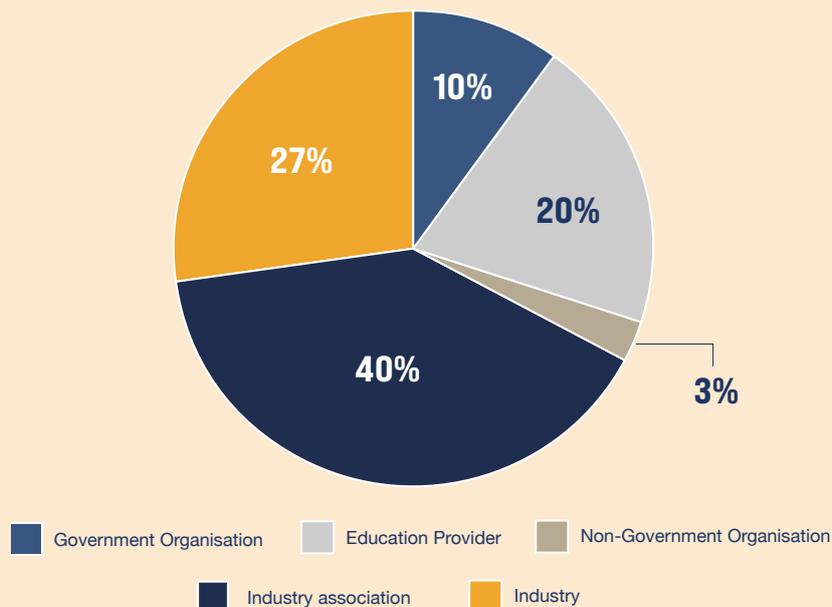
The types of post-trade opportunities considered in this report includes vocational education and training (VET), industry accreditation, industry and stakeholder webinars, university courses, and CPD.

3.2 DATA COLLECTION FOR WORK PACKAGES 3 AND 4

The research for this project was designed to capture the complexity of how skills and training relevant to energy efficiency improvements in mid-tier buildings are delivered. This required looking beyond employment datasets at the national scale, to gather qualitative data necessary to understand how the current HVAC&R workforce engages with existing skills and training offerings. In total, 30 interviews were conducted with 37 stakeholders and those working on HVAC in buildings. These were grouped into stakeholder interviews and career trajectory interviews with participants for both being sourced through industry connections developed through the initial *Better Ways to Work* project.

The stakeholder interviews aimed to gain insights into HVAC&R workforce shortages, the success of current education and training programs in the sector, and barriers to skills development in the areas of energy efficiency in buildings. The interviews were purposively sampled to cover a range of industry organisations, government and education providers.

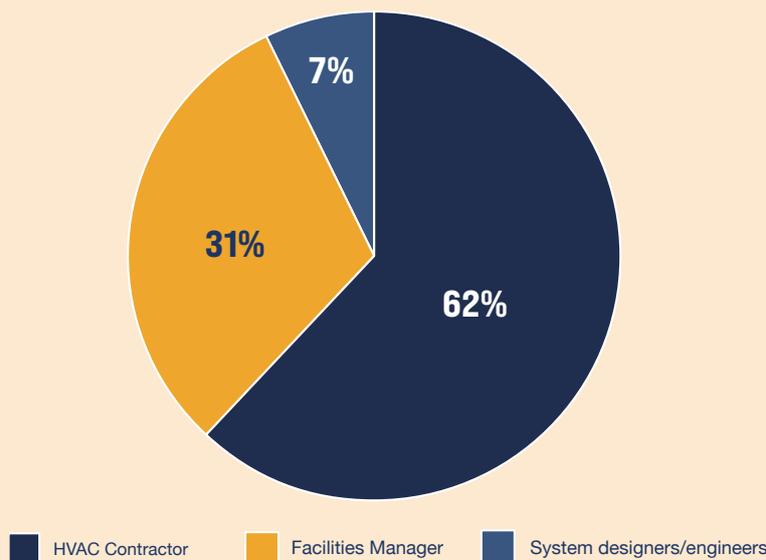
Figure 3.1: Breakdown of industry and education stakeholder interviews (n=24)



The career trajectory interviews aimed to gain deeper insights into the work practices of HVAC&R professionals, and the issues preventing them from engaging in further training and education. Participants were sourced from a database of over 500 professionals who had indicated willingness to participate in further research through the *Better Ways to Work* survey (Figure 3.2).

Interviews covered qualifications, experiences of education, the types of skills relevant to work, and where facilities managers and contractors source information. The interviews were purposively sampled to cover a range of role types, including contractors, facilities managers, and systems design specialists working across a variety of contexts (metropolitan, suburban and regional) and geographical locations.

Figure 3.2: Breakdown of career trajectory interviews (n=13)



Recognising the broader context of achieving energy efficiency in mid-tier buildings, data in this report has also been drawn from the *Better Ways to Work* survey. A total of 1548 useable responses were received, with 1072 responses completing over 45% of the survey. This data helps to contextualise the detailed insights gained through qualitative data collection.

Finally, additional quantitative data was also drawn from a follow-up to the *Better Ways to Work* survey, which examined decision making and policy options across the HVAC maintenance lifecycle. During the first stage of that work, 10 qualitative interviews were conducted to guide the design of a modified Policy Delphi process. This involved three survey rounds with a purposively-selected sample of between 48 and 68 respondents.

A final draft of the report was sent to industry stakeholders as part of a consultation process to validate findings of key issues impacting on the HVAC&R sector's capacity to deliver on energy transitions in the built environment. Feedback was also invited on the opportunities to address workforce capacity-building to meet the *Trajectory for Low Energy Buildings*.

4. IDENTIFYING BLOCKAGES TO IMPLEMENTING HVAC REPAIR AND MAINTENANCE IN LINE WITH THE TRAJECTORY

SEVEN KEY ISSUES

4.1 Workforce shortages and pipeline issues

Issue 1: Attraction, retention and attrition of HVAC contractors

Issue 2: Professionalisation of Facilities Managers

4.2 Barriers to new skills development

Issue 3: Obdurate VET training regimes for HVAC Contractors

Issue 4: Limited capacity for responding to new technology for HVAC Contractors and Facilities Managers

Issue 5: Misalignment of routine tasks with skill levels of HVAC Contractors

Issue 6: Lack of recognition for soft skills for HVAC Contractors and Facilities Managers

4.3 Challenges of governing skills and training for energy efficiency

Issue 7: Complex regulatory environments across states for HVAC Contractors

4.1 WORKFORCE SHORTAGES AND PIPELINE ISSUES

ISSUE 1: ATTRACTION, ATTRITION AND RETENTION OF HVAC CONTRACTORS

National workforce figures mask pressing challenges for the HVAC&R workforce that services the commercial built environment. Attracting people to train in the sector is challenging and, once trained, enterprises experience difficulties in retaining employees. Additional attrition is likely due to an aging workforce.

Attraction: While employment statistics suggest growth in HVAC&R contractor roles, our research found that attracting new people to the sector is challenging. The workforce combines electrical and mechanical skills and sits at the intersection of two major trade areas: electrical and plumbing. Many HVAC&R Contractors found their way into the trade through alternate pathways such as pre-apprentice training in electrical, trade-show days, or on the recommendation of friends and family. These diverse pathways make targeted workforce recruitment difficult.

HVAC&R work in the built environment is diverse, and contractors service a range of different building types including residential, commercial, retail and industrial. Contractors also service a diversity of equipment, from small split air-conditioning units through to commercial refrigeration systems. This breadth of work leaves the sector largely unrecognised, and this invisibility makes it difficult for industry organisations to gain traction around recruitment. With over eight peak organisations across HVAC&R, the sector lacks a central voice to unify and promote recruitment.



'I was at an apprenticeship Open Day, and (I) networked and I ended up finding the fridgies' store. I hadn't even heard of fridgies at that stage, well not much about them. I was only thinking about 'electrician' and I gave him my number and I got a phone call and that's where I'm working today'.

Current HVAC Apprentice



'We're electrical, we're chemical, we're mechanical. We're bits and pieces of several industries in reality. I think that also has kept us fragmented'.

HVAC Educator

These insights echo the South Australian Training and Skills Commission's Workforce Insights report findings that, while employers reported attracting many applications for their advertised vacancies for air-conditioning and refrigeration mechanics, they were unable to recruit sufficient workers due to lack of sector-specific experience in industrial and commercial applications.¹⁸

Recruitment problems lead to workforce shortages, especially in regional and rural locations. A participant working in regional Queensland for example, described an instance where a DX plant was selected for installation over a chiller system, despite higher lifecycle costs, because no skilled personnel were available locally to service and maintain the chiller.

Attrition: Workforce shortages in the HVAC&R sector also result from high attrition rates during both trade certification and over the course of a career. The completion rate of apprenticeships and traineeships in Refrigeration and Air-Conditioning-related qualifications are low (Figure 4.1).¹⁹ Of the 1664 apprentices who commenced training in 2016, only 785 had completed by 2020: a 47% completion rate.²⁰

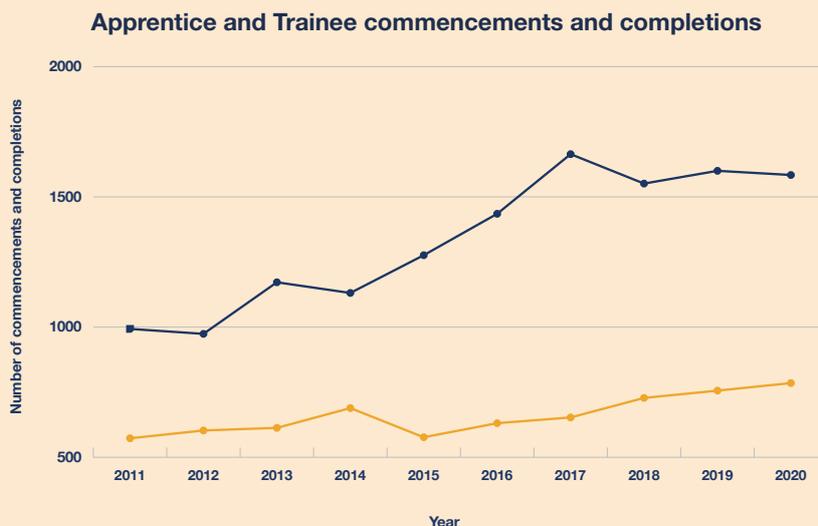


18. South Australia Training and Skills Commission (TASC) (2019) *Construction, mining and energy workforce insights*. South Australia Training and Skills Commission.

19. There were over 7,500 program enrolments in Refrigeration and Air-conditioning related qualifications across Australia in 2020. The bulk of enrolments were in trade certification training (4786 program enrolments, 73% of total program enrolments), followed by Cert II in Split Air-Conditioning and Heat Pump systems (25% of program enrolments). A far smaller number of enrolments were in Cert IV or diploma/adv. diploma programs (131 enrolments, 1.7% of total program enrolments). In the same year, just over 2000 people completed refrigeration and air-conditioning related training programs (Cert II – Diploma level).

20. AISC (2021)

Figure 4.1: Refrigeration and air-conditioning apprentice and trainee commencements and completions, 2011-2020
(Source: NVQER/AISC)



Retention: Once trained, retaining engaged HVAC Contractors also proves difficult. One reason for this is the lack of clear career and development pathways for early career contractors. Participants in this research cited frustrations around a lack of mentorship and difficulty gaining support from employers to undertake relevant training. In a sector dominated by small-medium enterprises (SMEs), education and training are time-intensive activities that impact on employee availability. In an industry where lowest-cost contracting is an identified issue, SMEs already experience time and financial constraints in carrying out their work. There is a need for a targeted strategy for career development (including both upskilling and re-skilling) within the sector that can account for these challenges.



'if you've got a class of 15 students or whatever, and then they go through the trade, if you went and caught up with them in say 10 years' time, you'd probably find there's only about five left still in the trade.'

Current HVAC Educator



'We're already an industry in demand, and we're already an essential service. The whole time even COVID's going on, a refrigeration mechanic can go to work; he can do his job. We're hard to get hold of.'

Current HVAC Educator

Ageing workforce: More than 40% of respondents to the BWW survey reported having over 20 years of experience in the commercial property industry. A much smaller percentage (14.7%) reported having worked in the industry for less than five years. While the HVAC&R sector clearly has an experienced workforce, this comes with the challenges of an ageing workforce. The loss of key skills and industry knowledge caused by workers retiring will contribute to a growing skills replacement gap. This will put a significant strain on the workforce, and further increase competition with other trade areas.²¹ There is a need to invest in growing the HVAC&R workforce during the next decade, particularly through recruitment of apprentices to replace the loss of skills and labour from an ageing workforce.

Our interviews with industry stakeholders suggest that, to retain a skilled and engaged workforce, focus should be placed on providing industry entrants a better understanding of career pathways and opportunities. With investment in energy performance to move the built environment towards net-zero ready buildings by 2030, further research is needed to understand how these predicted shortfalls can be alleviated.

21. Australian Industry Skills (2019) *Electrotechnology Skills Forecast 2019*. Australian Industry Standards.; SA TASC (2019)

ISSUE 2: PROFESSIONALISATION OF FACILITIES MANAGERS

Facilities Management is vital to managing increasingly complex buildings, however it remains an emergent profession in Australia. The workforce has tended to migrate into the sector from other property roles, which means FMs hold diverse qualifications and levels of experience.

Like the HVAC&R trade, a career in Facilities Management is often not on the radar of school leavers due to its low profile. This is partly due to its being formally recognised as an occupation in Australia only within the last 15 years (ANZSCO 149913 – Facilities Manager; and 599916 – Facilities Administrator). According to the FMA, the biggest barrier for attracting young people to the industry is the lack of targeted courses and clear career paths.²² Yet as buildings become more complex, there is a growing need for skilled professionals equipped to interpret complex regulatory frameworks around building operation and energy management, and to communicate these requirements to building owners and tenants. FMs also need to negotiate with contractors and other service providers who manage and maintain energy-intensive systems such as HVAC&R.

Pathways into the profession are diverse and this is especially the case for those working on mid-tier commercial buildings. One industry stakeholder described it as a *'career of chance, rather than choice'*. While some research participants in this study had moved into the field from cleaning services or through an informal role as a building caretaker, others came from backgrounds in property management, marketing and accounting. Few had completed training specific to facilities management. Of Facilities Managers who completed the BWW survey, 45.3% held trade qualifications, indicating significant career mobility from contracting to facilities management.²³ The low numbers of people with a specific facilities management qualification is one barrier to raising profile and professionalisation. This also makes it difficult to develop training packages that resonate across these varied backgrounds.



22. Facilities Management Association. 2014. Facilities Management Industry Census. Trends and Insights 2013–2014.

23. Carr et al. (2021)

Because it is a relatively new profession in Australia, vocational qualifications are more limited than other comparable sectors in the built environment, and there are no regulatory or accreditation-based requirements. The lack of consistent standards or benchmarks for FM professionals has led to inconsistencies in education and training programs across VET, industry organisations and higher education. The FMA has been actively engaged in developing a holistic competency framework for the sector, and is working in conjunction with the University of New England to deliver an industry-focused and work-integrated qualification.



'I don't have any formal qualifications in FM. I've been doing this for 15 years now. And I've got to quite a senior level, and I have no formal qualifications at all. I did an Arts degree at uni, finished that with no job prospects, got a job at a local building company, writing processes for them, and from there kind of just getting a job in a management company, then got a job as an FM on, you know, low level shopping centres and just kind of kept working up from there. But you had no formal qualifications whatsoever.'

Facilities Manager



'I've done NABERS courses. I've done a graduate diploma in energy efficiency, and sustainability courses and the like. There are no actual formal FM qualifications whatsoever. But that hasn't hindered my career at all. When I first started these qualifications, these diplomas just weren't there. Traditionally, they just gave these jobs to ex-tradies who were looking for something else to do.'

Facilities Manager



'I think one of the things which we're looking at the moment is a professional standards code... We know the contracting environment's not ideal, like cost of contracting and race to the bottom type stuff occurring, and the other side of that coin is that the client side of the equation is not skilled up, not tech'd up, they don't understand what they're procuring necessarily. And so how do we build a system where we can isolate professionals who have skills and competencies in particular areas that can be relied on and deliver good outcomes?'

FM Industry Stakeholder



4.2 BARRIERS TO NEW SKILLS DEVELOPMENT

ISSUE 3: OBDURATE VET TRAINING REGIMES FOR HVAC CONTRACTORS

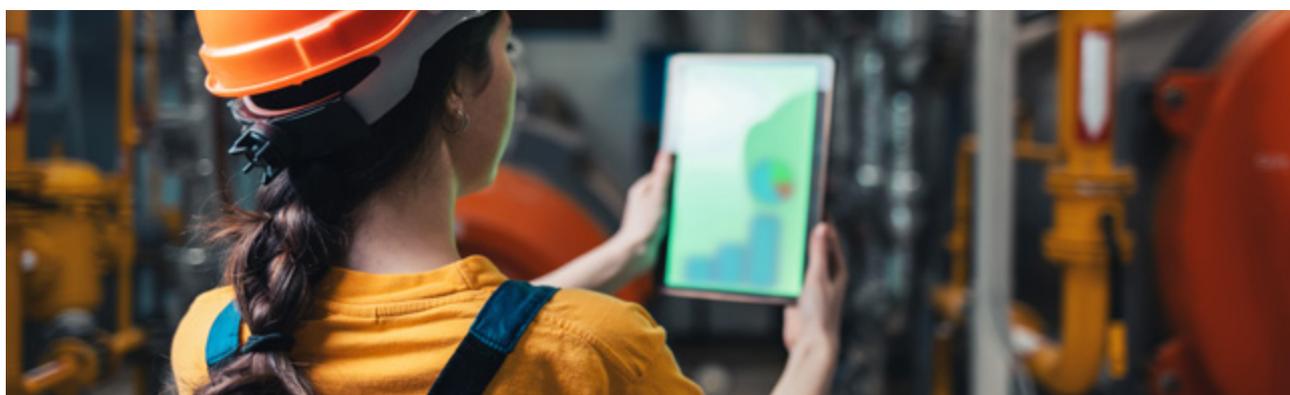
HVAC&R trade qualifications have evolved over time to cover the diversity of applications a contractor may encounter. Opportunities to extend the trade curriculum further are very limited. Industry plays an important role in filling gaps around energy efficiency training and upskilling in building performance.

Australian VET and higher education systems offer a number of trade and post-trade programs to aid workforce growth and address skills and knowledge needs. However, the VET system is notoriously under-resourced, which creates challenges for adapting to change in fast-paced industries. Several studies raise concerns about the capacity of the VET sector to meet the scale of needs for the energy sector balanced against industry demand.²⁴

This research found evidence that existing training programs do not fully meet skills and workforce needs for the HVAC&R sector. A set of issues around the nation-wide Certificate III training in Air-conditioning and Refrigeration was identified, in particular:

- the generalist nature of the Certificate III program, aimed to ‘teach them the basics’, has become overburdened with content, outdated competency packages, and the challenges of meeting VET sector compliance requirements;
- an overcrowded curriculum leaves little room for innovation, which limits the VET sector’s capacity to develop a skillset specifically targeting energy efficiency and future energy transitions in the built environment;
- an increasing mismatch between the trade certification training and industry needs;²⁵
- the low ratio of qualified and skilled HVAC educators to student numbers. Increasing workloads in education mean that there are limited opportunities for HVAC educators to engage in career development to cultivate the skills and knowledge needed for new and emerging technologies.

In 2012, Industry Reference Committees (IRCs) were established to act as a formal channel for working with industry skills requirements on the development of new training packages for Registered Training Organisations. As an industry that supports the design, maintenance, installation and repair of electrical equipment, the HVAC&R sector is embedded within the Electrotechnology IRC. The Electrotechnology IRC offers a multi-stakeholder, nation-wide approach to designing HVAC&R-related VET course programs. However, there are significant lags between identifying industry needs and securing approvals for updates to specific competency or skills packages. Lack of investment of time, lack of resources for program development, and changing bureaucratic procedures were cited as root causes of these lags.



24. Lucas, H., Pinnington, S., Cabeza, L. (2018). Education and training gaps in the renewable energy sector. *Solar Energy*, 173, 449-455.; Pears, A. (2020). Energy efficiency education and training: Australian lessons on what employers want — or need. *Energies*, 9(13), 2386.; Rutovitz, J., Visser, D., Sharpe, S., Taylor, H., Jennings, K., Atherton, A., Briggs, C., Mey, F., Niklas, S., Bos, A., Ferraro, S., Mahmoudi, F., Dwyer, S., Sharp, D., and Mortimer, G. (2021). *Developing the future energy workforce. Opportunity assessment for RACE for 2030.*

25. Lucas et al. (2018).

The trade certificate (Cert III) program has been designed to deliver the core principles of HVAC&R: ‘compressor, heat rejection, metering device, and heat absorption’, with the expectation that a HVAC&R contractor can adapt these to any application. More advanced or technology-specific skills come from post-trade training. However, the BWW survey identified the lack of incentives in the sector for continuing education through post-trade qualifications, and a resultant lack of uptake. Just under 30% of HVAC Contractors who responded to the BWW survey held a Cert IV, and 17% held diploma-level qualifications.²⁶ Low engagement with post-trade training is also likely to result from the sectoral dominance of SMEs, lack of support from employers and time pressures. This may also be compounded by the geographical supply of post-trade courses and availability of skilled educators. Post-trade training packages are often unavailable outside of the major training centres of Sydney and Melbourne. The availability of remote delivery and training by correspondence has only just commenced.²⁷

Outside of VET and higher education qualifications, sources of knowledge and skills development are more diffuse, encompassing workplaces and jobsites, colleagues, industry peak organisations and equipment manufacturers and suppliers. For example, the BWW survey found that equipment suppliers and informal knowledge sharing networks (experienced colleagues) were a key source of information to assist people to do their job well, at almost double the rate of more formal CPD training. These important sites of education, training and skills development are not well recognised and are thus challenging to cohere and marshal, with significant implications and opportunities for the delivery of energy efficiency training and information dissemination.



‘It’s a very broad industry, so you might have apprentices coming in that are doing nothing but installing splits. You might have other apprentices coming in that work on nothing but domestic industry...I’ve got one student that does nothing but ammonia stuff. All of a sudden we’re trying to teach them all of this other equipment, they’ve never seen it; they don’t see it in their everyday practice. The only time they see it is eight times a year when they come in to school’.

HVAC&R Educator



‘I think one of the most frustrating things is the time from recognising an issue in the industry--for us that might be a digital transform in the industry--the timeframe from there to getting a course accredited in the marketplace, by the time we’ve done that, cars will fly, they won’t only be electric, they’ll be flying, and then we’ll have to build another course’.

Industry Stakeholder



‘Yeah, we don’t deal with fault finding, any types of PCBs or anything. It’s more about the old style of relays, contactors. And we don’t do much on DC motors, we’re all about AC motors and direct online stuff that hasn’t been in service well, for the most part hasn’t been in service for the last 20 years’.

Current HVAC&R Apprentice



‘In my opinion the bulk of them are not well trained. They’re trained to do certain aspects, but often not trained to think and look further to the problem. Because in everybody in our industry, behind every air conditioning system is a refrigeration system. As a mechanic you’re taught to tweak and fiddle and adjust and if you get it going that’s great, everyone’s happy - it’s working. But often you don’t understand the fundamentals’.

HVAC Stakeholder

26. The BWW survey did not ask specifically ask respondents to provide details of post-trade qualifications undertaken. The distribution strategy used in the survey may have reached highly engaged professional networks.

27. COVID-19 has played a factor in this.

ISSUE 4: LIMITED CAPACITY FOR RESPONDING TO NEW TECHNOLOGIES FOR HVAC CONTRACTORS AND FACILITIES MANAGERS

Technical skills needed within the HVAC&R sector constantly change with the emergence of new technologies. With overcrowded curricula and dispersed pathways in to the workforce, there is limited capacity within the sector to respond with appropriate training. Failure to keep up with changing skills needs will further compound the impact of workforce shortages.

New technologies: Emerging technologies present new opportunities for increasing comfort and energy efficiency in the built environment. Some technical skillsets become sub-optimal in light of technological advances, e.g. additional reliance on IT to diagnose issues meaning that older work practices may not be the most efficient or automation and computational controls requiring new skills to effectively service systems.

Trade and diploma level certification must address HVAC skills across domestic, commercial and industrial applications. Training packages struggle to keep abreast of the uneven pace of technological innovation across these applications. This is likely to be compounded by workforce challenges for skilled HVAC educators outlined above in Issue 3. While the basic principles of HVAC systems are unchanged, *‘the things that manufacturers are doing with basic principles is a different story’*, as one equipment supplier put it. The result is that a growing skills gap is emerging based on differences between equipment used for training in TAFE colleges and RTOs, and equipment deployed in the real-world contexts of building HVAC systems. Furthermore, the multiple tenancies and mixed-ownership structures of the mid-tier presents *‘multiple functioning parts’* with complex technological mixes of old and newer technologies for contractors to contend with. The skills gap around emergent technology may be hardest felt amongst the more experienced cohort of HVAC contractors who are embedded in ingrained practices and tend to have lower levels of engagement in post-trade training.

Equipment manufacturers and suppliers have a key role in skills development for new technologies. The *BWW* survey established that ‘equipment suppliers’ was the most frequent cited key source of information relied upon by respondents in carrying out work (76.3%). This is almost double the rate of Continuing Professional Development (CPD) (42%).²⁸ One multi-national HVAC supplier cited receiving *‘over 40,000 phone calls a year and probably the same amount in emails’* from contractors and FMs. Many of these calls were from HVAC Contractors on site working on equipment. The nature of those calls is logged and used to inform training and short courses developed and delivered by suppliers. With trade certificate curricula already full, manufacturers and equipment suppliers have a key role to play in upskilling the industry to keep pace with inevitable technological change. There is scope to leverage and better support the existing delivery of skills and training by suppliers.



‘Technologies come out of the industry, and we’re teaching apprentices, so we have to teach them the basics, the ducks guts of the industry. We’re not teaching them some of that newer stuff yet, because they’re just learning the basic fundamentals. Some of that newer technology is, in actual fact, beyond what you teach them in the apprenticeship. That’s something that they’ll specialise in when they break out of their apprenticeship and start to go beyond being a mechanic for four years, they start to head towards their 10 years’ experience level, and they’ll be getting into specific technologies and industries that will be much different. But we are also on the foot of, as that technology’s coming in, we’re trying to capture it and deliver the basics of that, so that it brings their basics up to speed. We do get caught in the middle quite a bit’.

HVAC Educator



‘There’s a big gap between the TAFE institute and what is really happening on site, on a day-to-day level...We’ve spent time with the [teachers at] TAFE colleges just so we can get those TAFE teachers up to a level about some of the new products that are out in the market that they are not aware about.’

HVAC Supplier



'if I see trends, like maybe one particular company is calling quite frequently or one particular technician is calling quite frequently, we try and identify the gaps in his skills and then either invite the company along for a training session with us for a day or just target that particular technician. If they're in a regional area...we would make sure that they come through for a training session that day.'

HVAC Supplier

Natural refrigerants: The phasedown of hydrofluorocarbons (HFCs) from 1 January 2018 onward has had implications for the HVAC&R workforce. While alternative/natural refrigerants are more sustainable, they also create a range of risks for workers handling them due to their flammability and toxicity, particularly at high operating pressures. Future training packages in the Electrotechnology streams for Air-Conditioning and Refrigeration will be updated with Skills Sets and Units of Competency covering health, safety and environment conditions of alternate refrigerants across operation, installation and maintenance. However further skills development will be needed across the entire sector and regulatory and licensing adjustments may be needed to drive uptake.



'28,600 Cert III mechanics [will] all have to be retrained to understand. Because the refrigerants that come in are either going to require more engineering knowledge - they'll either be flammable, work at high pressure, or toxic, or have more complicated issues - air and water. They just require a higher degree of engineering and understanding and what's going to be.'

HVAC Stakeholder

Digital and data literate workforce and BMS upskilling: As the built environment transitions towards digital technologies, the need for digital and data literacy skills is increasing. Building Management Systems (BMS) and data analytics provide building owners, FMs and HVAC contractors with a higher degree of monitoring and control capability over building systems, including HVAC systems, lighting and equipment.

In the *BWW* survey, respondents reported that just over half (56.6%, mean average) of the buildings they work on had a functional BMS. Where a BMS was installed, 79.3% reported using it for monitoring the performance of building systems (such as HVAC). BMS data is highly valuable for enhancing building energy performance. However, both the survey and follow-up interviews confirm that the skills to access and interpret this data are variable, and in many cases non-existent for those servicing the mid-tier. Monitoring and control in mid-tier buildings could be improved significantly through developing digital literacy skills, including data literacy skills and diagnosis. Training should be specifically targeted to FMs and HVAC contractors to meet their respective needs. With already full curricula in the Cert III, and without networks to support data interpretation, HVAC contractors are more likely to fall behind in the digital divide.





'...data is gold in the space of sustainability. Throughout my experience with the introduction of BMS systems, and the ability for electrical contractors to monitor your electricity consumption in a more detailed fashion than what you would get off a bill enables us and empowers us to properly be able to monitor building usage with relation to electricity consumption...which, like feeds all into sustainability efforts... I just see everyone being pushed through the technology tunnel with relation to embracing the use of sustainable assets... I just see so much growth in that space.'

Facilities Manager



'...the next thing will be for tradesmen will have to be keeping up with electronic control systems. Coming into the industry, that's getting bigger and bigger, so there's a lot of people will have to upskill to keep up with that kind of thing... We're a multi-platform industry where we're working on chemical, and mechanical, and electrical, now it will [become] electronics are coming into it. Our industry is massive in the change.'

HVAC Educator

ISSUE 5: MISALIGNMENT OF ROUTINE TASKS WITH SKILL LEVELS OF HVAC CONTRACTORS

Regular maintenance on HVAC&R systems ensures that equipment performs efficiently and is operating safely. However preventative maintenance involves routine tasks that do not require the technical and diagnostic skills held by HVAC contractors. In a lowest-cost contracting environment like the mid-tier, there is a need to explore ways in which routine tasks might be undertaken more cost-effectively.

The business case for better maintenance of HVAC&R systems is well-established, despite not being well understood by building owners and managers. Good maintenance practices ensure HVAC&R systems remain reliable and deliver comfort, while minimising operational costs and energy use. However, the value of preventative maintenance is often not realised by owners in the mid-tier, where systems are commonly run to fail. This reactive approach presents a risk of higher overall costs to both the building owner and the service provider. This was reflected in the *BWW* survey, where participants identified planned and preventative maintenance as the single most important action that could be undertaken to improve building energy performance.²⁹

However, undertaking routine preventative maintenance on HVAC&R systems is not valued work within the sector, and is not a focus within VET training for HVAC&R contractors. It rarely utilises the technical and diagnostic skills that HVAC&R contractors develop over the course of their careers. Simple tasks like cleaning air filters and heat exchange surfaces are often seen as mundane, even though they have a significant impact on HVAC&R system energy efficiency. The *BWW* survey demonstrated that in a lowest-cost contracting environment like the mid-tier, the standard of maintenance is limited by poor procurement practices, which in turn impacts on the time available to undertake this important work. Consequently, there is a need to explore ways in which these routine tasks might be undertaken more cost-effectively. One innovative example is the relatively recent development of specialist hygienist roles and related training, tasked specifically with cleaning components such as ductwork. Hygienists work with HVAC contractors to ensure cleaning is done during routine maintenance.

29. Daly, M., Carr, C., Santala, I., Daly, D., Stanes, E., McGuirk, P. (2021), *Better Ways to Work: Mapping decision-making and policy intervention across the HVAC maintenance lifecycle*. Final report, December 2021. ISBN: 978-1-74128-356-3.



'When I went and did maintenance, I got it over and done with as quick as I could, I probably didn't do it as well as I probably should, because it was a shit job. I shouldn't say a shit job, but it's a boring, repetitious, but very important job'.

HVAC Educator



'Yeah, but the maintenance is – when I had to do maintenance, and it would have been easier to drill a hole in my head with a blunt drill bit than do maintenance. It is as boring as bat shit. You can teach people to do maintenance and change belts, check fan belts and do all that sort of stuff, but you're never going to get away from the boredom. It's just boring. Usually, when there's not a lot of money around, maintenance is the first thing that goes out of the window'.

HVAC Educator



'One of the problems we have on my side is keeping guys there because all I do is wash filters. So I'm lucky at the moment I've got a few guys that are my age, they're happy to wash filters. I've done the hard work and this is a nice little number... But we keep losing [people] because they're not interested. You know, they're not doing any diagnostic work... the technical work that is, you know, HVAC work, repair and maintenance. So how do we fix that?'

HVAC Contractor

ISSUE 6: LACK OF RECOGNITION FOR SOFT SKILLS FOR HVAC CONTRACTORS AND FACILITIES MANAGERS

Technical skills alone are not sufficient to lift building energy performance. Interpersonal and negotiation skills and the capacity to illustrate the value proposition for energy efficiency will be vital in the delivery of net-zero ready buildings by 2050. Soft skills are not adequately addressed in existing training regimes for HVAC Contractors or Facilities Managers.

Soft skills are becoming important in engineering and technical trades, however they are rarely recognised and developed explicitly. Lifting energy performance in the mid-tier requires a number of essential skills, including relationship management, the ability to communicate a value proposition, and the negotiation of a business case.

Building effective and trustworthy relationships: Building and maintaining relationships is an important part of building management and the provision HVAC&R Services. The *BWW* survey identified that HVAC&R contractors rated good relationships with building owners and managers as the most important factor in winning work. Facilities managers, however, rated their relationships with contractors as the least important factor in engaging the services of a HVAC&R contractor. There is a need to develop skills around building effective and trustworthy relationships between these roles.



'I think the biggest part of my job, and what probably gets me through the day is my relationship management. Just the array of people that I have to work with in my job going from, your Center Managers to your Mr. Bob Smith down the road who has a superannuation property, to consultants to certifier, and then contractors store teams.

Facilities Manager

Understanding the value proposition for preventative maintenance: The benefits of maintenance for energy efficiency are often difficult to quantify. The BWW survey demonstrated that HVAC&R contractors are inherently aware of the lifecycle cost benefits of preventative maintenance, but find it difficult to communicate this to building owners and managers. The development of financial and contractual literacy amongst HVAC&R contractors and facilities managers is key to communicating the value proposition of preventative maintenance to building owners.



'To remain compliant on a day-to-day basis [requires] in excess of about 140 Australian Standards and nobody's ever going to know that level of detail in a single person. Our [facilities managers] job is, what are the questions in the HVAC space you should be asking your supplier to make sure you're getting the service that you need, it's compliant, and you're not overpaying for something that you don't need. If we split up the supply chain into all the different key areas, our job is to build that toolkit so that FMs can do that.'

Facilities Management Stakeholder

Building a business case: Developing and communicating a business case for energy efficiency is challenging. Energy efficient upgrades tend to be more expensive, and it is difficult for building owners and managers to look past up-front costs, to lifecycle costs. Further training is required for HVAC&R contractors and facilities managers to develop a skillset around developing and communicating a business case to building owners and managers. This recognises that HVAC&R contractors and facilities managers in the mid-tier are often dealing directly with building owners, and are best placed to facilitate the installation of more efficient HVAC systems.



'Technicians and, by extension, the businesses that employ the technicians, haven't necessarily seen themselves as experts or providers of an energy efficiency service, if you like. So that's kind of a bit of a paradigm shift that's required. If there's no demand from clients, you go, well, how does the paradigm shift take place?'

HVAC Stakeholder



'we're kind of hoping that technology's going to help a little bit there, because if we're getting better data on buildings and we can do preventative maintenance and all of that good stuff, then it potentially helps you tell that story a little bit better. But I don't think that the clients are out there demanding better energy efficiency by and large.'

HVAC Stakeholder



4.3 CHALLENGES OF GOVERNING SKILLS AND TRAINING FOR ENERGY EFFICIENCY

ISSUE 7: COMPLEX REGULATORY ENVIRONMENT ACROSS STATES FOR HVAC CONTRACTORS

HVAC&R exists in a complex regulatory environment that sits across both federal and state departments, and with stakeholder groups – including the ARC. This complexity has direct impact on skills and training, and the energy performance of buildings in the mid-tier.

Regulatory frameworks in the sector are complex and ownership is diffused across Federal and state governments and industry agencies (e.g. the ARC supports regulations for DAWE under the Ozone Protection and Synthetic Greenhouse Gas Management Act 1989). Regulation also entails diverse Australian standards systems. For the HVAC&R sector, these cover mechanical, electrical and building related standards, none of which are uniformly well understood. There is a lack of clarity around which standards should be applied to which systems and what industry-appropriate standards should routinely be attained. Application of standards for preventative maintenance, for instance, is routinely negotiated between contractors, FMs and building owners.

As a result, there are significant gaps around compliance and a lack of consequences arising from poor practice or malpractice.³⁰ The HVAC&R sector lacks a licensing body or regulator with the power to punish malpractice. When poor practices and/or operators are uncovered, there are few consequences.



'...the hard thing is, is that it's not legislated as such, so there's no, you have to do this, in order to meet these standards'

Facilities Manager



'All clients and building managers are different and have various ideas and knowledge of why should be done to what is done to what can actually be achieved'

HVAC Contractor

This has direct flow-on effects for skills development and training. There are limited incentives for contractors to upskill in order to improve the performance of buildings they work on, and few consequences to malpractice. Enforcing regulation to improve standards has received high levels of support from the industry.³¹ However, any action to improve minimum maintenance standards and licensing will require sector-wide education strategies in order to build the skillset required to act on and communicate standards regulation to clients and colleagues.

30. Daly, M. et al. (2021)

31. Daly, M. et al. (2021)

5. DEVELOPING HVAC SKILLS AND TRAINING TO ADDRESS ENERGY EFFICIENCY

THREE KEY OPPORTUNITIES

5.1 Opportunity 1: Shaping a workforce on the frontline of energy transitions in the built environment

Action: Work with industry to develop a workforce attraction strategy

Action: Government and industry support for workforce retention

5.2 Opportunity 2: Enhancing capacity for skills and training to meet the *Trajectory for Low Energy Buildings*

Action: Support upskilling to keep pace with new technologies and information

Action: Broaden the remit of energy efficiency training to include soft skills

5.3 Opportunity 3: Supporting the development of skills and training through a multi-scalar, cross-sectoral approach

Action: Recognise diverse ways of acquiring skills and knowledge to deliver a future-focused workforce

Action: Develop a training eco-system approach to skills development for energy efficiency

Delivering the *Trajectory for Low Energy Buildings* is dependent on the development and retention of a future-focused skilled and capable workforce. There will be a growing demand for skilled trades and energy professionals on the frontline of addressing Australia global climate change commitments in the built environment. However the goals of the Trajectory will not be met by following a ‘business-as-usual’ approach. While improving HVAC maintenance practices remains an untapped opportunity, a range of policy, regulation and market changes will be needed to drive market change and lift energy performance in the mid-tier building stock. The development of multi-scalar and cross-sectoral initiatives will be needed in parallel to support the sector to attract, retain and develop a skilled workforce capable of delivering this change.

In this section, we outline three key opportunities that address workforce capacity-building to meet the *Trajectory for Low Energy Buildings*. We suggest a range of actions that address the capacity of the HVAC workforce to deliver improved energy performance in Australia’s mid-tier building stock. Industry Insights are used to highlight existing indicative examples of the actions proposed.

5.1 OPPORTUNITY 1: SHAPING A WORKFORCE ON THE FRONTLINE OF ENERGY TRANSITIONS IN THE BUILT ENVIRONMENT

ACTION: WORK WITH INDUSTRY TO DEVELOP A WORKFORCE ATTRACTION STRATEGY

Our research established the absence of clear entry pathways to the industry for both HVAC Contractors and Facilities Managers. Pipeline issues for bringing new entrants into the sector can be improved with greater coordination across different educational providers and with industry to profile, promote and recruit.

Our research pointed to multiple possibilities for career progression across and between different role types in HVAC Contracting and Facilities Management as well as career mobility between geographical regions. However, as a career opportunity, the HVAC&R sector remains largely unrecognised. There is an untapped opportunity for government to provide targeted support to the industry (largely SMEs) around traineeship, apprenticeship and professionalisation programs that build the profile of the sector and create attractive entry pathways.

Future initiatives can focus on attracting high-calibre entrants motivated to deliver net-zero ready buildings, work with technology, and build relationships across the property industry. There is an opportunity to develop sector-wide programs that address the provision of energy efficiency as a key service across the HVAC&R workforce. This should include mitigating the impact of passive design on building energy consumption, and through improving HVAC contractors and facilities managers' literacy in building design, including aspect, solar gain, building envelope performance, and air locks. Skilled tradespeople and professionals from adjacent sectors may also be attracted through short courses and micro-credentials.

INDUSTRY INSIGHT 1: COLLABORATIVE INITIATIVES FOR SECTORAL WORKFORCE ATTRACTION

'TRADES IN WORKSHOP' DAY:

In 2021, a state-based Department of Education worked with a network of HVAC professionals from equipment manufacturers and suppliers, and industry peak organisations for a 'Trades in Workshop' day. Alongside other trade areas, the overarching aim was to showcasing the HVAC&R industry as an 'important and aspirational' trade area for school leavers to consider.

Around 40 students from Year 9, Year 10 and Year 11 worked on a range of practical activities that applied high-school level mathematics to hands-on, real-world scenarios. Uncertainty about the industry and how it applies to a career is a known barrier that impacts pipeline issues.

By profiling HVAC, the 'Trades in Workshop' day is one example of an opportunity to effectively introduce and market the HVAC&R sector to new entrants.



'HVAC being one of those hidden types of industries, it was a great day for us. Because in most cases, the students didn't know that HVAC existed or they thought we were just electricians or they thought we were just plumbers. Before, they would just go for their usual trades, like carpentry or plumbing or something like that. so, it was a great day. We took working units out there; we took them through some of the things we work on; we showed them the machines; we gave them some handouts to take away with them.'

HVAC Supplier

ACTION: GOVERNMENT AND INDUSTRY SUPPORT FOR WORKFORCE RETENTION

Stakeholder and career trajectory interviews highlighted both the importance and the current absence of coherent career development pathways as an issue impacting workforce retention. There is an urgent need to articulate and communicate career development pathways from traineeships and apprenticeships into early career roles and onwards to senior roles. A program of incentives could be developed in parallel to these pathways to develop cultures of lifelong learning and lift engagement with post-trade training across VET and university coursework³² and CPD opportunities.

This research also uncovered barriers to engaging in post-trade training. These arise from a complex of factors including the dominance of SMEs in the sector, lack of support from employees associated with the prevalence of lowest-cost contracting and related time pressures³³, and shortage of courses beyond hubs of Sydney and Melbourne.

Given the dominance of SMEs in the sector, pilot programs could be designed with incentives to encourage SMEs to promote relevant post-trade training among employees (e.g. around standards, compliance etc).

Industry and industry peak organisations can play an important role in identifying emergent workforce needs in the sector and articulating career pathways (e.g. what are the alternative avenues for those looking to move ‘off the tools’) and opportunities to build energy efficient-related experience and skills beyond the immediate workplace. Opportunities for transfer and mobility into growth areas within the sector could be investigated with the industry partnerships.

5.2 OPPORTUNITY 2: ENHANCING CAPACITY FOR SKILLS AND TRAINING TO MEET THE TRAJECTORY FOR LOW ENERGY BUILDINGS

ACTION: SUPPORT UPSKILLING TO KEEP PACE WITH NEW TECHNOLOGIES AND INFORMATION

Findings from the *BWW* survey identified under-utilisation of existing formal post-trade training in the Australian HVAC workforce as a problem for an industry on the frontline of increasingly rapid environmental, technological and economic change.³⁴ New equipment technologies, alternative refrigerants and increasing use of digital platforms and data will all require skills development and innovation in the post-trade training landscape.

To increase that capacity of the vocational education models to meet the pace of change, there is a need to recognise what skills are best developed by the VET sector, and what skills development can be tackled by other avenues. These may include short courses or micro-credentials (accrued progressively), delivered by peak organisations, and equipment suppliers and manufacturers (See Industry Insight 2).³⁵

32. Noting that building services degrees currently have limited coverage in higher education settings in Australia.

33. See Daly, M. et al (2021)

34. Carr et al. (2021); Rutovitz et al. (2021)

35. Rutovitz et al. (2021)

There are opportunities for government to work with peak organisations and equipment suppliers to develop specific programs to target, for example, data literacy amongst both HVAC&R contractors and facilities managers (recognising that their needs will be different). Current industry collaborations with education providers present rich opportunities for these materials to be ‘product-tested’ and shared with education providers (e.g. FMA/UNEP collaboration) to ensure they reach the right audiences. Product-testing with a cohort who are already engaged in further skills development can also play an important role in addressing workforce issues and skills shortages. Skills and knowledge development of HVAC and FM educators must be fostered alongside this.

Accounting for disincentives and inertia that limits engagement with post-trade workforce training, government can also look to build targeted information about diverse training opportunities that can be disseminated through existing knowledge sharing networks (e.g. FMA/AIRAH) and through equipment suppliers and manufacturers.

ACTION: BROADEN THE REMIT OF ENERGY EFFICIENCY TRAINING TO INCLUDE SOFT SKILLS

Soft skills—such as the ability to develop and effectively communicate a persuasive business case for maintenance, or to project manage HVAC&R upgrades--will be essential to achieving uplift in the energy performance of commercial buildings. Such skills need to be integrated across the skill set of the HVAC&R and FM workforce. This requires both recognition of the importance of these skills and the means to develop appropriate training.

To best develop these competencies, soft skills need to be integrated alongside technical skills in ways that specifically target energy efficiency. Flexible course programs that are embedded within work-integrated training programs are one way forward (see Industry Insight 2). Micro-credentials and short courses developed and delivered with industry partners or other intermediaries (e.g. universities or RTOs) also present opportunity. Crucial however is the evaluation of course outcomes to meet industry needs and demands.

The current Building Energy Advice Program offers an opportunity for a pilot. The program provides a small business energy check, using a benchmarking tool to allow businesses to compare energy spend against similar businesses in their industry or region. This program may be adapted so that HVAC&R contractors and facilities managers can compare energy use for businesses they currently service. This data may assist with building a business case for better HVAC maintenance, or energy efficiency upgrades.



INDUSTRY INSIGHT 2: CROSS-STAKEHOLDER INVESTMENT IN THE DEVELOPMENT AND DELIVERY OF WORK-INTEGRATED TRAINING PROGRAMS

The research uncovered many examples of exemplary cross-stakeholder engagement between industry and education and training providers. With pressures on the VET system, such engagement is essential to delivering high-quality and relevant training across the complexity and diversity of role types in the HVAC&R industry. At the Refrigeration and Climate Control Centre at Box Hill Tafe (designed in partnership with AMCA), for example, manufacturers, suppliers and industry have teamed up to design innovative teaching spaces at the forefront of technological skills development.

Collaboratively developed and delivered programs also offer flexibility. For instance, the collaboration between the FMA and University of New England Professional (UNEP) has designed a flexible program based on modularisation and embedded within principles of work-integrated learning. The electives chosen as part of the Diploma of Facilities Management can be 'sliced and diced' to fit training needs to the specificity of work the student hopes to define. This means, for example, that a student could design a program based on 'sustainability and resilience' or 'compliance'.



'You could be a specialist FM in compliance activities and so that would skill you up to do a particular thing, and you could do that by the way that you selected your electives'

Facilities Management Stakeholder

A key point, however, is that evaluation of programs is needed to ensure they are meeting the needs of the market, the workforce and the wider sector.

5.3 OPPORTUNITY 3: SUPPORTING THE DEVELOPMENT OF SKILLS AND TRAINING THROUGH A MULTI-SCALAR, CROSS-SECTORAL APPROACH

ACTION: RECOGNISE DIVERSE WAYS OF ACQUIRING SKILLS AND KNOWLEDGE TO DELIVER A FUTURE-FOCUSED WORKFORCE

With existing workforce pressures, including workforce pipeline issues and the dominance of SMEs in the mid-tier sector, it is vital that knowledge sharing is fostered in ways that work with the industry, rather than against it. While our research suggests that engagement in skills development via post-trade qualification avenues is currently low, skills and knowledge are being acquired in other informal ways. These include routes of connection with webinars and short-courses, but also knowledge sharing via informal networks and communities of practice. Equipment suppliers were identified as central players in these communities. Industry peak organisations offer another site (Industry Insight 3)

Though difficult to govern, efforts could be made to foster and expand industry networks, as our research uncovered a wide range of success stories where important learning cultures are being developed in this space. An example of this is AIRAH's weekly 'Muck-up Mondays' social media posts, which use humour to showcase poor installation and maintenance practices.

INDUSTRY INSIGHT 3: INDUSTRY ORGANISATION DEMYSTIFYING SESSION

Informal communities of practice are formed when people engage in a process of collective learning around a shared concern. Our research found multiple examples where informal networks served as an alternative to formal training.

One industry stakeholder spoke of the success of ‘demystifying sessions’ held with members to tackle specific issues related to work roles and practices. These were aimed to debunk common problems that were prominent in member enquiries or feedback. Events are held in person and usually run for two to three hours. They involve a mix of discussion and presentation.



‘...we got these three parts, the policy, the supply chain, and the others who could verify things, in the room to again demystify this space’

Industry Stakeholder



‘... I can just remember the session... 70 people in the room and the number jaw drops over the course of the first hour, and then the questions and you could see people leaving going, ‘oh my goodness I’ve been so ripped off, not only that, my building’s not compliant, and they’ve relied on somebody’.’

Industry Stakeholder



ACTION: DEVELOP A TRAINING ECO-SYSTEM APPROACH TO SKILLS DEVELOPMENT FOR ENERGY EFFICIENCY

Lifting energy efficiency in the built environment is a complex issue that is dependent on a skilled and experienced workforce. Developing the industry's capacity to meet the Trajectory for Low Energy Buildings presents a challenge for governance and policy-making because it involves multiple stakeholders:

- Australian Government agencies with an interest in energy efficiency (DISER and DAWE)
- Australian Government agencies responsible for VET and higher education (DESE)
- State and Territory agencies responsible for VET skills and training
- Professional organisations (AIRAH, FMA, AMCA, RACCA etc)
- Registered training organisations
- Equipment suppliers.

Each of these has an important role to play in providing training to a workforce that is on the front line of energy transitions in the built environment.

A **'training eco-system'** approach is a holistic way of responding to the scale and pace of change required to deliver the *Trajectory for Low Energy Buildings*. This approach recognises that skill development and capacity building for HVAC&R contractors and FMs requires a combination of trades and professional qualification (delivered via state-based education systems) and continuing professional development (CPD). CPD is conceived of broadly, to include professional industry diplomas, short courses, single day workshops run by professional organisations, and supplier training. Across these various modes of training, stakeholders can work to develop a shared view of energy efficient buildings that specifically encompasses expectations for the mid-tier, and guidance on how to approach this. There are a number of different delivery mechanisms that coalesce around the 'training eco-system' and which can assist the development of a skilled and capable workforce required to lift HVAC energy performance. These include:

1. DISER-led skills and training initiatives



Training is key to ensuring maximum compliance with regulation for energy efficiency, and the more widespread uptake of targeted information and incentive schemes, all of which fall within DISER's purview. Whilst initial qualification of the HVAC&R workforce falls within the remit of existing VET and higher education programs, there is a need for DISER to have an overview of how existing training impacts on the capacity to deliver the *Trajectory for Low Energy Buildings*.

2. Industry-led skills and training initiatives



Professional organisations are already playing an active role in the skills and training space, with key organisations representing both HVAC&R contractors and FMs involved in the delivery of Continuing Professional Development, and Professional Diplomas. Equipment suppliers also play a role in delivering technology-specific training in a targeted and agile way. Industry is best placed to respond to market-driven demand for specific skills, particularly where they involve the introduction of new technologies.

3. DESE-led skills and training initiatives



There is a need for the Australian Government, in collaboration with State and Territory Governments, to continue to develop and adapt existing VET and higher education offerings that integrate energy efficiency and performance across the curriculum. These programs should incorporate work-integrated learning to maximise their impact.

6. REFERENCES

- Australian Energy Regulator (2021) Annual electricity consumption. <https://www.aer.gov.au/wholesale-markets/wholesale-statistics/annual-electricity-consumption-nem>
- AIRAH (2020) HVAC&R licensing in Australia: Now and towards 2050. <https://www.airah.org.au/licensing>
- Australian Industry Skills (2019) Electrotechnology Skills Forecast 2019. Australian Industry Standards.
- Australian Refrigeration Council (2021) Cool Change Newsletter https://www.arctick.org/media/17502/arc4918-coolchangenewsletter62_web.pdf
- Australian Industry Skills Commission (2021) Refrigeration and Air-conditioning overview <https://nationalindustryinsights.aisc.net.au/industries/electrotechnology/refrigeration-and-air-conditioning>
- Brodribb, P. and McCann, M. (2018) *Cold Hard Facts 3*. Prepared for the Department of Environment and Energy.
- Carr, C., Stanes, E., Daly, M., Daly, D., McGuirk, P. (2021) *Better Ways to Work: HVAC management, repair and maintenance in the mid-tier commercial office sector*. Final report, March 2021. ISBN: 978-1-74128-359-4.
- CSIRO (2021) Net-zero energy HVAC Roadmap <https://www.csiro.au/en/research/technology-space/energy/net-zero-energy-hvac-roadmap>
- Daly, M., Carr, C., Santala, I., Daly, D., Stanes, E., McGuirk, P. (2021), *Better Ways to Work: Mapping decision-making and policy intervention across the HVAC maintenance lifecycle*. Final report, December 2021. ISBN: 978-1-74128-356-3.
- Department of Industry, Science, Energy and Resources (2021) Commercial buildings <https://www.energy.gov.au/government-priorities/buildings/commercial-buildings>
- EY. 2015. *Mid-tier commercial office buildings in Australia: Research into improving energy productivity*.
- Facilities Management Australia 2020. Facility Perspectives. Executive Media. Retrieved from <https://www.fma.com.au/common/Uploaded%20files/Facility%20Perspectives%20MK%202021.pdf> [last accessed 30/11/2021].
- Facilities Management Association. 2014. Facilities Management Industry Census. Trends and Insights 2013–2014.
- Green Building Council of Australia. (2015). *Mid-tier commercial office buildings in Australia: A national pathway to improving energy productivity* (Issue November).
- GBCA, PCA, AIRAH, EEC, FMA, City of Sydney, & CitySwitch. (2017). *Opportunity knocks: Accelerating energy efficiency for mid-tier buildings*.
- Lucas, H., Pinnington, S., and Cabeza, L. (2018). Education and training gaps in the renewable energy sector. *Solar Energy*, 173, 449-455.
- Pears, A. (2020). Energy efficiency education and training: Australian lessons on what employers want — or need. *Energies*, 9(13), 2386.
- Rutovitz, J., Visser, D., Sharpe, S., Taylor, H., Jennings, K., Atherton, A., Briggs, C., Mey, F., Niklas, S., Bos, A., Ferraro, S., Mahmoudi, F., Dwyer, S., Sharp, D., and Mortimer, G. (2021). *Developing the future energy workforce. Opportunity assessment for RACE for 2030*.
- South Australia Training and Skills Commission (TASC) (2019) *Construction, mining and energy workforce insights*. South Australia Training and Skills Commission.
- Sustainability Victoria. (2016). *Energy efficient office buildings: Transforming the mid-tier sector*. Sustainability Victoria.

