FUTURE BATTERY INDUSTRIES CRC

Vocational skills gap assessment and workforce development plan

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EXECUTIVE SUMMARY

This study reviewed the extent to which national Training Package qualifications cover the vocational skills and knowledge required in Australia's future battery industries.

Battery value chain industries were analysed from mining through to refining and processing, battery cell manufacturing, battery energy storage system (BESS) manufacturing, BESS deployment, electric vehicle servicing, electric vehicle supply equipment manufacturing and installation and lithium-ion battery recycling.

It was found that current qualifications under a range of national Training Packages provide many of the skills and knowledge required.

However, the nature of future batteries in terms of their chemistry, the purity of the materials required, the new technologies required for production as well as the new technologies they represent and enable, means that there are areas where new vocational skills and knowledge are needed.

Based on the skills gap analysis, a Vocational Workforce Development Plan has been developed. It is intended to guide vocational workforce development as part of the Future Battery Industries Cooperative Research Centre program. The Plan proposes actions across three areas:

1. VOCATIONAL SKILLS FOR GROWING AUSTRALIAN BATTERY INDUSTRIES

Demand for batteries is forecast to accelerate and increase by 9- to 10- fold over the next decade[1]. Vocational skills training is recommended to build on and maintain Australia's mining strength, support the establishment of the battery minerals refining and processing industry, prepare for cell and component manufacturing, and support BESS manufacturing and lithium-ion battery recycling.

The mining and production of battery mineral concentrates was reported to not require any new skills or knowledge as Australia's existing vocational sector mining skills are relevant to battery minerals. Some customised training may be required where companies use processes not commonly used. In addition, new mines incorporating Industry 4.0 technologies such as automation and machine learning will provide further impetus to developing these skills in the mining workforce.

However, battery minerals mining projects are subject to skills shortages in the mining sector generally. A focus on battery minerals projects may be appropriate to ensure access to workers.

The refining and processing of battery minerals into the raw chemicals required for downstream battery manufacturing has been identified as key to expanding Australia's presence in the battery value chain. Due to the high purity nature of battery chemicals, Process Operators, Process Technicians and Laboratory Technicians require skills and knowledge in working with automation to achieve high product quality standards, knowledge of the value chain and understanding of the battery chemistry and chemicals used.

Training in these skills and knowledge for battery refining and processing is required now as there are a number of companies who have commenced operations or plan to in the next few years.

Vocational workers required for the maintenance of process control equipment are also critical to the battery refining and processing industry. These include tradesworkers such as Electricians, Mechanical and Electrical Fitters and Electrical Instrumentation Technicians. Peak industry skills bodies have identified a need for training in skills to install and maintain systems that involve automation, artificial intelligence and big data.

Mass production of lithium-ion battery components and cells will require Production Operators and Battery Test Technicians with skills and knowledge pertaining to the battery cell production process such as controlled slurry mixing, electrode coating and the formation process. This is not currently covered in existing training but can be developed once companies confirm skills needs.

The manufacturing of BESS requires workers with both electrical and engineering manufacturing skills and knowledge. Current training covers the skills needed however it can be difficult to source workers. Strategies are required to ensure the supply of Electricians, Electrotechnology Workers and Engineering Manufacturing Workers to the BESS manufacturing industry.

2. VOCATIONAL SKILLS FOR BATTERY APPLICATIONS IN AUSTRALIA

Vocational skills training is required to support the adoption of BESS and electric vehicles (EVs) in Australia.

As BESS and EVs are increasingly adopted in Australia, Firefighters, other First Responders and related occupations require training in attending to emergencies involving BESS and EVs. There are existing guidelines for Firefighters in BESS that will guide training. First Responder training in BESS and EVs is required for all emergency workers and related occupations.

The installation of BESS relies on Electricians. Current post-trade national training units for Electricians provide the skills required however, feedback has been that it requires updating to industry developments. A national Training Package review in 2021 will cover the battery storage units. In addition, the number of Electricians who have completed the available post-trade training in battery storage design and installation is currently low. This may reflect market demand and industry consultation is required as to whether any additional strategies are needed to encourage training take up.

The integration of BESS into the electricity network will require new skills and knowledge for Tradesworkers and Technicians in electricity generation and supply such as systems thinking for interconnected resources, digital skills for fault finding and repair and working safely with new technologies. However, wider consultation is required with electricity utility companies as to how the vocational education and training (VET) sector can assist workforce skilling. Existing partnerships between industry and the VET sector will develop enterprise training in stand alone power systems.

A key workforce issue concerning EV adoption is the skilling of Automotive Service Technicians to work on EVs. Whilst a new national qualification in EV Service Technician will be developed in 2021, government, industry and VET sector partnerships are required to prepare training facilities, apprenticeship placements, VET teaching staff industry experience and learning and assessment materials. Public investments into adopting EVs such as for public transport or government fleets provide opportunities for partnerships between VET sector and industry to train vocational workers in EV servicing.

The battery recycling, re-use and refurbishment industries will require new training developed for Recycling Centre Workers, Waste Collection Workers and Process Operators in the handling and storage of lithium-ion batteries, disassembly and shredding of batteries and the chemical processes used to recover valuable materials.

3. ENSURING THE FUTURE VOCATIONAL WORKFORCE FOR AUSTRALIAN BATTERY INDUSTRIES

In order to provide vocational workers with the skills required for Australia's growing battery industries, more accurate and timely data will be needed on industry needs.

This study was focused on new vocational skills and knowledge required however, battery industries

will also require a range of vocational workers whose existing skills and knowledge are also relevant. For example, workers in logistics, warehousing and transport.

Ongoing data will also provide information regarding skills needs as industries grow and become more established and new occupations or skill needs emerge.

Enrolments and completions in vocational occupations relevant to battery industries should be monitored for workforce supply. For example, Electricians and the electrotechnology workforce are very relevant to the manufacture and deployment of BESS and electric vehicle supply equipment (EVSE) and the maintenance of process control equipment. Process Operators and Process Technicians are key vocational workers for battery minerals refining and processing as well as battery recycling once it becomes established. Manufacturing workers with skills in electronics and engineering are critical to BESS manufacturing.

Battery industries all along the value chain utilise advanced technologies that involve automation, machine learning, big data, robotics and integrated communications technologies. Digital skills will be required for all vocational workers in battery industries. The inclusion of battery industries and workplace contexts in the many initiatives underway to develop digital skills training is another way to support vocational skills for battery industries.

Australia's future battery industries provide rewarding careers for VET graduates. The promotion of the battery industries and related occupations is required to attract students into training courses.

Vocational workers with science, technology, engineering and mathematics skills and knowledge will be able to participate and further Australia's battery industries.

ABBREVIATIONS AND ACRONYMS

AISC	Australian Industry Skills Committee
AUR TP	Automotive Retail, Service and Repair Training Package
BESS	Battery energy storage system
BSB TP	BSB Business Services Training Package
CPP TP	CPP Property Services Training Package
DER	Distributed energy resources
ESI	Electricity supply industry
EV	Electric vehicle
EVSE	Electric vehicle supply equipment
FBP TP	FBP Food, Beverage and Pharmaceutical Training Package
ICT	Information and communication technology
IRC	Industry Reference Committee
MEM TP	MEM Manufacturing and Engineering Training Package
MSA TP	MSA07 Manufacturing Training Package
MSL TP	MSL Laboratory Operations Training Package
PMA TP	PMA Chemical, Hydrocarbons and Refining Training Package
RII TP	RII Resources and Infrastructure Industry Training Package
RTO	Registered Training Organisation
STEM	Science, technology, engineering and mathematics
TAFE	Technical and Further Education college
TLI TP	TLI Transport and Logistics Training Package
TP	Training Package
UEE TP	UEE Electrotechnology Training Package
UET TP	UET Transmission, Distribution and Rail Sector Training Package
VET	Vocational education and training

1. ABOUT THE RESEARCH

This study analysed the skills needs of future battery industries across Australia as they relate to 'vocational' jobs. The jobs reviewed were those Trade, Technician, Machine Operator and Driver, Production Worker and Labourer roles where there is a relevant vocational education and training qualification. The focus of the study was the extent to which the skills required are covered by existing qualifications from national Training Packages.

The study segmented the future battery value chain into the following industries for analysis:

- battery minerals mining and concentrate production;
- battery minerals refining, processing and precursor production;
- battery component and cell production;
- battery energy storage system (BESS) assembly;
- BESS installation, servicing and maintenance;
- electric vehicle servicing and electric vehicle supply equipment manufacturing and installation;
- battery recycling.

Using the data generated through the desktop research and interviews and surveys undertaken, the identified job roles and skills were mapped against qualifications in national Training Packages that are listed on training.gov.au. This mapping was used to identify any gaps in the current training available.

The gap analysis has informed a plan for developing the vocational workforce for future batteries as part of the Future Battery Industries Cooperative Research Centre program.

PROJECT LIMITATIONS

This project is limited to the information that was available at the times of data collection (approximately mid - late 2019 and mid- late 2020). The rapid change that is occurring across the future batteries value chain will impact the data generated and the skill and training gaps identified.

It is important to note that as Australia's current engagement in some components of the future battery value chain is only at feasibility, scoping or pilot stages, some interviewees were not yet in a position to fully inform the consultation on workforce development requirements.

Furthermore, most of the consultation took place during the global COVID-19 pandemic, meaning that this may have limited stakeholders' ability to engage at the time.

For each battery value chain industry, the skills required were identified through:

- a literature review;
- a review of vocational job advertisements listed in Australia and overseas; and
- interviews and surveys with a range of participants (n = 64) in the future battery value chain in Australia that included representatives of companies, peak and industry bodies, training providers and national training bodies and and subject matter experts.

[2]Additional data from a Western Australian study in 2019 was also incorporated with permission from the Western Australian Department of Training and Workforce Development (n = 42).

Figure 1 shows the spread of participants from both this study and the Western Australian 2019 study across the battery value chain industries.

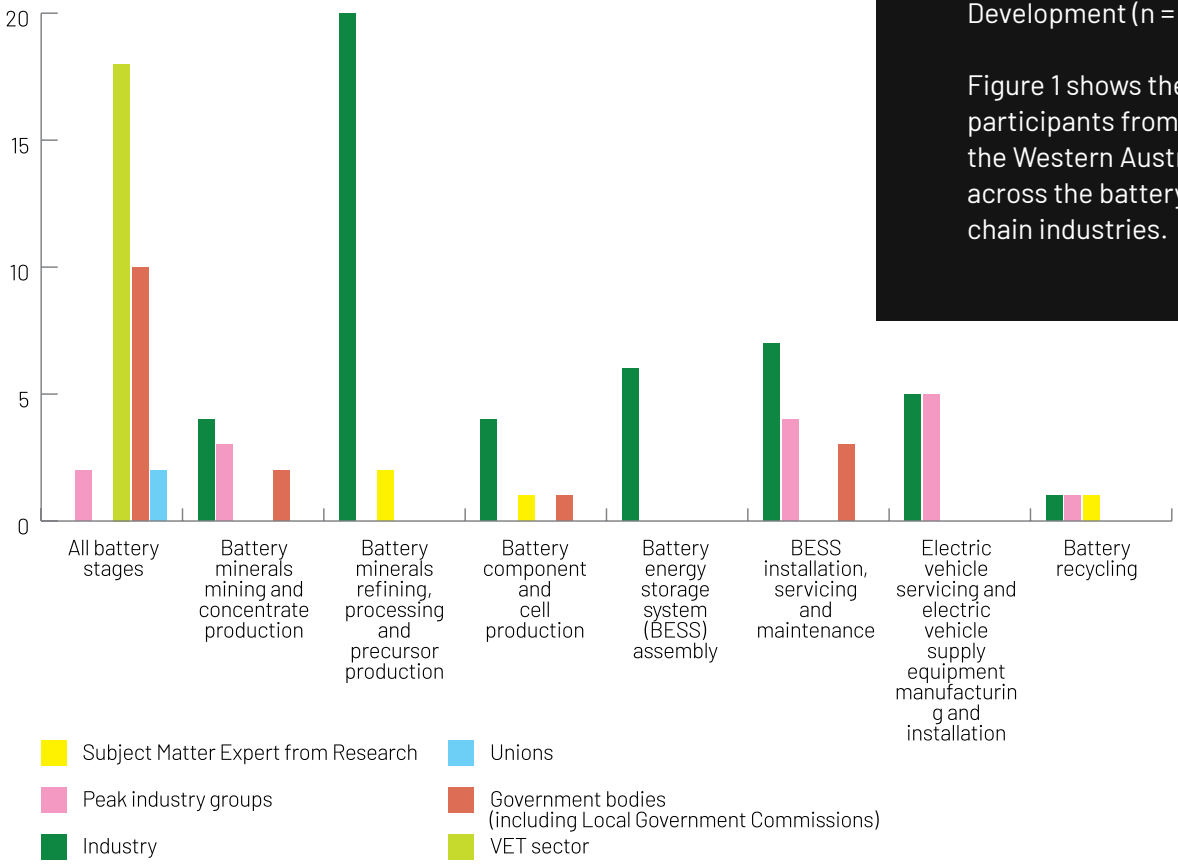


Figure 1. Total number of participants whose information is included in this report[3] across battery value chain stages.

2. VOCATIONAL EDUCATION AND TRAINING SECTOR OVERVIEW

Australia's vocational education and training (VET) system is a national system designed to provide up to date workplace skills and knowledge.

Key statistics include:

- over 4 million students participated in VET in 2019;
- close to one third of working-age Australians hold a VET-level qualification as their highest qualifications';
- more than 4000 registered training organisations (RTOs) deliver VET; and
- in 2019 the Australian, State and Territory Governments together spent about $6.4 billion on VET[4].

It comprises three main components that are designed to ensure:

- skills and qualifications gained are nationally recognised and portable across Australia;
- training meets industry and enterprise needs by being based on levels of competency agreed by industry; and
- the quality of training delivery across different training providers is consistently of the high level required.

The vocational education and training system provides qualifications from levels 1 to 8 in the Australian Qualifications Framework. These cover the Certificates I, II, III, IV, Diploma, Advanced Diploma, Graduate Certificate and Graduate Diploma.

National Training Packages comprising training qualifications exist for all industries in Australia. The Australian Industry and Skills Committee works with Industry Reference Committees (IRCs), supported by Skills Services Organisations and Technical Advisory Committees, to develop and maintain national Training Packages and qualifications ensuring that they remain responsive to evolving industry needs. Industry Refence Committees provide the avenue through which State and Territory industries, professional bodies and training organisations are consulted on Training Package changes.

In addition, training courses can be developed and nationally accredited outside of the national Training Packages where there is a training need not addressed by a Training Package. In order to be accredited the training must also meet specified national quality standards. These accredited courses are then available for RTOs to register to deliver.

Training Package qualifications comprise a set of core and elective units where there are rules regarding which electives can be chosen and how many. The precise combination of elective units undertaken by a student will be determined by the RTO and depends on factors such as workplace requirements and available equipment. There are "packaging" rules for each qualification that determine how electives can be chosen. Usually, there are opportunities for relevant units from other Training Packages and qualifications to be imported at a similar level to provide additional skills.

Registered Training Organisations are responsible for developing the learning and assessment strategy for students to gain a qualification. Assessment is 'competency based' which means that learners are assessed on whether they can demonstrate competency in a skill. Learners undertake training in 'units of competency' and must demonstrate competency according to national standards which are defined in the Training Packages.

Training can be delivered either wholly or partially at the training institution or a workplace. Certain trade occupations can only be undertaken and delivered under an apprenticeship where the student is employed under a contract between the employer, student and RTO that

Figure 2. Australian national training system

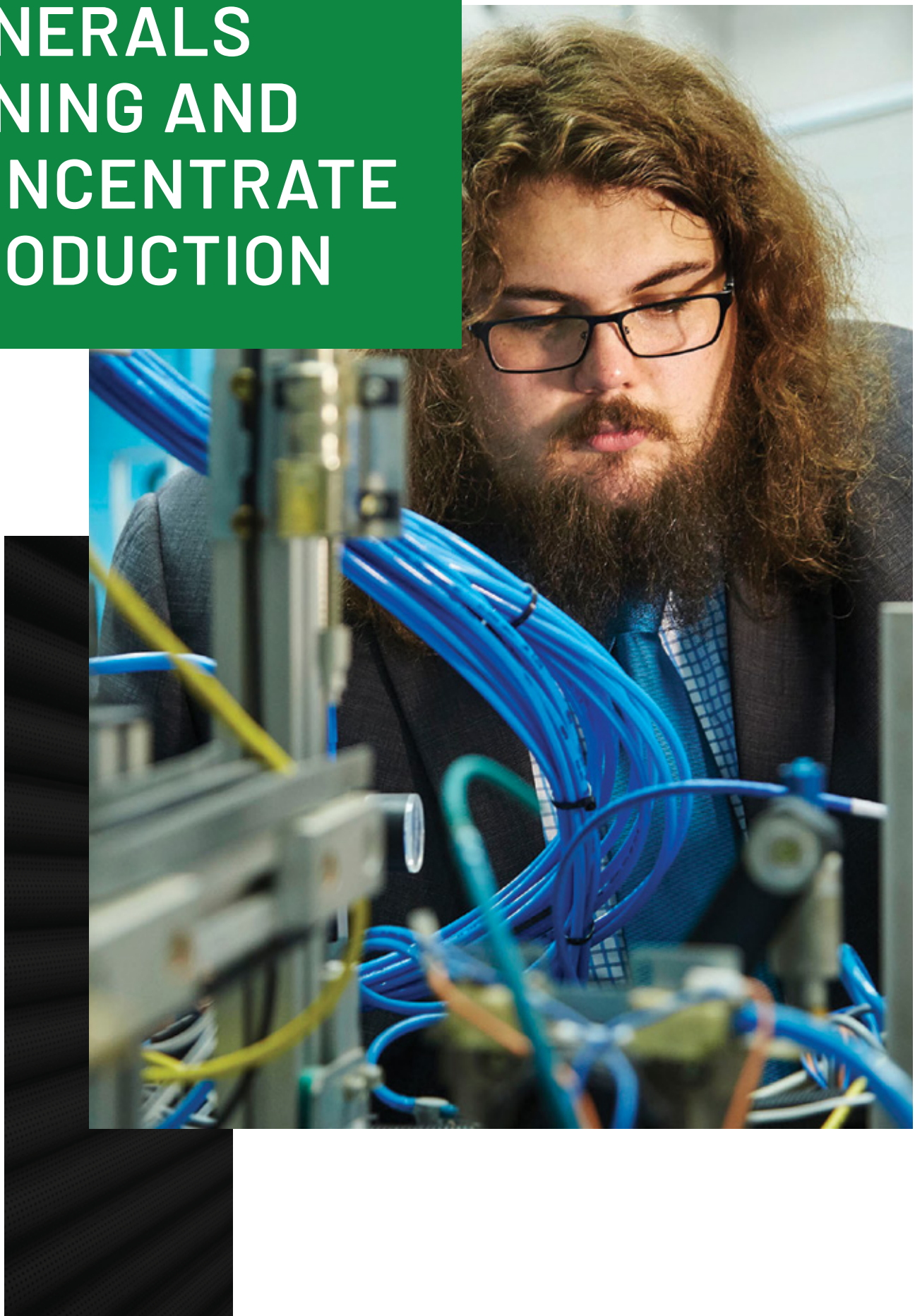
governs the employment and training conditions (for example, Electrician, Plumber, Carpenter). State based legislation regulates the occupations that must be delivered as an apprenticeship. There are also a range of other VET qualifications that may be delivered under a 'traineeship' where the arrangement is also governed by an employment and training contract.

FUNDING

The Australian, State and Territory Governments share responsibility for funding, regulation and performance of the VET system. This includes allocation of funding to public and private RTOs for training delivery, fee regulation, fee subsidies and student loans.

Through performance agreements and funding policies, Governments can prioritise training and courses. For example, the Australian Government provides financial incentives to encourage the uptake and completion of apprenticeships. A 'National Skills Needs List' identifies occupations that are deemed to be in national shortage[5]. Additional financial incentives are provided for apprenticeships on the National Skills Needs List. State and Territory Governments also provide financial incentives for apprenticeships and fee subsidies targeting occupations and student groups to address jurisdictional skills shortages and encourage participation [6, 7, 8].

3. BATTERY MINERALS MINING AND CONCENTRATE PRODUCTION



3.1 Roles, current training and skills gaps

EXISTING MINING SKILLS ARE SUITABLE FOR 'BATTERY' MINERALS MINING

Interviewees and survey respondents consistently stated that in general there are no new or unique skills required for the mining of 'battery' minerals as opposed to other hard rock or base metal mining and concentrate projects.

The companies interviewed in 2019 as part of the Western Australian study[9] who were either operating or planning mines for 'battery' minerals such as lithium, nickel, vanadium, rare earths, graphite, manganese and kaolin, stated that they require the standard skills sets for mining, crushing, milling and beneficiation as used in other base metal or hard rock mining operations.

Additional companies interviewed for this study in 2020 who were planning or operating mining projects in graphite, nickel, rare earths, bauxite or kaolin reiterated that the mining skills currently available in Australia were sufficient for their mining and concentrate processes.

Interviewees across both studies consistently reported that the existing mining sector skills are suitable for their battery mineral mining and concentrate projects. Workers experienced in other mining operations such as those for gold, copper, mineral sands and iron ore were seen as having transferable skills and experience for battery mineral mines.

The mining and production of mineral concentrates involves a wide range of vocational job roles across mine surveying, contracted activities, operations, maintenance and support.

Existing training for jobs in mining and concentrate production are provided by qualifications from the following national Training Packages:

- RII - Resources and Infrastructure Industry Training Package.
- MSL – Laboratory Operations Training Package
- UEE – Electrotechnology Training Package
- MEM – Manufacturing and Engineering Training Package
- BSB – Business Services Training Package
- TLI – Transport and Logistics Training Package

POSSIBLE LACK OF EXPERIENCE IN SOME PROCESSING SKILLS NOT WIDELY USED

One interviewee noted that experience in certain processing techniques used for battery minerals (for example, flotation techniques) may not be as readily available in certain States where the processes are not as widely used in other mining operations. In addition, the PwC Skills for Australia Skills Forecast 2019[10] reported some industry interest in developing training to address different concentrate production processes such as dry, wet and chemical processes, that are used to process different minerals. However, this did not translate into a desire to amend the structure of the RII Training Package.

Where training already exists for processing techniques that are not widely used, Registered Training Organisations (RTOs) can customise existing training courses to incorporate or address skills required for a company's processes and procedures. This is a standard service provided by RTOs. For example, in 2018, North Metropolitan TAFE in Western Australia and Pilbara Minerals collaborated to develop a customised Certificate III qualification from the RII Training Package customised to the company's lithium mining processes[11].

NEW TECHNOLOGY SKILLS ARE VERY APPLICABLE TO NEW BATTERY MINERALS OPERATIONS

Interviewees noted that battery mineral mines that are new have the opportunity to incorporate a high level of automation and Industry 4.0 technologies to improve efficiency, enhance worker safety and improve workers' experiences. They stressed that the degree of automation went beyond remote and automated operations to include artificial intelligence, machine learning and connected technologies. For example, automated processes will gather detailed data on stockpile characteristics and use machine learning to adjust processes accordingly.

The issue of new integrated systems technology in mines and the impact on skills has been well documented. A 2019 report commissioned by the

Minerals Council of Australia described the increased need for skills such as data and data literacy, data analysis and design thinking[12].

The vocational education and training sector has responded to the requirement for new technology skills in mining through initiatives such as:

- the Mining Skills Organisation Pilot – Digital Transformation project hub; and
- new training units to address new and emerging technology in the Resources and Infrastructure Industry Training Package[13].

There are also training initiatives to develop Industry 4.0 technology skills in other industry sectors such as business, finance and manufacturing. For example, new training for skills in working with big data in the Business Services Training Package; and a Diploma of Applied Technologies developed by Swinburne University. This is in the context of much wider cross-sector initiatives such as the Prime Minister's Digital Technology Taskforce and the Industry 4.0 Advanced Manufacturing Forum convened by Ai Group.

Battery minerals mining and concentrate projects using new and advanced Industry 4.0 technologies will require workers with the relevant digital skills.

THE CHALLENGE OF ATTRACTING WORKERS TO BATTERY MINERALS PROJECTS

Interviewee and survey respondents described workforce supply and demand factors experienced by the resources sector in general as also impacting battery minerals mining and concentrate projects. For example, larger infrastructure projects occurring at the same time are likely to reduce the availability of construction workers for smaller projects.

Several interviewees also raised the issue of difficulty in attracting and retaining staff when competing with larger and more established mining companies.

Recent reports of another mining sector 'boom'[14] and the effect of COVID-19 related travel restrictions means that battery minerals projects are also likely to be affected by any mining skills shortages.

The relative size of the battery mining sector workforce can be seen in Western Australia where the workforce for battery minerals mining projects is 11% of the total mining workforce for that State[15].

Additional State and Commonwealth Government support is already provided for some battery minerals projects through the granting of a special 'major project'[16] or similar status which provides additional government agency support.

State and Commonwealth Governments also have existing processes to identify and address skills shortages across all industries including mining. These include annual surveys and consultations to identify workforce needs surveys. Strategies are then formulated and implemented such as priority skills training, fee subsidies and/or financial incentives programs.

It may be appropriate to have a focus on the needs of the battery minerals sub-sector within these existing wider initiatives to ensure the growth of battery minerals projects.

3.2 Summary

Battery minerals mining projects in Australia can be supported in vocational workforce and skills in the following ways:

- Monitor industry need and appetite for more specialised training in different processing techniques such as dry, wet and chemical processes.
- Ensure the technologies involved in new battery mining projects is part of the Mining Skills Organisation Pilot – Digital Transformation project; and provide training for workers in new RII Resources and Infrastructure Industry Training Package units covering new and emerging technologies where relevant to battery minerals mining projects.
- Monitor the effect of general workforce skills shortages in the mining sectors within each State and Territory on battery minerals projects and ensure their needs are addressed in any government or vocational education and training sector responses.
- Customised training by RTOs is provided as required by companies especially for processing techniques that are not as commonly used in other mining operations.

4. REFINING, PROCESSING & PRECURSOR PRODUCTION

The refining, processing and precursor production stage of the future battery value chain incorporates the refining of mineral concentrates and production into higher purity chemicals suitable for use in downstream battery component manufacturing. The chemicals produced include lithium hydroxide, nickel sulphate, cobalt sulphate, battery grade graphite, vanadium pentoxide and high purity alumina.

This stage of the battery value chain involves mainly chemical production processes where resultant products have very high purity and detailed physical specifications at the particle level.

Companies currently range from being in feasibility study stages through to plant construction and planned commissioning[17].

Some are focused only on refining and processing mineral ore from another source whereas others plan to integrate refining with mining operations thus creating vertically integrated operations.

4.1 Roles, current training, training or skills gaps and potential solutions

Table 1 summarises the findings from literature review, participant interviews, review of job advertisements and curriculum mapping of the key vocational skills required for the refining and processing of battery minerals and precursor production.

KEY ROLES AND RESPONSIBILITIES	EXISTING TRAINING
Process Operators Responsibilities: • Operates production equipment or undertakes similar roles directly involved in production • Monitor, control and operate specific unit operations of the processing plant. • Ensures corrective actions are agreed and taken when required.	• Certificate II in Process Plant Operations (PMA20116) – approx. 6 months duration • Certificate III in Process Plant Operations (PMA30120) – approx. 13 months duration
Process Technicians Responsibilities: • May also operate production equipment but is focussed on maintenance functions and will typically be involved in solving complex problems which require theoretical knowledge, combined with an understanding of the production process and equipment across the plant.	• Certificate IV in Process Plant Technology (PMA40116) – approx. 10 months duration. • The PMA Chemicals, Hydrocarbons and Refining Training Package prepares Operators through to Advanced Operators and Technicians in the chemical, hydrocarbons and refining industries. • Qualifications are available as institutional based study or traineeships.
Laboratory Technicians Responsibilities: • Collect and prepare samples. • Conduct specialist bench scale tests. • Produce certificates of assay.	The MSL Laboratory Operations Training Package provides qualifications to prepare graduates for employment as Laboratory Technicians through to Laboratory Supervisors: • MSL30118 Certificate III in Laboratory Skills • MSL40118 Certificate IV in Laboratory Techniques • MSL50118 Diploma of Laboratory Technology
Maintenance teams: • Electrician • Electrical Fitter • Mechanical Fitter • Electrical Instrumentation Technician.	• Certificate III in Electrotechnology Electrician (UEE30820) – 4 year apprenticeship • Certificate III in Electrical Fitting (UEE33020) – 4 yar apprenticeship • Certificate III in Engineering – Mechanical Trade (MEM30219)(approx. 3 year apprenticeship) • Certificate IV in Electrical Instrumentation (UEE40420) - for Electricians to become specialised.

TABLE 1: VOCATIONAL SKILLS ANALYSIS FOR REFINING, PROCESSING AND PRECURSOR PRODUCTION

TRAINING OR SKILLS GAPS	POTENTIAL SOLUTIONS
Quality control - ensuring high purity • Implement production processes and quality standards required to achieve very high purity chemicals measured in parts per million as well as specific particle level physical characteristics. • Awareness of contamination risks and capable of maintaining a clean environment. • Additional mathematical skills related to purity and contamination may be required.	• Develop new training unit/s to address; and/or • Investigate suitability of importing and customising units on working in controlled environments and maintaining hygiene from the FBP - Food, Beverage and Pharmaceutical Training Package.
Working with automation • New refining and processing plants will incorporate control machinery, equipment and instrumentation with tight tolerances and a high degree of automation[18,19]. Machine learning and artificial intelligence will be utilised to optimise operations.	• Investigate suitability of importing and customising units from the 52844WA Course in Working Effectively in an Automated Workplace.
Knowledge of the value chain • Understanding the value chain and 'ripple effect' of steps taken and the impact on product quality.	• Develop new training unit/s to address (other Training Packages units exist on value stream improvement however may be too high level).
Basic understanding of chemicals and chemistries involved in battery manufacturing • Specific hydrometallurgical and pyrometallurgical processes, additional chemical safety skills for battery chemicals e.g. the cumulative effect of nickel and the handling and storage requirements for lithium hydroxide	• Develop new training unit/s to address. • Contextualisation of existing training on safe handling of bulk and toxic chemicals. • Note: similar training is required for Battery Component and Cell Manufacturing stage of value chain.

Quality Control – ensuring high purity
• Awareness of contamination risks and capable of maintaining sample integrity and a clean, high purity environment.
• Knowledge and ability to perform specialist sampling, testing and analysis of high purity products in very low parts per million.
• Use scanning electron microscopy, atomic absorption spectrometry, x-ray diffraction, mass spectrometry techniques, OES, ICP-MS, XRF, and various other wet chemistry testing methodologies.
	• Customisation of existing training unit MSL954004 - Obtain representative samples in accordance with sampling plan to battery minerals context.
	• Customisation of existing training units for high purity testing standards, procedures and equipment:
	  • MSL973013 Perform Basic tests
	  • MSL974019 Perform chemical tests and procedures
	  • MSL974016 Perform physical and mechanical tests
	  • MSL975046 - Perform complex tests to measure chemical properties of materials.
	  • MSL975047 Apply complex instrumental techniques
	  • MSL975048 - Apply routine spectrometric techniques

Skills and knowledge in crystallisation and particle sizes.
• No specific mention of particle size/crystallisation in training units.
	• Customisation of existing training units for high purity testing standards, procedures and equipment:
	  • MSL954005 - Prepare mineral samples for analysis
	  • MSL953003 Receive and prepare samples for testing
	  • MSL974019 Perform chemical tests and procedures

• No training or skills gaps identified however, this issue should be monitored as more refineries are established and new technology and equipment is adopted. • The requirement for Electricians means that teams may be affected by general skills shortages in the electrotechnology industry.	• Further strategies to increase enrolments and completions of Electrical apprenticeships. Existing strategies include reduced fees and apprentice wage subsidies. Other strategies that have been suggested by the National Electrical and Communications Association include mature apprentice wage subsidy, greater support for pre-apprenticeships and apprenticeship mentoring[20].

TRAINING AND SKILLS GAPS FOR PROCESS OPERATORS AND TECHNICIANS

Process Operators and Process Technicians will be key roles in the vocational workforce for battery minerals refining, processing and precursor production. Interviewees and survey respondents confirmed that the skills required for producing battery raw chemicals can be adapted from skills that are already available in mining, oil and gas separation and bulk chemicals production. They stated that it was important to maintain the supply of mining and processing type skills.

The PMA Chemicals, Hydrocarbons and Refining Training Package contains qualifications that prepare Operators through to Advanced Operators and Operations Technicians in the chemical, hydrocarbons and refining industries. The refining sector covers the refining and smelting of metals such as iron, alumina, copper, silver, lead, zinc, gold and other non-ferrous metals. The chemical manufacturing sector involves taking organic and inorganic materials and manufacturing them into products using a scientific process[21].

There was a wide geographic spread of Registered Training Organisations (RTOs) delivering qualifications from the PMA Training Package in 2018 with the most popular being the Certificate III in Process Plant Operations. Employment was dominated by oil and gas and steel manufacturing sectors[22].

Process Operators and Process Technicians in refining, processing and precursor production will be required to work with highly automated process control equipment and machines to undertake hydrometallurgical and pyrometallurgical processes to refine battery minerals and produce very high purity salts and chemicals.

Gaps were found in existing training in relation to knowledge and skills in:

- achieving very high purity and other product quality standards;
- working with automation;
- knowledge of the value chain and effects on quality downstream; and
- additional chemistry and chemical safety knowledge related to the chemicals used and produced.

The training and skills gaps could be addressed by developing a skill set comprising units that are either new or imported from other qualifications or Training Packages and contextualised.

Some employers were keen to see training developed soon to address the skills gaps that relate to battery minerals processing as additional workers will be required over the next few years when more companies begin refining. However, other employers do not require Process Operators to be trained in a formal vocational qualification, considered the training required to be specific to the company's processes and plan to train Operators in-house.

Development of nationally accredited training will assist workers and the industry as it becomes established over the next few years.

RII – RESOURCES AND INFRASTRUCTURE INDUSTRY TRAINING PACKAGE

A peak industry group for the resources sector reported that some companies in rare earths and other battery minerals processing currently train Process Operators using the RII30420 Certificate III in Resource Processing from the RII – Resources and Infrastructure Industry Training Package rather than the qualifications from the PMA Chemicals, Hydrocarbons and Refining Training Package mapped in this study. The PMA Training Package was identified in this study because it was deemed to be more suited to the chemical manufacturing aspect of battery minerals refining activities. However, the gaps in existing training identified here should also be reviewed against RII Training Package qualifications as they may be more suitable for some companies.

SUPPLY OF PROCESS OPERATORS AND PROCESS TECHNICIANS

Companies interviewed in this stage of the battery value chain reported that they would initially source Process Operators and Technicians from existing mining or other processing operations. The companies reported that a skilled Process Operator could take approximately three years to train internally.

Some interviewees reported that it may be a challenge to attract workers from mining and oil and gas industries to move into battery refining, processing and precursor production. The location of processing plants was reportedly a factor in ease of recruitment with metropolitan located operations able to more easily attract workers than remotely located operations.

As the industry is currently still emerging it is difficult to establish how many workers will be required. Projects have been reported as requiring between approximately 100 – 300 operations staff [23, 24, 25] .

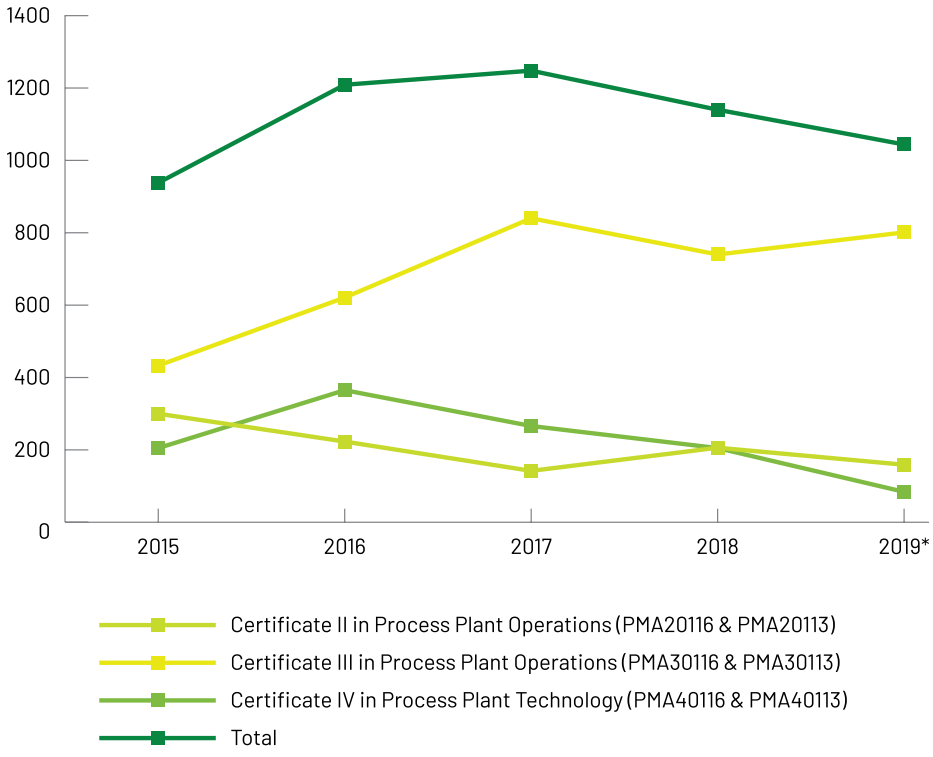
Figure 3 below shows the number of course completions across Australia for the years 2015 – 2019 in process operations qualifications relevant to battery minerals refining and processing.

Whilst completions in the Certificate III in Process Plant Operations have increased over the reporting period, completions in the Certificate IV in Process Plant Technology which prepares Process Technicians have decreased.

Employment in the sector is dominated by oil and gas and steel manufacturing and changes in training enrolments have previously been attributed to changes in those industries.

Further research is required to ascertain the reasons for the decreasing completions and how to address the decline.

Figure 3. Total VET Activity (TVA) program completions 2015-2019 in selected Process Operations qualifications.



*Preliminary for 2019 data.
Source: : NCVER VOCSTATS, extracted on 20 June 2021.

TRAINING AND SKILLS GAPS FOR LABORATORY TECHNICIANS

The MSL Laboratory Operations Training Package provides qualifications to prepare graduates for employment as Laboratory Technicians through to Laboratory Supervisors. A wide range of laboratory techniques are covered including manual, semi-automated and fully automated techniques to collect and prepare samples. Each qualification takes approximately one year to complete. Training is available to prepare students for a wide range of industries including in chemical analysis.

In total there are 54 RTOs nationally that deliver laboratory operations qualifications. Training is available in all States and Territories with the exception of the Certificate II in Sampling and Measurement but this was not reviewed as job advertisements preferred higher level qualifications.

Key skills required for Laboratory Technicians are related to the achievement of high purity and physical specifications at the particle level for battery mineral salts and chemicals.

These skill requirements are not explicitly evident in the existing national training, however, industry consultation indicated that existing training is flexible enough to be customised to the battery minerals refining and processing context and provide the skills required.

The contextualisation of existing training for Laboratory Technicians to the battery minerals refining, processing and precursor production context will provide valuable support for upskilling workers for the industry.

TRAINING AND SKILLS GAPS FOR MAINTENANCE TRADESWORKERS

Maintenance teams consisting of Electrical, Mechanical and Instrumentation and Control Tradesworkers were reported as being critical to refining plants to maintain and repair equipment. However employers or subject matter experts interviewed for this study did not identify any new skill requirements. One employer will work with a TAFE provider to train workers in a dual Operator-Maintainer role for their processing plant.

The high degree of automation and advanced nature of the technology involved in battery minerals refining and processing suggests that this issue should be monitored as more refineries are established. The national Electrotechnology Skills Forecast Annual Update 2020 identified that increased digital competence will be required for electrotechnology workers to establish and maintain the systems involved in new technologies such as artificial intelligence, computer technology, automation and big data.

One issue that could impact maintenance workers is a general skills shortage in the electrotechnology industry. This was recently reported by the National Electrical and Communications Association (NECA) and also documented for Electricians in most States and Territories in 2018 .

Both State and Commonwealth Governments have implemented strategies to support increased training and enrolment in electrotechnology courses. These include reduced fees and apprentice wage subsidies. Other strategies suggested by NECA include mature apprentice wage subsidy, greater support for pre-apprenticeships and apprenticeship mentoring.

4.2 Summary

FOCUSSED TRAINING SUPPORT FOR PROCESS OPERATORS, PROCESS TECHNICIANS AND LABORATORY TECHNICIANS IN PARTNERSHIP WITH INDUSTRY

Downstream refining and processing of battery mineral ore concentrates and precursor production will require Process Operators, Process Technicians, Laboratory Technicians and Maintenance Tradesworkers in electrical, mechanical and instrumentation and control.

New skills and knowledge are required for Process Operators and Process Technicians in using highly automated process control equipment to produce battery raw chemicals that meet high purity and physical property specifications. In addition, an understanding of the chemical processes involved and additional safety knowledge concerning the particular chemicals involved would also be useful.

The skills and knowledge gaps identified in this study should also be reviewed against qualifications from the RII Resources and Infrastructure Training Package.

Training in these new skills and knowledge will likely require new nationally accredited training units developed that relate to achieving high levels of product quality for battery raw chemicals, as well as contextualisation of existing units on complex laboratory techniques and chemical safety. This training could be in the form of a new skill set available for upskilling existing workers or as elective units for trainees.

In addition, the contextualisation of existing training for Laboratory Technicians in achieving high purity products, particle crystallisation and using more complex instruments will better prepare laboratory staff for the industry.

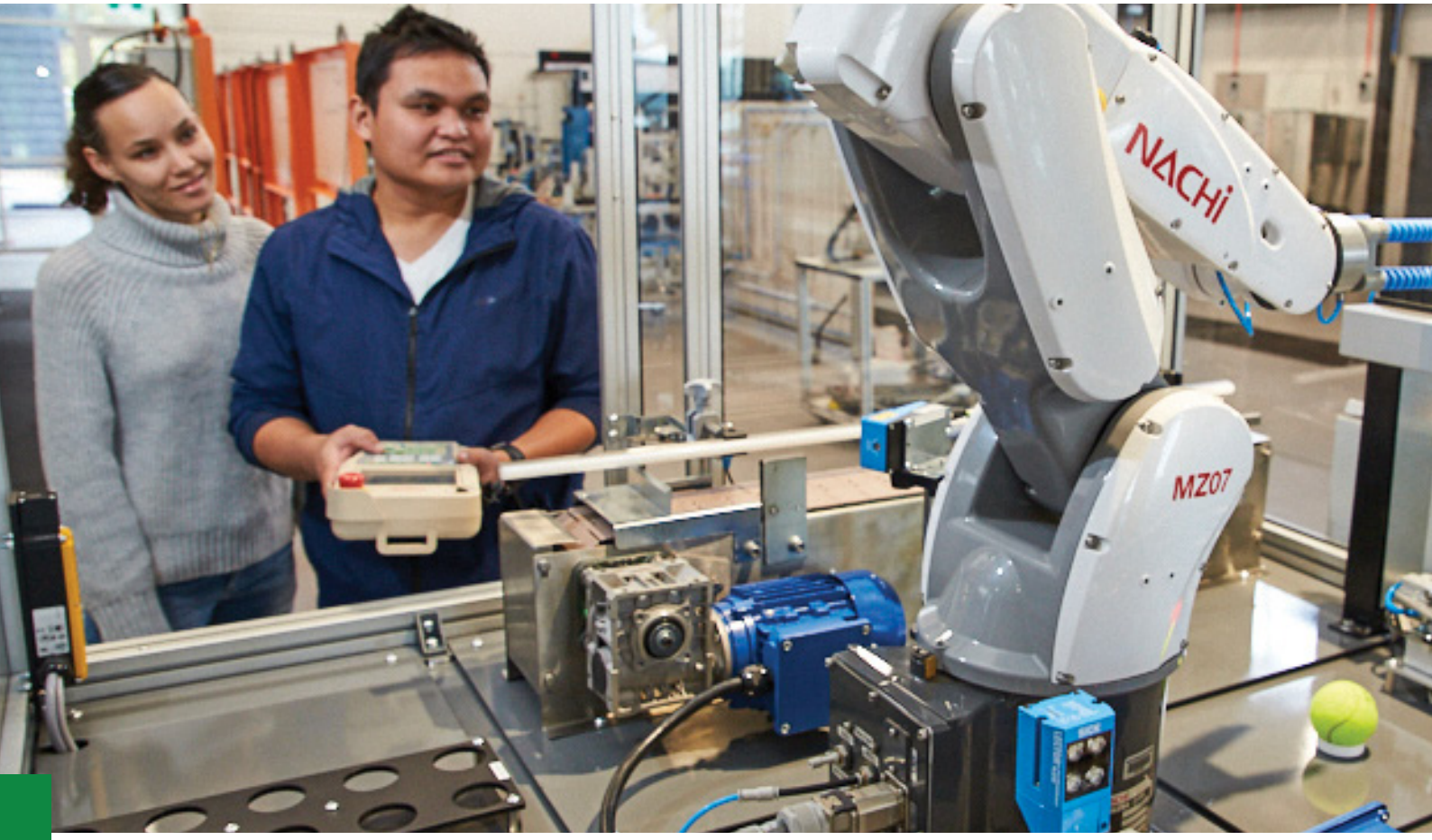
The development of this training will support the establishment of the battery minerals refining industry in Australia.

MONITOR TRAINING AND SKILLS GAPS FOR MAINTENANCE TEAMS

As more battery mineral refineries and processing plants are established, the skill requirements for Maintenance Tradesworkers should be revisited in relation to the advanced technology involved in battery minerals refining and chemical manufacturing including automation, big data and machine learning.

LABOUR SUPPLY

As more battery mineral refineries and processing plants are established, the number of enrolments and completions in courses for key vocational occupations should also be reviewed. For example, Process Operators, Process Technicians, Laboratory Technicians and the trades involved in maintenance.



5. BATTERY COMPONENT AND CELL MANUFACTURING

Lithium-ion battery component and cell manufacturing is currently only just emerging in Australia.

Queensland's University of Technology has a lithium-ion battery manufactory facility in Brisbane, and there are two Australian companies pursuing lithium-ion cell manufacture.

Energy Renaissance is currently constructing Australia's first commercial lithium-ion battery manufacturing facility at Tomago, New South Wales. The focus will be on producing batteries for stationary energy storage. The facility will be automated, use robotics and incorporate automated quality control[29]. It is expected to require a workforce comprising approximately 100 – 1,200 jobs[30] although estimates have been higher for when it is operating at capacity.

Magnis Energy Technologies is also planning a potential lithium-ion battery manufacturing facility in Townsville, Queensland[31].

Some companies focused on precursor materials production are also planning component production.

The skills identification and curriculum mapping has focused on skills for lithium-ion battery component and cell manufacturing.

There are also several long-established manufacturers of lead-acid batteries, other manufacturers planning for vanadium redox-flow batteries and several companies developing and/or manufacturing zinc-bromine batteries for energy storage . However, skills for manufacturing these battery types were not analysed in this study.

5.1 Roles, current training, training or skills gaps and potential solutions

As lithium-ion battery component and cell manufacturing is just emerging in Australia, data regarding vocational skills was gathered through literature review, job advertisement review and interviews with subject matter experts rather than companies in lithium-ion battery cell manufacturing.

Subject matter experts identified that any initial start-up or pilot projects in Australia will most likely involve the use of a multidisciplinary university qualified team of staff to complete the component and battery cell production. It was advised that most of these staff are typically trained 'in-house' and are dominated by professional workers. It is anticipated that as early battery cell production in Australia will be batch rather than automated, manual handling skills will be required, in conjunction with the ability to control and monitor production machines.

However, once the manufacturing process is established, it is believed it will be highly automated which would then see a reduction in the need for university qualified workers and more need for vocational workers.

The current manufacturing process for lithium-ion batteries consists of three main stages: electrode manufacturing, cell assembly and cell finishing[33]. Maintenance workers were also identified as being critical roles.

Table 2 summarises the findings from participant interviews, literature review, job descriptions review and curriculum mapping of the key vocational skills required and any gaps in training or skills for battery component and cell manufacturing, on a mass production scale.

TABLE 2: VOCATIONAL SKILLS ANALYSIS FOR LITHIUM-ION BATTERY COMPONENTS AND CELL MANUFACTURING

KEY ROLES AND RESPONSIBILITIES	EXISTING TRAINING
Electrode production Production Operator Responsibilities: • Use multiple equipment types equipment and computerized systems to produce, evaluate, process and package. Processes include: mix chemical raw materials, micro-layer coating, cutting, assembly, notching, folding, drying, charge/discharge, and packaging) • Mixing of slurries and coating of electrodes • Conduct quality checks • Troubleshooting • Basic equipment maintenance • Collect qualifying products and package for shipment.	• MEM20219 - Certificate II in Engineering - Production Technology; • MEM30119 - Certificate III in Engineering - Production Systems; or • MSM30116 - Certificate III in Process Manufacturing These qualifications prepare workers for a wide range of engineering / manufacturing jobs within the metal, engineering, manufacturing and associated industries. Workers will be prepared for production, distribution, stores and warehousing.
Production Supervisor Responsibilities: • Responsible for ensuring that production requirements are met • Ensure appropriate staffing levels are maintained • Ensure a safe/clean work environment is maintained	• MEM30119 - Certificate III in Engineering - Production Systems; or • MSM30116 - Certificate III in Process Manufacturing
Production Controller / Quality Technicians Responsibilities: • In-process controls • Confirmation of specifications (parts and supply) • Performance evaluation • Assessment of defects	• MEM20219 - Certificate II in Engineering - Production Technology; or • MSM30116 - Certificate III in Process Manufacturing
Cell assembly Cell Assembly Technician Responsibilities: • Operate equipment that carries out cell assembly tasks • Carry out any manual tasks required to feed materials into the cell assembly equipment • Produce products according to specifications. • Work with precision and adherence to quality standards • Reset, re-start, and perform minor adjustments to production equipment as directed • Perform required preventive equipment maintenance	• MEM20219 - Certificate II in Engineering - Production Technology; • MEM30119 - Certificate III in Engineering - Production Systems; or • MSM30116 - Certificate III in Process Manufacturing
Cell finishing Battery Test Technician Responsibilities: • Conduct the "formation" stage of cell production and end of line testing • Operating cell testing equipment • Station equipment preparation and set-up (instruments, cables, fixtures, station software install, network set-up) • Manage infrastructure maintenance according to projects schedule and space requirements	• MEM30405 - Certificate III in Engineering - Electrical/Electronic Trade • UEE31220 - Certificate III in Instrumentation and Control
Equipment Technicians • Process Technicians • Electrical Fitter • Electrician • Mechanical Fitter Electrical Instrumentation Technician Responsibilities: • Machine servicing and maintenance; • Optimising machine performance; • Quality control; • Reviewing cost and delivery	• PMA40116 Certificate IV in Process Plant Technology • UEE42220 Certificate IV in Instrumentation and Control • UEE40420 Certificate IV in Electrical - Instrumentation • UEE50920 - Diploma of Industrial Electronics and Control Engineering

TRAINING OR SKILLS GAPS	POTENTIAL SOLUTIONS
• Verify correct alignment and flow of product during operation. • Monitor HVAC and maintain room conditions for optimal production. • Monitor mixing process to meet the desired mixing grade. • Working with specific machines for mixing of powder and inks. • Printing electrodes on foils and working with viscous materials in a controlled clean and dry space. • Note: low training completions in MEM20219 and MEM30119	• Develop new training unit/s to address. Contextualisation of MEM07028 - Operate computer controlled machines and processes or MEM07025 - Perform advanced machine and process operation - may be suitable. • Investigate the suitability of other courses with higher enrolments and importing relevant units from MEM20219 and MEM30119.
• Knowledge of cell chemistry, electrical products, raw materials, production processes, automated equipment, manufacturing cost reduction, and other techniques for maximizing the manufacturing efficiency.	• Develop new training unit/s to address.
• High purity concentrates handling and storage. .	• Contextualise MEM13003 - Work safely with industrial chemicals and materials for existing courses.
• Knowledge of cell chemistry • Operate equipment for cell assembly, filling and sealing of cells, winding and finishing. • Interpret instructions on cell assembly with precision and high quality control adherence especially to chemical handling. • Complete documentation of process and data entry to track battery cell assembly. • Maintain dry, clean room atmosphere – low humidity, air conditioned. • Work with continued use of respirators while - standing 50 percent sitting 50 percent.	• Develop new training unit/s to address. Contextualisation of MEM07028 - Operate computer controlled machines and processes or MEM07025 - Perform advanced machine and process operation - may be suitable.
• Operate equipment to conduct the "formation" stage of cell production, other finishing processes and end of line testing. • Test cells, process and summarise test data • Understanding of voltage profiles and curves for standard battery chemistries. • Understanding of galvanostatic charge/discharge procedures and battery testing equipment.	• Develop new training unit/s to address.
	• Revisit skill requirements as operations are established

TRAINING AND SKILLS GAPS FOR PRODUCTION OPERATORS AND PRODUCTION TECHNICIANS IN BATTERY COMPONENT AND CELL PRODUCTION

Production Operators and Technicians will be required in the manufacture of battery components and cells.

Existing qualifications from the MEM Manufacturing and Engineering, and MSM Manufacturing Training Packages were identified that prepares workers with advanced manufacturing skills that are relevant to lithium-ion battery component and cell manufacturing.

The MEM Manufacturing and Engineering Training Package covers a diverse range of businesses and occupations associated with designing, making, assembling, installing, maintaining and repairing manufactured products. The MSM Manufacturing Training Package covers the production of goods that are manufactured in bulk quantities from raw materials.

Workers are prepared for a wide range of engineering / manufacturing jobs within the metal, engineering, manufacturing and associated industries.

These qualifications are generally undertaken as 14 – 24 months traineeships.

However, review of completion numbers shows that the Certificate III in Process Manufacturing is much more popular than the other qualifications identified from the MEM Training Package. This is generally undertaken as a one year traineeship.

Table 3. below shows the total national number of completions in the qualifications deemed most relevant to battery component and cell manufacturing.

A peak industry body suggested that the low numbers of students in these qualifications may be because the qualifications do not lead to a trade outcome. Further research is required as to the feasibility of RTOs providing the qualifications identified in this study for this industry and the extent to which the qualifications lead to employment outcomes. A potential solution is to import the relevant units from those qualifications into other qualifications that provide a pathway to a trade or other related occupations.

Gaps in current training were identified for the more operational roles of Production Operator and Cell Assembly Technician. These skills and knowledge gaps relate to:

- specific skills in battery production such as controlled slurry mixing and electrode coating; and
- maintaining the dry and clean room production environments required for battery production which have been likened to pharmaceutical production settings[34].

Contextualisation of existing training units in working with computer controlled machinery may

TABLE 3. TOTAL VET ACTIVITY (TVA) PROGRAM COMPLETIONS 2015-2019 IN SELECTED MANUFACTURING QUALIFICATIONS.

QUALIFICATION	YEAR				
	2015	2016	2017	2018	2019 (Pre-Liminary)
Certificate II in Engineering - Production Technology (MEM20205)	79	85	35	12	22
Certificate III in Engineering - Production Systems (MEM30105)	34	9	41	10	6
Certificate III in Engineering - Electrical/Electronic Trade (MEM30405)	98	34	58	53	62
Certificate III in Process Manufacturing (MSM30116 & MSA30107)	1039	626	2291	2260	2940
Total	1256	756	2430	2337	3033

*Preliminary. Source: : NCVER VOCSTATS, extracted on 20 June 2021.

be suitable but would need to be confirmed by industry.

The skills gap may also be covered through customisation of existing units including units on working in controlled environments and maintaining hygiene in the FBP - Food, Beverage and Pharmaceutical Training Package. Pharmaceutical and food manufacturing have been identified as industries where workers have relevant skills . Pharmaceutical manufacturing workers make high volume products in ultra-clean environments using high purity chemicals as a starting point.

The emerging nature of this industry and the very small number of companies will mean that demand for this specialised training may be limited.

TRAINING AND SKILLS GAPS FOR BATTERY TEST TECHNICIANS

The formation and other cell finishing and packaging stages where battery cells are tested is a critical part of production.

The qualification MEM30405 - Certificate III in Engineering - Electrical/Electronic Trade prepares workers for employment as an Engineering Tradesperson - Electrical/Electronic within the metal, engineering, manufacturing and associated industries. Competencies achieved include the design, assembly, manufacture, installation, modification, testing, fault finding, commissioning, maintenance and service of all electrical and electronic devices systems, equipment and controls e.g. electrical wiring, motors, generators, PLCs, and other electronic controls, instruments, refrigeration, telecommunications, radio and television, communication and information processing.

Alternatively, the qualification UEE31220 - Certificate III in Instrumentation and Control prepares workers with competencies to select, install, set up, test, fault find, repair and maintain systems and devices for measurement and recording of physical/chemical phenomenon and related process control.

Both qualifications are undertaken as apprenticeships that could take up to four years.

Skills and knowledge gaps were identified that relate to battery cell chemistry and operating cell testing equipment and processes. These are specific skills and knowledge that are likely to require new training units developed in partnership with industry as it is established.

5.2 Summary

Companies that will enter into mass production of lithium-ion battery components and cells will require Production Workers and Production Technicians with skills and knowledge in advanced manufacturing.

Existing qualifications from the MEM Manufacturing and Engineering Training Package prepares workers with suitable skills.

However, additional training will be required that pertains to lithium-ion battery chemistry, operating equipment to carry out the sometimes delicate and precise processes required, and working in and maintaining the dry, clean room environments required.

The qualifications that are used to train workers for this industry should be reviewed to ensure they provide a trade outcome or lead to employment opportunities.

Similar industries where there are relevant skills are the pharmaceutical manufacturing and processed food industries. These could be areas where workers are initially sourced and training adapted for the battery cell manufacturing industry.

Maintenance trades and workers are also critical for maintaining the process control equipment and ensuring the automated processes are working as they should. Further detail is required regarding the skills needed for maintaining the machinery and equipment involved in lithium-ion battery component and cell manufacturing.

6. BATTERY ENERGY STORAGE SYSTEM MANUFACTURING

Battery energy storage systems (BESS) are increasingly being used to store and manage energy generated from renewable sources. BESS can be utilised at residential levels, through to commercial, industrial and utility scales and can be either stand-alone power systems (SPS) or grid-connected.

BESS are currently manufactured in Australia through the assembly of battery cells, which are currently mainly imported, into modules and then battery packs. The cells within the modules are connected electrically through the attachment of a Battery Management System (BMS) which regulates and monitors factors such as charging, discharging, capacity, current and temperature. Battery box and equipment rack containers are produced in Australia and assembled along with the BMS to meet end user requirements. All battery packs and systems require testing and quality control requirements.

While battery cells used in BESS are currently mainly imported, there is an emerging BESS assembly industry in Australia, however, the actual size of the Australian BESS assembly industry is hard to pinpoint.

6.1 Roles, current training, training or skills gaps and potential solutions

Table 4 summarises the findings from literature review, participant interviews, job advertisement reviews and curriculum mapping of the key vocational skills required for BESS manufacturing in Australia.

KEY ROLES AND RESPONSIBILITIES

Assembly Team Lead Responsibilities:
- Monitor and maintain production schedules and operations to find efficiencies and ensure product quality and safety.
- Assist in training, development, and monitoring of team and operations for safety, product quality, regulatory requirements and production efficiencies.

Electrical Assembler / Electromechanical Assembler Responsibilities:
- Precise and accurate assembly of all standard products for manufacturing as per design.
- Assemble electrical or electronic systems, support structures and install components, units, sub-assemblies, wiring, or assembly casings, using common hand tools and power tools.
- Reading and following electrical drawings, schematic drawings, diagrams, blueprints, specifications, work orders or reports.
- Neat and accurate wiring of equipment
- Upkeep of tools and ensuring compliance with standards.
- Ensure quality assurance standards are adhered to.
- Knowledge of controlling the robotics and automation for manufacturing.

Trade Technician Responsibilities:
- Assist with the assembly and production of our mechanical assemblies.
- Perform mechanical assembly, potting and soldering applications.
- Assemble products in accordance with technical drawings, specifications, documents and/or blueprints.
- Process electrodes (clean tabs, sort for defects, assemble cells, activation, etc.).
- Conduct testing using specialised equipment such as electronic volt meters, helium leak test equipment and/or digital X-ray systems.
- Operate specialised equipment such as winders, wrappers, filling systems, X-ray, stackers, welders, winders, activation systems, mixing, coating, calendaring, slitting and blanking equipment, surface grinders.
- Perform electronics soldering, spot welding, crimping, laser beam welding, electro-static discharge, brazing.

Electrician Responsibilities:
- Assist in design and troubleshooting BESS products
- Assemble, install, test and commission BESS products.
- Diagnose, maintain and repair electrical networks, systems, circuits, equipment, components, appliances for industrial, commercial and domestic purposes.
- Conducts tests of electrical systems.
- Prepares charts and tabulation

Battery Test Technician Responsibilities:
- Execution of testing following detailed test procedures, use electrical and mechanical lab measurement equipment, preparing and documenting test results.
- Troubleshooting equipment and sample issues, maintaining and solving test equipment problems as needed.

Customer Service Worker Responsibilities
- Employed by BESS manufacturers to provide post-installation customer service support to users.
- More technical support for Installers
- Monitoring of BESS
- Trouble-shooting

TABLE 4: VOCATIONAL SKILLS ANALYSIS FOR BATTERY ENERGY STORAGE SYSTEM (BESS) MANUFACTURING

EXISTING TRAINING	TRAINING OR SKILLS GAPS	POTENTIAL SOLUTIONS
MEM30119 - Certificate III in Engineering - Production Systems	• No gaps however currently low training completions in this qualification.	• Investigate other suitable qualifications and import units from MEM30119 as required. • Investigate suitability of Industry 4.0 higher apprenticeship in the Diploma in Applied Technologies.
MEM20219 - Certificate II in Engineering - Production Technology	• Knowledge of robotic control and manufacturing automation. • • Low training completions.	• Import the units VU22310 - Work in Industry 4.0, VU22318 Work Safely With Collaborative Robots, or UEEAS0007 - Assemble, mount and connect control gear and switchgear. • • Investigate the suitability of other courses with higher enrolments and importing relevant units from MEM20219.
MEM30405 - Certificate III in Engineering - Electrical/Electronic Trade; or UEE30920: Certificate III in Electronics and Communications	• Low training completions in MEM30405. • • Some gaps for UEE30920 relating to soldering and other hand tool skills.	• Import relevant units from other courses into the UEE30920 Certificate III in Electronics and Communications course.
4 year Electrical apprenticeship UEE30820 Certificate III in Electrotechnology	• Knowledge of robotic control and manufacturing automation. • Knowledge of Industrial Internet of Things (IIOT) • Some programming skills for battery management systems. • Project management skills	• Import the units VU22310 - Work in Industry 4.0 or VU22318 Work Safely With Collaborative Robots from the VIC22460 Diploma of Applied Technology
4 year Electrical apprenticeship UEE30820 Certificate III in Electrotechnology.	• Use various types of measurement equipment to test batteries and cells.	• Import the post-trade unit: UEERE4001 - Install, maintain and fault find battery storage systems for grid-connected photovoltaic systems (if course "packaging" rules allow).
Internal manufacturers' training	• Fundamental understanding of BESS operation • Different levels of customer service will require different levels of technical expertise	• Existing national training units and skills sets in customer service are available but further research required as to the extent of technical training needed.

TRAINING AND SKILLS GAPS FOR BESS MANUFACTURING

The assembly of battery cells into modules, packs and then energy storage systems will require Electromechanical Assemblers and Electronics Technicians to carry out manufacturing tasks.

Currently there is vocational education and training to prepare engineering production workers, electrical and electronic assemblers for the BESS manufacturing industry.

BESS manufacturing companies often employ university qualified Electrical Engineers and ICT professionals for the design of customised BESS including battery management systems.

Electricians play a key role in the BESS manufacturing industry and skills shortages for Electricians will impact the industry. Some employers reported no difficulty attracting Electricians however others reported losing staff to the mining industry where there were higher wages.

Employers stated that vocational workers' knowledge of electricity and electrical systems and prior experience assisted with accurate assembly. They emphasised the current need for manual skills in delicately and accurately assembling electrical and electronic parts, including specialist soldering skills and following instructions accurately. They also stated that some robotics are used currently and that this trend will continue as the industry develops.

Electronic Equipment Trades Workers typically maintain, adjust and repair computers, photocopiers, fax machines, cash registers and other electronic commercial and office machines. The qualifications are undertaken as apprenticeships that generally take four years to complete.

The qualifications from the MEM Manufacturing and Engineering Training Package that provide most of the skills required for BESS assembly currently have low numbers of students completing them (see Table 3 previously). A peak industry body suggested that the low completions in the qualifications may be because the qualifications do not lead to a trade outcome. Further research is required as to the feasibility of RTOs providing the qualifications identified in this study for this industry and the extent to which they lead to employment outcomes. A potential solution is to import the relevant units from those qualifications into other qualifications that provide a pathway to a trade or other related occupations.

The re-skilling of workers from other advanced manufacturing industries has also been found to provide the vocational workforce needed. This was the case in 2018 for workers with automotive manufacturing skills being re-employed at the South Australian Sonnen factory manufacturing BESS[37].

Interviewees reported that knowledge of lean manufacturing and the ability of production workers to work flexibly across several roles and tasks was also important. The BESS manufacturing companies interviewed were relatively small

or start-up enterprises and as such workers who had dual skills sets or were willing to learn and be trained were highly sought.

A skills gap was identified in the vocational qualifications reviewed in regards to knowledge of robotic control and automation for manufacturing. Working with automation and robotics will be required as BESS manufacturing scale increases to incorporate these technologies. A unit in working with robotics from the VIC22460 Diploma of Applied Technology may be suitable.

BESS manufacturers also provide post-installation support to customers. Services include monitoring BESS performance and answering / trouble-shooting customer service queries re BESS operation. These are technically focused customer service roles. Further research and industry consultation is required regarding skills needs and training solutions.

6.2 Summary

The vocational workforce for BESS manufacturing in Australia would be supported by:

- continued strategies to support the supply of Electricians to the industry;
- further research and consultation with industry and RTOs as to the feasibility of the manufacturing and engineering qualifications identified in this study and the most appropriate qualifications that would also ensure a trade or employment outcomes;
- inclusion of training in working with automation and robotics as the industry scales up; and
- further research regarding the skills and training needs for customer service staff working in BESS.

7. BESS INSTALLATION, OPERATION AND MAINTENANCE

Battery energy storage systems (BESS) can be small scale / behind the meter, community / industrial scale, or large scale.

The Australian Energy Market Operator's Integrated System Plan 2020 forecasted increasing growth in batteries as sources of dispatchable storage over the next 20 years, with behind the meter batteries playing a larger role than large scale batteries.

The CSIRO has predicted that there will be accelerated BESS adoption over the next decade when price falls are steepest. The predicted average proportion of residential solar installations that will also have BESS by 2030 across States and Territories ranges from 15% for a slow change scenario to 60% for a step change scenario[38].

It is estimated that in 2019 the number of workers in in the manufacture, supply, installation and operation and maintenance of battery energy storage systems was 1,700 and that the majority of workers were in small scale, distributed batteries installations[39].

7.1 Roles, current training, training or skills gaps and potential solutions

Table 5 summarises the findings from the review of literature, participant interviews, review of job advertisements and curriculum mapping of the vocational skills required for the deployment of battery energy storage systems in Australia.

KEY ROLES AND RESPONSIBILITIES	EXISTING TRAINING
Installers • Consumer education • Design and install BESS • Some operation and maintenance of BESS Note: Only Licensed Electricians can install BESS.	• 4 year Electrical apprenticeship (the most popular is the Certificate III in Electrotechnology) • UEE Electrotechnology Training Package units in design, install, maintain and fault find Stand alone Power Systems and Battery Storage for Grid Connected Photovoltaic Systems. (required for Clean Energy Council accreditation[40]). Units in installation require Unrestricted Electrical License, units in design do not. • BESS manufacturers' training (sometimes compulsory)
Electricity generation and supply workers • Linesworkers • Cable Jointers Electrician Responsibilities: • Integrate, repair and maintain BESS as part of the electricity supply network Electrical Engineering Technician Responsibilities: • Assist Electrical Engineers	Apprenticeships or Traineeships that range from 2 to 4 years duration. UET Transmission, Distribution and Rail Sector Training Package: • Certificate III in ESI – Power System Distribution / Transmission Overhead • Certificate III in ESI – Power Systems - Distribution Cable Jointing • 4 year Electrical apprenticeship - Certificate III in Electrotechnology.
First Responders Firefighters and Emergency Workers Responsibilities: • Attend to BESS emergency incidents • Extinguish fires • Rescue any injured people • Secure the site.	• Firefighters, once they have passed recruitment processes, are trained by State and Territory fire and emergency services' own training academies. • VET qualifications for Firefighters are available from the PUA12 Public Safety Training Package. • Australian Fire and Emergency Service Authorities Council (AFAC) 2020 guidelines for emergency responses involving photovoltaic arrays and battery energy storage systems.
Property Services sector • Building Designers, Local Government Planning and Building Compliance, Real Estate Agents, Property Managers, Facility Officers and Managers	• The CPP and CPP07 Property Services Training Packages provide qualifications for many occupations in the sector. • UEE Electrotechnology Training Package units in designing Stand alone Power Systems and Battery Storage for Grid Connected Photovoltaic Systems are available but have pre-requisite units in photovoltaic systems design.

TABLE 5: VOCATIONAL SKILLS ANALYSIS FOR BATTERY ENERGY STORAGE SYSTEM DEPLOYMENT

TRAINING OR SKILLS GAPS	POTENTIAL SOLUTIONS
New BESS technology and standards • BESS industry developments and technology advances. • Increasing range of BESS available, each with operational differences. • Implementing new industry standard AS/NZS 5139:2019 Electrical installations - Safety of battery systems for use with power conversion equipment.	• National Electrotechnology Industry Reference Committee 2021 review of renewable energy qualifications to include BESS units and address gaps where industry has advanced. • Ongoing BESS manufacturers' training.
ICT skills • ICT skills for fault finding and trouble shooting when BESS does not function as expected. • Installations requiring connected loads and micro-grids will require more advanced information and communications technology skills and digital skills for the battery management systems involved.	
Low rates of training in post-trade national UEE Training Package BESS skill sets	• Consult with industry as to whether additional strategies are needed to increase training uptake.
• SPS repair and maintenance • Remote access to systems to identify, diagnose and resolve faults and alarms. • Data communications, data analysis and data monitoring skills. • A system thinking mindset • Increased telecommunication and associated protocols • Network integration • Testing and commission • Isolation of multiple electricity feeds • Increased working knowledge of direct current (DC) • Remote monitoring and control of distributed energy resources to optimise electricity supply • Systems approach to working that recognises how assets are interconnected and can impact each other.	• Develop new accredited training to upskill electricity supply occupations – require further industry consultation.
• Training for other occupations that may be required to attend BESS emergency incidences e.g. Emergency workers on mine sites.	• Further research required regarding the skills needs and training solutions for other occupations required to attend BESS emergency incidences.
• Further research required. Possible gaps: Skills and knowledge in BESS basics, BESS types and availability, modifications, managing safety risks, BESS operation and maintenance requirements, benefits and opportunities presented by BESS, regulations and standards for BESS.	• Require assessment of suitability of existing training units to be contextualised or new training content needed.

TRAINING AND SKILLS GAPS FOR INSTALLERS / ELECTRICIANS

Installers of BESS must hold an Unrestricted Electrical Licence. Typically installers of BESS are primarily installers of solar photovoltaic energy systems.

There currently exists post-trade national Training Package units for Electricians in the installation, maintenance and repair of battery energy storage systems that are either grid-connected or part of stand alone power systems.

Completion of this training is required for battery storage accreditation by the Clean Energy Council (CEC).

Interviewees identified areas where the current national training units could be further developed. These included:

- advances in BESS technology;
- implementation of the standards for BESS installation; and
- increased ICT skills for more complex installations such as for multi-unit dwellings or where there is integration with other distributed energy resources.

To deal with the advances in technology, BESS manufacturers offer further training for installers in their products and will often establish a network of preferred installers. Some manufacturers also have partnered with Registered Training Organisations (RTOs) to deliver training using their products[41, 42].

A new standard was recently developed and implemented for BESS installation: AS/NZS 5139:2019, Electrical installations – Safety of battery systems for use with power conversion equipment. Some interviewees suggested that further training in this standard is required.

In terms of ICT skills, BESS were generally described as being straightforward for connecting to the internet router. However, installations in multi-unit dwellings that involve connected loads, and connection of some BESS and PV communications, were cited as examples where Electricians required further ICT training.

Interviewees reported that BESS manufacturers are involved in maintaining their batteries (such as maintenance and software upgrades) rather than installers.

Interviewees reported that demand for post-trade BESS training was currently low because the price of residential BESS was still high. It was commented that in regional areas it can be difficult to find a qualified installer.

In addition, States and Territories differ as to whether they provide financial incentives for residential BESS and whether they require installers to have CEC battery storage accreditation to be part of the financial support programs, although almost all do.

The number of enrolments in post-trade training in battery energy storage units is shown in Figure 4.

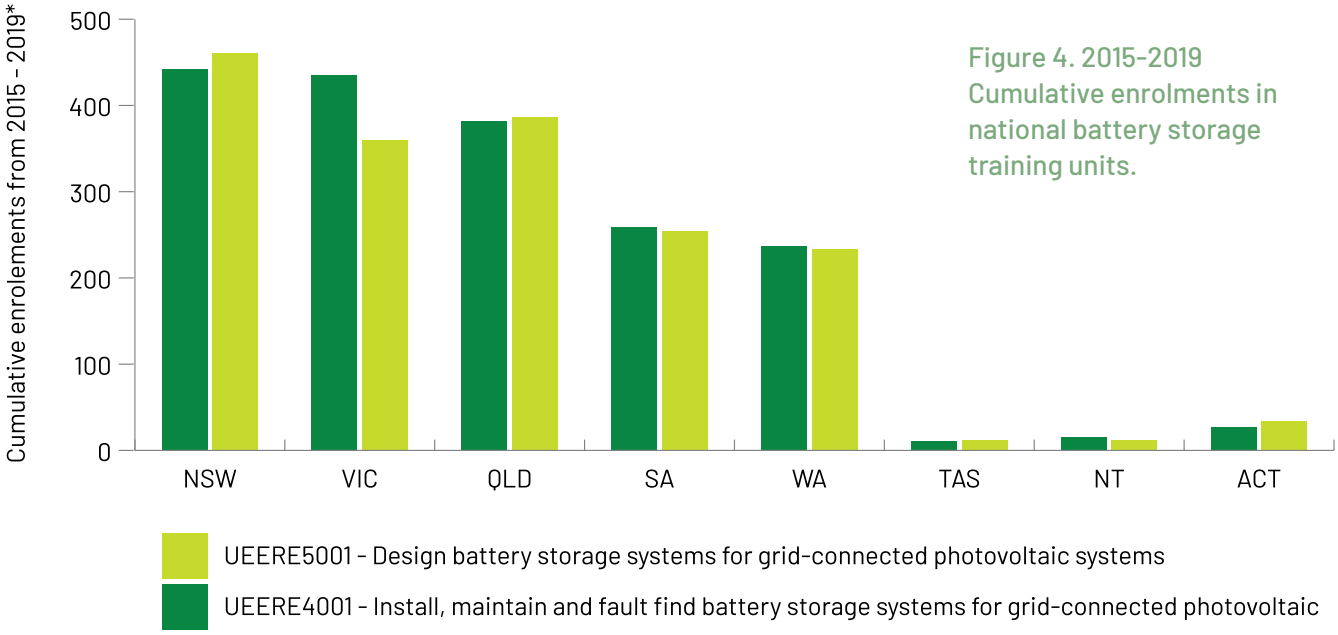


Figure 4. 2015-2019 Cumulative enrolments in national battery storage training units.

*Preliminary for 2019 data.
Source: : NCVER VOCSTATS, extracted on 20 June 2021.

The total number of Electricians who have enrolled in post-trade national training units in the installation of BESS for grid-connected photovoltaic systems over the period 2015 – 2019 is low compared to the number of current unrestricted Electrical Licenses which is in the thousands and tens of thousands for larger States.

The low number of enrolments is unlikely to increase unless there is increased demand for residential BESS by consumers. Increased demand can be supported by government subsidy programs as has been the case in States and Territories that have introduced the programs. These programs also support installers training where it is made a condition of the program.

In addition, there is a shortage of Electricians skilled in installation and maintenance of solar systems[43].

The areas identified here for further training development may be addressed as part of the Electrotechnology Industry Reference Committee planned 2021 review of the renewables qualifications in the UEE Electrotechnology Training Package.

TRAINING AND SKILLS GAPS FOR ELECTRICITY GENERATION AND ELECTRICITY SUPPLY INDUSTRY WORKERS

There is a fundamental transition occurring as Australia's electricity supply networks incorporate increasing levels of renewable energy generation, small and large scale storage and digitised power system services.

Research conducted by Energy Skills Queensland[44] identified the key vocational occupations that will be affected by a changing energy network:

- Engineering Technical Officers
- Electricians
- Electrical Linesworker.

In general, this research identified the following new skills and knowledge as being required by vocational workers in energy supply:

- a systems approach to working and problem solving that recognises the interconnection between energy resources and systems;
- digital literacy for fault-finding and analysis using data networks and telecommunications products and services;
- capability to integrate emerging technologies into existing consumer networks; and
- skills to work with emerging technologies safely e.g. increased working knowledge of direct current.

New skill requirements have also been identified by the Electrotechnology Industry Reference Committee and ESI – Transmission, Distribution and Rail Industry Reference Committees. They identified that:

- digital literacy is essential for the vocational workforce;
- industry-specific cyber-security is required; and
- a systems approach to operations that utilises the interconnected, data-rich environment.

In 2021, the ESI Transmission, Distribution and Rail, and the ESI Generation Industry Reference Committees will develop new training in isolating multiple feeds prior to working.

This study was not able to interview a wide sample of electrical generation and supply companies. The few electrical generation and supply companies that were interviewed reported training to upskill workers in the operation and maintenance of stand alone power supply systems was a priority. This training has commenced development with a local RTO[45]. Further industry consultation is required to confirm skills gaps identified in earlier research and to develop any new accredited training.

TRAINING AND SKILLS GAPS FOR FIRST RESPONDERS AND OTHER RELEVANT OCCUPATIONS

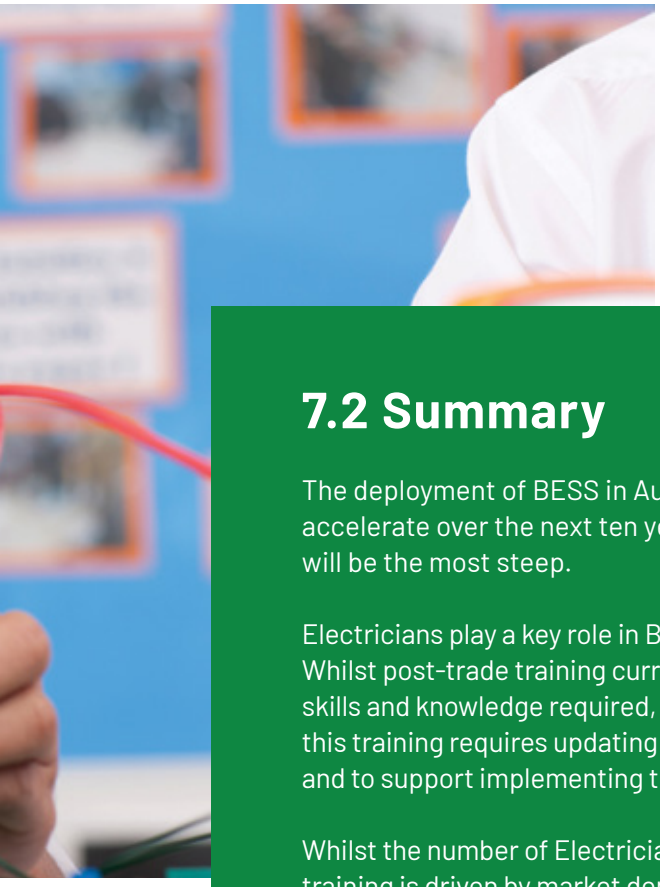
The Australasian Fire and Emergency Service Authorities Council (AFAC) have developed guidelines for the management of incidents involving BESS for fire fighters.

Further consultation with industry groups representing other occupations required to attend BESS emergency incidences is needed to identify the skills and training needs of those occupations. For example, emergency workers on mine sites and Facilities Managers.

TRAINING AND SKILLS GAPS FOR THE PROPERTY SERVICES INDUSTRY VOCATIONAL WORKERS

As BESS are increasingly incorporated into new and existing homes and buildings, vocational workers involved in pre-building design and compliance assessment and post-building sales and management services will require knowledge of BESS design, operation and maintenance, safety risk management and emergency procedures and the opportunities they present for energy management.

Further research is required into the suitability of existing training from either the CPP Property Services Training Package or other Training Package to meet the needs of the property services sector.



7.2 Summary

The deployment of BESS in Australia is expected to accelerate over the next ten years when price falls will be the most steep.

Electricians play a key role in BESS installation. Whilst post-trade training currently provides the skills and knowledge required, there are areas there this training requires updating to current technology and to support implementing the new standard.

Whilst the number of Electricians undertaking this training is driven by market demand, governments and peak industry groups can plan for training capacity and capability in regional and remote areas or where government investment in BESS will be introduced or expanded.

As more BESS are installed in homes and other larger scale settings, distribution network service providers or electrical utility companies will need to integrate them into the electricity supply network. Vocational workers are required to have new skills that include adopting a systems approach to working and greater digital literacy. Specific skills such as SPS operation and maintenance and the safe isolation of multiple feeds is of immediate concern for some in the industry.

The increased deployment of BESS necessitates the preparation of First Responders for emergency incidents involving BESS. Further industry consultation is required on training required by other vocational occupations to attend BESS emergency incidences.

The installation of BESS into existing and new homes and buildings will require workers in the property services industry to have skills and knowledge in designing, assessing compliance, managing and maintaining BESS. This study did not analyse this industry and further research is required to confirm skills and training needs.

8. ELECTRIC VEHICLE SERVICING AND ELECTRIC VEHICLE SUPPLY EQUIPMENT MANUFACTURING AND INSTALLATION

Globally, car manufacturers continue to increase electric vehicle (EV) production[46] with EVs expected to comprise 54% of the global passenger car fleet and 73% of all vehicle sales by 2050[47].

In Australia, it is expected that EVs will comprise 26 per cent of new vehicle sales in by 2030[48]. However, the transition from internal combustion engine vehicles to EVs will occur over a long period as full transport electrification is not expected in Australia until 2050. Automotive peak industry groups have identified EVs as posing the biggest challenge to Australia's automotive industry[49].

Car manufacturers view Australia's electric vehicle charging infrastructure as being robust. Several State Governments, the Commonwealth Government and private sector investment have contributed to the growth of public charging stations. Australian companies have also had significant success in manufacturing EV charging stations for local and international markets[50].

KEY ROLES AND RESPONSIBILITIES	EXISTING TRAINING

EV Servicing
 	
EV Service Technician – Light vehicles
• Knowledge of methods, techniques, parts, tools and materials used in the maintenance and repair of EV drive system, electrical, steering, suspension, braking, HVAC.
• Testing and repair of electronic systems and modules
• Manage electrocution & fire risk and work safely with high voltage EV batteries.
• ICT and networking skills for working with the software upgrades.
• Knowledge and experience using diagnostic scan tools, following diagnostics and operating scopes
Automotive Electrician Responsibilities:
• Install, maintain and repair electrical wiring and electronic components in electric vehicles.
• Work with on-board and external computer diagnostic tools.
• Manage electrocution & fire risk and work safely with high voltage EV batteries.
• Operation and maintenance of Battery Management Systems.
	• 3 - 4 year apprenticeship in AUR30620 Certificate III Light Vehicle Mechanical Technology (this is the most popular qualification for becoming a mechanic[51])
	• National training skills sets:
	  • AURSS00034 – Battery Electric Vehicle Diagnosis and Repair Skill Set.
	  • AURSS00035 - Battery Electric Vehicle Inspection and Servicing Skill Set
	  • AURSS00037 - Hybrid Electric Vehicle Inspection and Servicing Skill Set
	• 3 year apprenticeship in AUR30620 Certificate III in Automotive Electrical Technology
	• States and Territories also have regulations for car mechanics to be registered.

EV Service Technicians – Heavy Vehicles • Perform maintenance and repair activities on EV heavy vehicles • Diagnose, service and repair various systems: brakes, cooling system, drivetrain components, electrical motors, wiring and modules, high voltage batteries, HVAC, steering and suspension system, software diagnosis and uploading. • Manage electrocution & fire risk and work safely with high voltage EV batteries.	• 3 year apprenticeship in AUR31120 Certificate III in Heavy Commercial Vehicle Mechanical Technology or AUR31220 Certificate III in Mobile Plant Technology.

8.1 Roles, current training, training or skills gaps and potential solutions

Table 6 summarises the findings from the review of literature, participant interviews, job advertisement reviews and curriculum mapping of the vocational skills required to service EVs and manufacture and install EV charging infrastructure.

TRAINING OR SKILLS GAPS	POTENTIAL SOLUTIONS
• Despite national training skills sets and units in servicing EVs and EV systems being available, interviewees reported not experiencing demand for EV service technician training to date. • Differences between different EVs in terms of hardware and software. • Interviewees reported that EV manufacturers currently require Service Technicians to undergo manufacturers' own additional training. • Current training requires skills and knowledge in internal combustion engines which is not required for EVs.	• In 2021 the Automotive Industry Reference Committees (IRCs), through their supporting Skills Service Organisation PWC Skills for Australia will develop a new national qualification Certificate III in EV Service Technology that will have both a light vehicle and heavy vehicle stream. The new proposed qualification will combine training from mechanical and auto electrician courses. In working with industry the new qualification will bring training up to date with industry needs. • The Automotive IRCs will also update two existing skills sets in battery electric vehicles to upskill existing Automotive Mechanics and Auto Electricians in the diagnosis, service and repair of battery electric vehicles.
• Understanding of EV systems and technology • Service and repair of heavy vehicle EVs. • Experience and qualifications as an Auto Electrician considered an advantage.	

TABLE 6: VOCATIONAL SKILLS ANALYSIS FOR ELECTRIC VEHICLE SERVICING AND CHARGING EQUIPMENT MANUFACTURE AND INSTALLATION - PART 2

KEY ROLES AND RESPONSIBILITIES	EXISTING TRAINING
EV Service Technicians – Heavy Vehicles • Perform maintenance and repair activities on EV heavy vehicles • Diagnose, service and repair various systems: brakes, cooling system, drivetrain components, electrical motors, wiring and modules, high voltage batteries, HVAC, steering and suspension system, software diagnosis and uploading. • Manage electrocution & fire risk and work safely with high voltage EV batteries.	• 3 year apprenticeship in AUR31120 Certificate III in Heavy Commercial Vehicle Mechanical Technology or AUR31220 Certificate III in Mobile Plant Technology.
EV charging equipment manufacture Electromechanical Equipment Assembler Responsibilities: • A wide variety of mechanical and electrical tasks including complex mechanical assembly on different products using hand tools and light power tools. • Assemble, mount and wire products to specifications of assembly drawings - size and complexity of the product varying from a tabletop unit to a large console. Electronic Assembler Responsibilities: • Assemble, fasten and/or modify electronic components to precise specifications, including: include: soldering, snipping, hand assembly, crimping. • Perform production assembly operations on electronic or electro-mechanical components or sub-assemblies. • Assembly duties • Install accessory assemblies in electrical or electronic units, using soldering iron and hand tools.	• MEM20219 - Certificate II in Engineering - Production Technology
End of Line (EoL) Testing Technicians Responsibilities: • Conduct EoL testing / configuration / calibration activities on product and subassemblies • Conduct troubleshooting / diagnostic activities including repair of non-functioning / malfunctioning product. • Maintain and update EoL Test / issue reporting / documentation. • Root cause diagnostics & debugging of electrical systems	Possible qualifications: • 4 year Electrical apprenticeship (the most popular is the Certificate III in Electrotechnology); • MEM30405 - Certificate III in Engineering - Electrical/Electronic Trade; or • MEM31219 - Certificate III in Engineering - Industrial Electrician
EV charging equipment installation Electricians Responsibilities: • Install electric vehicle charging infrastructure in residential, commercial and public settings.	• 4 year Electrical apprenticeship - Certificate III in Electrotechnology). • Manufacturers' training
First responders: Firefighters Police, Emergency Medical Related occupations: • Tow truck drivers and vehicle storage facilities workers • Staff at specific events e.g. EV racing.	• Firefighters, once they have passed recruitment processes, are trained by State and Territory fire fighting organisations' own training academies. • VET qualifications for Firefighters are available from the PUA12 Public Safety Training Package. • Accidents and fires involving EVs can be approached using existing standard procedures and frameworks. • Electric car manufacturers have made safety information for first responders publicly available globally[62] and through the Australasian New Car Assessment Program (ANCAP) rescue app[63]. • Short course training for first responders in relation to EVs is available through some private RTOs.
Property Services sector • Building Designers, Local Government Planning and Building Compliance, Real Estate Agents, Property Managers, Facility Officers and Managers	• The CPP and CPP07 Property Services Training Packages provide qualifications for many occupations in the sector.

TRAINING OR SKILLS GAPS	POTENTIAL SOLUTIONS
• Understanding of EV systems and technology • Service and repair of heavy vehicle EVs. • Experience and qualifications as an Auto Electrician considered an advantage.	
• No skills or training gaps identified however, low number of students in this course. (The skills required for Electromechanical Equipment Assembler and Electronic Assembler were found to be all covered in the MEM20219 Certificate II in Engineering – Production Technology)	• Investigate the suitability of other courses with higher enrolments and importing relevant units from MEM20219.
• Conduct EoL testing / configuration / calibration activities on product & subassemblies. • Maintain & update EoL Test / issue reporting / documentation. • Electromagnetic compatibility testing competency.	• Suitable units exist within the UEE and other Training Packages that could be contextualised and imported to cover the skills gaps identified.
• Knowledge and experience in EV charger installation, charging cables, plug types, installation standards, EV data acquisition systems and software and sensors. • Differences in charging systems and standards. • Installations requiring connected loads require additional ICT skills for battery management systems.	• Current manufacturers' training and other short courses (unaccredited) are meeting training needs.
Attending to accidents involving EVs • Identifying EVs • Disable and de-energise vehicle • Remove passengers • Extinguish any fires • Transportation of damaged EVs • Safe storage of damaged EVs	• Australian National Council for Fire and Emergency Services will soon develop national guidelines for fire fighters in responding to EV accidents – similar to those developed for battery energy storage systems. • Energy Skills Queensland's development of First Responder training for the electric vehicles industry[54] – further investigation required as to availability across Australia.
• Further research required. Possible gaps: ensuring a building is 'EV ready' with sufficient cabling and distribution boards, load management system monitoring, retro-fitting buildings, emergency response.	• Assessment required of suitability of existing training units to be contextualised or new training content needed.

TRAINING AND SKILLS GAPS FOR EV SERVICE TECHNICIANS

Peak automotive industry bodies have described the challenges that electric vehicles pose to the evolution of the automotive service and repair industry[55]. These include reduced servicing required by EVs overall compared to current internal combustion engine cars which will pose a challenge for existing vehicle servicing businesses and car dealerships. business models.

It is recognised that Automotive Service Technicians / Mechanics will require new skills to repair and maintain electric vehicles. These are centred around the systems and technology used in EVs, working with high voltage batteries and DC electricity.

A peak industry group representative also raised the issue of the requirement for Service Technicians to be regulated for working on EVs because of the high voltage batteries involved. The purpose of regulation would be to ensure that the Service Technician / Mechanic was appropriately trained.

Existing skills sets and units in the AUR Automotive Retail, Service and Repair Training Package cover the skills required for EV servicing and repair and provide training to upskill Service Technicians / Mechanics in EVs. However, no EV manufacturers were interviewed in this study and it may be that there are additional skills required that are not currently covered by national training.

Interviewees reported that currently there is very little demand for EV service training because of the low numbers of EVs in Australia and also they are being serviced under warranty by EV manufacturers. Some RTOs have been incorporating units in depowering and re-initialising batteries in EVs and hybrid vehicles into automotive service training for several years now.

Employers have also reported experiencing skills shortages of Light Vehicle and Heavy Vehicle Mechanics generally. This is expected to grow to being a shortage of 23,900 Light Vehicle Mechanics and 3,000 Heavy Vehicle Mechanics by 2022/23[56].

In 2021 the national Automotive Strategic Industry Reference Committees will develop a new qualification as part of the AUR Training Package. The new qualification Certificate III in Automotive Electric Vehicle Technology will be developed in consultation with industry including EV manufacturers and will provide skills for EV servicing with specialisations in light or heavy vehicles[57]. Existing skills sets providing upskilling training in EVs will also be updated.

Implementing the new qualification will require partnerships between industry and training providers to upskill teaching staff, develop teaching and learning materials, and provide apprentices with access to appropriate employment placements, workshops and equipment. There are existing projects and partnerships to prepare training facilities for electric vehicles[58,59], and implement training[60].

The issue of whether regulation or licensing of Service Technicians is required for working on EVs must also be resolved by States and Territory Governments and industry bodies.

TRAINING AND SKILLS GAPS IN EV SUPPLY EQUIPMENT MANUFACTURING

Australian companies have excelled in electric vehicle supply equipment manufacturing.

The skills required for manufacturing electric vehicle supply equipment in Australia are covered in existing qualifications from the MEM Manufacturing and Engineering with the exception of "end of line testing" skills and knowledge. However, existing training units can be contextualised to address the gaps in current training courses.

In addition, the low number of students in the manufacturing qualifications reviewed in this study requires further investigation and consultation with industry to assess the feasibility of RTOs delivering these qualifications or whether there are other qualifications leading to stronger trade or employment opportunities.

TRAINING AND SKILLS GAPS FOR FIRST RESPONDERS AND OTHER RELEVANT OCCUPATIONS

Road accidents involving electric vehicles will be attended by First Responders such as Firefighters, Police and Medical Emergency workers. Other relevant occupations are Tow Truck Drivers and Storage Facility Workers and Events Workers at events involving EVs.

Whilst accidents involving EVs can be approached and handled by Firefighters within existing standard procedures, no accredited national Training Package training was found.

EV manufacturers have made safety information for first responders publicly available globally and through the Australasian New Car Assessment Program (ANCAP) rescue app.

The National Council for fire and emergency services in Australia and New Zealand (AFAC) intends to develop guidance for EV incidents.

A skills set of First Responders in electric vehicles is also currently being developed by Energy Skills Queensland[61].

TRAINING AND SKILLS GAPS FOR THE PROPERTY SERVICES INDUSTRY VOCATIONAL WORKERS

Most EV charging will occur in people's homes with workplace charging also important because cars are parked at these places for long periods[62].

Vocational workers involved in pre-building design and compliance assessment and post-build sale, management, maintenance and security will require knowledge and skills about EV supply equipment installed in new and existing homes, apartment buildings and workplaces. The skills and knowledge required are related to ensuring the electrical and space requirements for EVSE are met, and managing EVSE operations, risks and opportunities.

Further industry consultation is required to map out the skill and knowledge requirements and the most appropriate training solutions.

TRAINING AND SKILLS FOR VEHICLE TO GRID TECHNOLOGY

The training and skill requirements for vehicle to grid (V2G) technology were raised by a peak industry body. Some interviewees commented that the technology was still years off implementation. A significant trial is currently underway by Australian Renewable Energy Agency and other partners to demonstrate V2G technology and develop a path to commercialisation for stakeholders[63].

The skill and training requirements for V2G were not identified in this project, however some implications can be drawn from the skills required for EVs and EVSE.

V2G technology may have additional knowledge and skill requirements for vocational workers already impacted by EVs. That is, EV Service Technicians servicing EVs, Electricians installing EV supply equipment and managers of car fleets and facilities.

Electric vehicles with V2G technology can interact with the electricity grid network. This has implications for workers in the electricity generation and supply industries who must work with the vehicles as part of the grid and orchestrate the part played by V2G EVs.

EV owners will also require customer service support for the V2G system from both the EV manufacturer or dealer as well as the electricity distribution network service provider.

8.2 Summary

ELECTRIC VEHICLE SERVICE TECHNICIAN TRAINING

The national Automotive Industry Reference Committees will, in 2021, develop a new Certificate III in Automotive Electric Vehicle Technology and update existing skills sets used to upskill Automotive Mechanics in EVs. These would then be available for RTOs to register to deliver as they experience demand.

Government investment in EVs may stimulate demand for EV Servicing training and also support opportunities for RTOs to partner with manufacturers to begin implementing the training. Lecturers are likely to require professional development, learning and assessment materials must be prepared and access to EVs and relevant equipment obtained.

TRAINING FOR FIRST RESPONDERS IN ELECTRIC VEHICLES

Work with industry and other stakeholders to ensure First Responder training in electric vehicles is developed and made available across Australia including to all relevant occupations.

AREAS FOR FURTHER RESEARCH: TRAINING NEEDED FOR THE PROPERTY SERVICES INDUSTRIES AND VEHICLE TO GRID TECHNOLOGY

This study was not able to interview participants in the property services industry to a sufficient extent to analyse the skills and training needs. However, these industries play a critical role in pre-building and post-building activities to incorporate and manage EVSE and EVs. Further research is required to examine the skills and knowledge needed and the best training solutions.

Vehicle to grid technology was also not examined to a significant degree in this study. Further investigation is required as to what additional skills and knowledge will be required in which occupations and the best training solutions.

9. LITHIUM-ION BATTERY RECYCLING

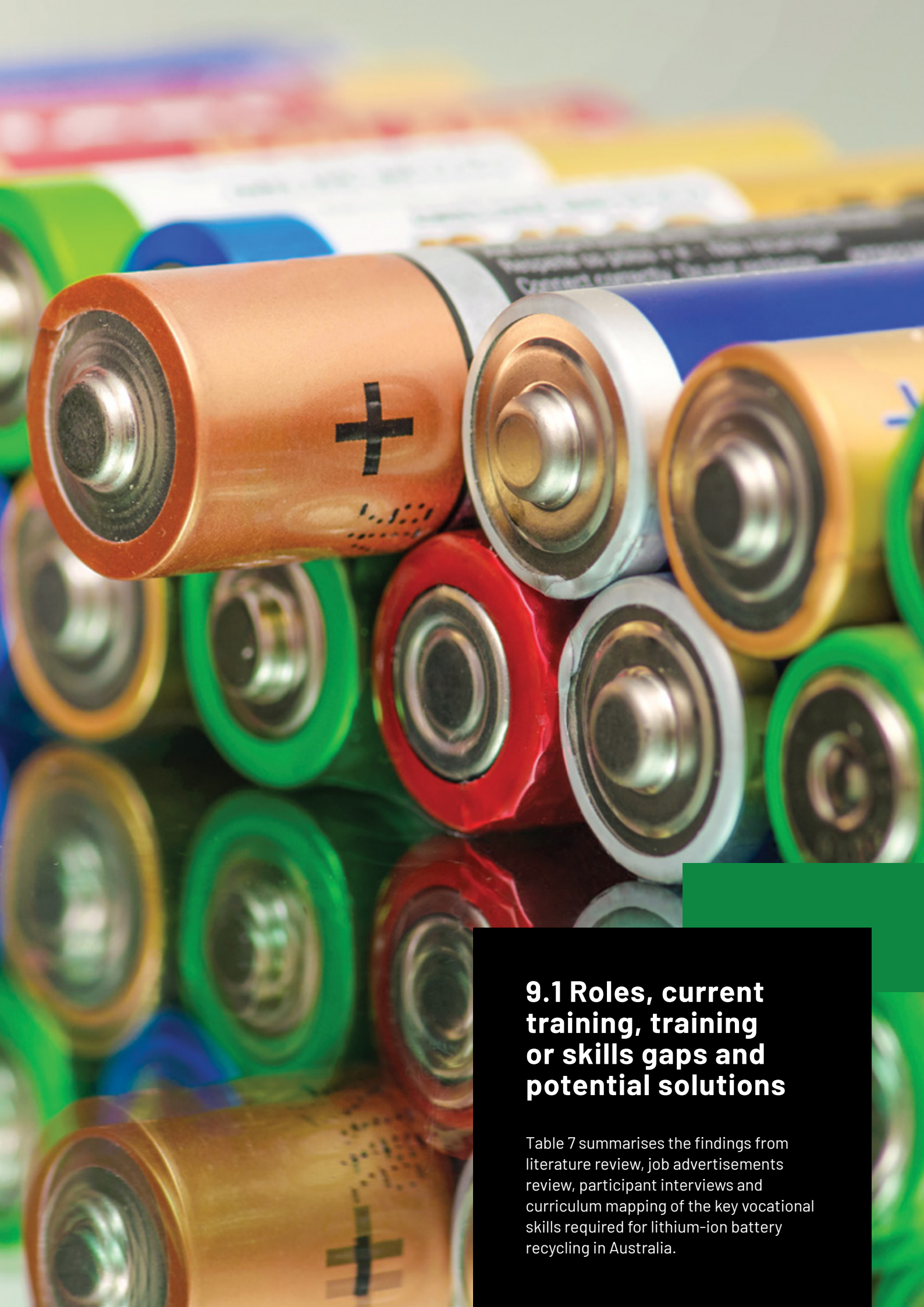
Currently, Australia has a very low rate of recycling batteries other than lead-acid batteries. Lead-acid batteries currently comprise approximately 90% of end of life batteries by weight, however, it is predicted that end of life lithium-ion batteries from electric vehicles and battery energy storage systems will "grow sharply" over the next decade and from 2040 will exceed lead-acid batteries[64].

There are well-established processes for the collection of lead-acid batteries in Australia and the local reprocessing industry is well developed. However, lead acid battery recycling technology is not transferable to lithium-ion batteries due to the differences in materials[65].

A small number of lithium-ion battery recycling facilities are currently operating in Australia. These companies collect, discharge and disassemble lithium-ion batteries with some also crushing and granulating materials into a "black mass" prior to exporting overseas for further reprocessing.

The lithium-ion battery re-use and refurbishment industry is currently at a very fledgling stage[66].

Battery recycling is a priority for all levels of government in Australia with the National Waste Policy Action Plan 2019 identifying batteries as a priority for product stewardship[67]. The Battery Stewardship Council have since developed a national, voluntary Battery Stewardship Scheme with industry and other stakeholders due to begin operating in early 2022[68]. Under the Scheme, a levy will be applied to imported batteries that is visibly passed onto consumers. The levy will be used to fund a rebate system for service providers accredited for battery collection, sorting and processing[69]. The Scheme will begin with loose and handheld batteries and those not sealed inside a product before further consultation to also include electric vehicle batteries and batteries from energy storage systems into the Scheme.



9.1 Roles, current training, training or skills gaps and potential solutions

Table 7 summarises the findings from literature review, job advertisements review, participant interviews and curriculum mapping of the key vocational skills required for lithium-ion battery recycling in Australia.

TABLE 7: VOCATIONAL SKILLS ANALYSIS FOR LITHIUM-ION BATTERY RECYCLING STORAGE, TRANSPORT AND OPERATIONS

KEY ROLES AND RESPONSIBILITIES	EXISTING TRAINING
Warehouse Operations Supervisor Responsibilities: • Supervise recycling and other post-collection activities. • Manage warehouse inventory control, daily operations of the warehouse, employee schedules, and recruit new staff. • Oversee a manual electronics disassembly process. • Manage stream of commodities that come from disassembly process including plastic, steel, aluminium, copper, and circuit boards. • Manage inventory of electronic equipment, scraps, and components in warehouse. • Manage employees and ensure productivity.	• TLI40619 - Certificate IV in Warehousing Operations; or • CPP40919 - Certificate IV in Waste Management
Warehouse Material Scheduler / Recycling Collector (Waste Removalist) Responsibilities: • Plan and organise the schedules for recycling collection. • Manage the transportation of vehicles between different locations. • Support freight inspection and payment process. • Proficient in transportation management system computer programs. • Drive collection vehicles such as trucks, which may be fitted with hydraulic lifting equipment and automated compacting equipment. • First Responder training. • Safe handling of bulky materials • Understand PPE requirements.	• TLI30419 - Certificate III in Waste Driving Operations; or • CPP30719 - Certificate III in Waste Management
HazMat and Dangerous Goods Analyst Responsibilities: • Implement transportation compliance with dangerous goods regulations. • Develop best-in-class processes to ensure handling of dangerous goods compliantly through the warehouses and partner carriers. • Knowledge of relevant Code of Practices for Storage and Handling of Dangerous Goods, Dangerous Goods Safety, and Australian Dangerous Goods Code.	• TLI40619 - Certificate IV in Warehousing Operations; or • CPP40919 - Certificate IV in Waste Management
Material Handler / Sorter Responsibilities: • Organise and prepare recycled materials for transport. • Move various materials and containers throughout the facility. • May be assigned to a driving role, sorting role or combination thereof. • Apply safety rules and wear appropriate PPE.	• TLI30419 - Certificate III in Waste Driving Operations; or • CPP30719 - Certificate III in Waste Management
Recycling Operator Responsibilities: • Unloading, disposal, and recycling of electronic waste and battery materials. • Recycling centre operations; handling recyclable commodities for sorting and processing. • Light equipment operation and maintenance.	• CPP30719 - Certificate III in Waste Management
Material Analyst Responsibilities: • Sample preparation including sorting, weighing, drying, crushing, splitting and pulverising. • Sample analysis and maintenance of laboratory equipment. • Conduct analyses in accordance with specified standards and procedures. Knowledge and understanding of: • pyrometallurgical and/or hydrometallurgical processes involving production of battery black mass.	• MSL30118 Certificate III in Laboratory Skills; or • PMA30120 Certificate III Plant Operations

TRAINING OR SKILLS GAPS	POTENTIAL SOLUTIONS
• Oversee a manual electronics disassembly process. • Safe removal, handling and storage of batteries. • Knowledge of circuit boards, processors, chips, and electronic equipment. • First Responder training.	• Contextualise training units: CPPWMT3001- Identify and segregate waste; CPPWMT3002- Conduct waste resource recovery • Import units from the Engineering or Electrotechnology TPs for knowledge of circuit boards, processors, chips and electronic equipment. • First responder training partly covered in unit CPPWMT3003 - Identify and respond to hazards and emergencies in waste management. However contextualisation for lithium-ion batteries is recommended.
• First Responder training.	• First responder training partly covered in unit CPPWMT3003 - Identify and respond to hazards and emergencies in waste management. However contextualisation for lithium-ion batteries is recommended.
• No skills or training gaps identified.	
• Safe removal, handling and storage of batteries. • Dismantling products and taking the battery out. • Sorting batteries by chemistry types. • Basic understanding of battery composition and components. • Basic understanding of hazards and working with medium/high voltage and partly charged components.	Contextualise training units: • CPPWMT3001- Identify and segregate waste • CPPWMT3002- Conduct waste resource recovery • CPPWMT3003- Identify and respond to hazards and emergencies in waste management • CPPWMT3004- Comply with environmental protection requirements when transporting waste • CPPWMT3011- Conduct waste assessments
• Unloading, disposal, and recycling of electronic waste and battery materials. • Safe removal, handling and storage of batteries. • Dismantling products and taking the battery out. • Sorting batteries by chemistry types. • Basic understanding of battery composition and components. • Basic understanding of hazards and working with medium/high voltage and partly charged components. • Operation of mechanical shredding units and mechanical separation equipment. • Knowledge of hazards involving battery shredding and crushing operations.	• See above for units to contextualise. • Also – contextualise training unit CPPWMT3007- Process waste using plant
• Operation of mechanical shredding units and mechanical separation equipment. • Knowledge of hazards involving battery crushing and centrifuge processing operations. • Knowledge of battery materials including anodes, cathodes, electrolytes and other active chemicals and their properties.	• Import and contextualise training unit CPPWMT3007- Process waste using plant • Develop new training unit to address knowledge of battery materials requirement.


Li-ion Battery
3.82V ⎓ 6.55Whr
APN: 616-00033
WARNING
Authorized Service
Provider Only
Potential for fire or
burning. Do not
disassemble, puncture,
crush, heat, or burn
YU3045
2S132Y
U3
MFG01/2013
CE
1440mAh
Apple Japan
Li-ion
Li-ion Polymer Battery
3.82V ⎓ 6.91Whr
APN: 616-0808
WARNING
Authorized Service
Provider Only
Potential for fire or
burning. Do not
disassemble, puncture,
crush, heat, or burn.
Li-ion
WARNING
Authorized Service
Provider Only
RE4421

TRAINING AND SKILLS GAPS IN LITHIUM-ION BATTERY RECYCLING STORAGE, TRANSPORT AND OPERATIONS

Training qualifications are available from the CPP Property Services Training Package that prepares workers for Operator and Supervisor roles in waste collection and transfer, waste treatment, disposal, remediation and resource recovery. Workers are prepared for a range of government and private sectors involved in local government, solid, commercial, industrial, construction and demolition waste management.

Training qualifications are available from the TLI Transport and Logistics Training Package that prepares workers for waste driving job roles within the transport and logistics industry.

Gaps were found in existing training to cover skills and knowledge specific to lithium-ion battery recycling processes. These pertain to lithium-ion batteries and their:

- basic chemistry and components;
- safe removal, handling and storage;
- disassembly;
- shredding and mechanical separation; and
- processing through hydrometallurgical and pyrometallurgical processes.

However, contextualisation of existing training units from the CPP Property Services Training Package and importing units from the MEM Manufacturing and Engineering, and UEE Electrotechnology Training Packages can cover most of the skills and knowledge required in lithium-ion battery recycling. A new training unit that covers knowledge of battery materials and components is recommended.

First Responder training is also required but it may be possible to contextualise existing training on emergency responses to situations involving lithium-ion batteries.

TRAINING AND SKILLS GAPS IN BATTERY REFURBISHMENT

Only one company was interviewed in relation to lithium-ion battery refurbishment.

The relevant vocational skills required were identified as those from logistics and manufacturing.

Partnerships between industry and RTOs on projects manufacturing lithium-ion batteries for a second use could provide valuable training and experience for students in this emerging area.

9.2 Summary

As recycling companies begin recycling lithium-ion batteries, customised training courses for recycling centre workers in specific lithium-ion battery recycling processes will address current skills and knowledge gaps.

Activities in lithium-ion battery refurbishment and reuse are also only just emerging. However, partnerships between recycling companies and the VET sector on battery re-use and refurbishment can be fostered to expose students and teaching staff to the skills required.

10. VOCATIONAL WORKFORCE DEVELOPMENT PLAN

The future battery industry value chain in Australia involves many different industries. Some are currently more established than others and have more defined workforce requirements.

The vocational workforce is a key part of all Australian battery industries.

This skills and training gap analysis has found that in general, existing qualifications and skills sets in national Training Packages are relevant to battery industries and cover many of the skills and knowledge areas that will be required.

This is in part due to the design of nationally accredited vocational training in Australia where training units can be contextualised to different workplaces. It is also because battery industries are extensions of Australia's existing mining, refining, manufacturing, electrotechnology, automotive and recycling industries.

However, the nature of future batteries in terms of their chemistry, the purity of the materials required, and the new technologies they require for production as well as the new technologies they represent and enable, means that there are areas where new vocational skills and knowledge are required.

The following Vocational Workforce Development Plan has been developed based on the skills gap analysis. It is intended to guide vocational workforce development as part of the Future Battery Industries Cooperative Research Centre program. The Plan proposes actions in three areas:

1.

Vocational skills for growing Australian battery industries

The expansion of Australia's battery minerals mining, refining and processing, cell and component manufacturing, BESS manufacturing and lithium-ion battery recycling industries can be supported by ensuring training in the new vocational skills required is available. Actions have been proposed here to address the gaps found in the skills gap analysis.

2.

Vocational skills for battery applications in Australia

Vocational skills to support the uptake of battery energy storage systems and electric vehicles are already provided for in existing training or training that will soon be developed or updated. Actions are proposed to facilitate and build on existing industry and VET sector projects for BESS and EV skills.

3.

Ensuring the future vocational workforce for Australian battery industries

As Australia's future battery industries become established, the ongoing supply of vocational workers for the industries will need to be ensured. Actions are proposed to identify the workers and skills required and attract students into the relevant training courses.

Stakeholder Engagement

The development of the vocational workforce for Australian future battery industries will involve many different stakeholders. Not all stakeholders were able to be interviewed as part of the skills gap research. More extensive consultation of stakeholders is recommended for the proposed vocational workforce development plan.

1. Vocational skills for growing Australian battery industries

ACTION 1.1

Monitor battery minerals mining industry for training needs for specialist processing and new Industry 4.0 technologies at new mines

This study found that although battery mineral mine and concentrate operations generally draw on the existing mining skills available in Australia, there may sometimes be a requirement for skills in processes that are not as commonly used but for which there are national training units available. In these cases, customised training is available from Registered Training Organisations (RTOs) to ensure workers have the skills employers need.

In addition, battery mineral mines that are being established as new operations will incorporate more Industry 4.0 technologies and require workers with new technology skills.

The Future Battery Industries Cooperative Research Centre network can be leveraged to monitor any increased industry need for specialised training and to ensure that new Industry 4.0 technologies at battery mineral mines are included as part of existing skills and training development projects.

ACTION 1.2

Develop a new skill set and customised training for process operations and laboratory operations workers

This study found the following gaps in existing nationally accredited training courses deemed most relevant to Process Operators, Process Technicians and Laboratory Technicians working in battery minerals refining and processing:

- working with automation to produce very high purity battery chemicals;
- understanding of the value chain and the effect of quality downstream; and
- chemistry and chemical safety knowledge related to the chemicals used and produced.

There were differing views between companies as to whether the training was more suitable for delivery in-house or by RTOs.

The development of a new accredited training skills set to address these gaps will assist companies in upskilling staff and provide workers with national skills recognition.

Commencing this training development now will provide a means to upskill workers as the battery minerals refining and processing industry becomes more established over the next few years.

Furthermore, future vocational workers can be prepared by, customising to the battery minerals refining context, the existing nationally accredited courses for Process Operators, Process Technicians and Laboratory Technicians.

ACTION 1.3

Identify vocational skills required for maintenance of new technologies in battery industries

Study participants did not report any new skill requirements for the trades involved in maintaining process operations equipment such as Electricians, Electrical Fitters, Mechanical Fitters and Instrument and Control Technicians.

However, national skills industry reference committees have noted the need for increased digital literacy and higher level skills in electronics and mechatronics for advances in maintenance techniques.

Advanced technologies such as automation, big data and machine learning are involved in batteries chemicals manufacturing and battery cell and component manufacturing. The future of BESS assembly will also involve robotics. BESS and EV uptake involve the installation and maintenance of information communications technology.

Ongoing consultation with companies as they become established is required to inform upskilling requirements for the maintenance trades in the new technologies involved in battery and battery materials manufacturing.

ACTION 1.4

Further research vocational skills for battery component and cell manufacturing

This study found that vocational roles such as Production Operators and Cell Assembly Technicians will most likely require new skills and knowledge relating to specific skills in battery production such as controlled slurry mixing and electrode coating; and maintaining the dry and clean room production environments required for battery production which have been likened to pharmaceutical production settings.

As companies establish battery cell production in Australia, further consultation is required to confirm vocational skill training requirements.

ACTION 1.5

Research the feasibility of RTOs providing the MEM and MSM training courses identified in this study for BESS manufacturing

This study identified existing nationally accredited qualifications in engineering product and process manufacturing that provided many of the skills required for BESS assembly.

However, some key qualifications currently have low numbers of completions. This may be due to these qualifications not leading to a trade outcome or strong employment opportunities.

Further research and industry consultation is required as to whether delivery of the qualifications identified here is feasible for RTOs or whether another solution, for example, importing the relevant units into courses with more enrolments, is preferable.

ACTION 1.6

Contextualise training in lithium-ion battery recycling processes

As the battery recycling industry develops lithium-ion recycling activities, contextualised training will be required for workers in waste collection, recycling and processing on skills and knowledge specific to lithium-ion battery recycling processes. These pertain to the safe removal, handling and storage of lithium-ion batteries, disassembly, shredding and mechanical separation and the chemical separation processes used.

GOAL:

To equip workers with vocational skills relevant to growing battery industries.

2. Vocational skills for battery applications in Australia

ACTION 2.1

Facilitate development of training for First Responders and other related occupations in emergencies involving BESS and electric vehicles

The Australasian Fire and Emergency Service Authorities Council (AFAC) have developed guidelines for BESS and Firefighters will be trained within firefighting training academies. AFAC are planning to soon develop similar guidelines for EVs.

Currently, EV car manufacturers make information for First Responders available through the Australasian New Car Assessment Program (ANCAP) rescue app.

There are instances of First Responder training in EVs being delivered or developed in Australia.

There is an opportunity to bring together the training for BESS and EVs and ensure it is available for all First Responders and related occupations such as Facilities Managers, Tow Truck Drivers and Recycling Centre Workers. Existing training units may be suitable to contextualise to incidences involving lithium-ion batteries.

ACTION 2.2

Facilitate increased post-trade training in BESS and EV supply equipment installation where there is demand

National training is available for BESS design, installation, repair and maintenance. Only Electricians can undertake the installation training unit. Currently there are low enrolments in this training relative to the number of Unlicensed Electricians, which industry stakeholders reported reflects current demand.

Where governments are introducing or extending subsidies or investing in community batteries, collaboration with industry and RTOs can assist in the delivery of post-trade BESS training for Electricians.

This study also identified areas where the current training for BESS requires updating to meet industry changes. The national Electrotechnology Industry Reference Committee will, in 2021, review and update renewable energy courses in the Electrotechnology Training Package[70]. The BESS units are part of the renewable energy courses in the UEE Training Package.

Training in the installation of electric vehicle supply equipment (EVSE) is currently provided by manufacturers and installation companies. Collaboration between EVSE manufacturers, industry professional

associations and the VET sector to expand training in EV supply equipment installation may be required to support EV uptake.

ACTION 2.3

Further research into vocational skills required by electricity supply industry

This study was not able to interview a wide sample of electricity generation and supply companies from across Australia.

However, a review of the literature and information from the few interviews that were conducted suggested there are new skills and knowledge required for Linesworkers, Electricians and Electrical Engineering Technicians in the integration of BESS into the electricity supply network.

The ESI Transmission, Distribution and Rail, and ESI Generation Industry Reference Committees for the energy generation and supply industries have also identified that new skills are required. In 2021, the IRCs will develop new training to address some of these skills.

Further industry consultation is required to confirm the skills gaps for utilities workers in working with BESS and the training required.

Western Australian utilities will continue to work with RTOs to develop training to upskill workers in the operation and maintenance of stand alone power systems.

ACTION 2.4

Facilitate EV Service Technician training where there is demand

The national Automotive Light Vehicle and Automotive Heavy Vehicle Industry Reference Committees will, in 2021, be developing a new qualification in EV Service Technician training with specialisations in light or heavy automotive. Existing skills sets to upskill Automotive Mechanics in EVs will also be updated.

Interviewees reported that demand for EV Service Technician training is currently limited due to EVs mostly being serviced under warranty by car manufacturers.

However, public investment into EVs, such as for government fleets, may provide opportunities to partner with industry and the VET sector to provide the upskilling skills sets.

GOAL:

Facilitate training for vocational workers for battery energy storage systems and electric vehicles uptake.

3. Ensuring the future vocational workforce for Australian battery industries

ACTION 3.1
Improved data on vocational workforce needs

Australia's future battery industries are sub-sectors within existing industries and also currently emerging or growth industries.

Ongoing consultation with companies as they plan and begin operations is required to estimate workforce needs in several of the more emerging battery industries.

In addition, incorporating a battery industries focus into existing workforce data collection processes, or development of a separate data collection process, is required to gain accurate and timely workforce needs data.

ACTION 3.2
Monitor and address the effect of more general skills shortages on battery industries

Battery industries must compete with other industries and sub-sectors for vocational workers.

The emergent nature of battery industries and their smaller size relative to other more established companies and industries will pose challenges for staff recruitment. On the other hand the opportunity to work in a new field can be attractive to workers.

Ongoing consultation with future battery industries is required to assess the effect of more general skills shortages and develop strategies to address.

For example, Electricians have a key role in several battery industries and a shortage of Electricians will likely hamper some battery industries. Likewise, the number of graduate Process Technicians has been in decline over recent years. This issue requires further enquiry and strategies developed to increase enrolments were required.

Strategies to address skills shortages and increase enrolments in relevant courses can include fee subsidies, increased support for apprentices and trainees, prior skills recognition and fast tracked training.

The re-training and upskilling of any groups of displaced workers may also provide the workforce required by battery industries. Workers in mining, bulk chemicals or oil and gas separation have relevant skills for the battery refining and processing industry. Workers from pharmaceutical and other advanced manufacturing industries have relevant skills for battery cell and BESS manufacturing.

ACTION 3.3

Including battery industries in digital skills training pilots and initiatives

The need for increased digital skills for Australia's economic growth has been extensively documented[71, 72].

Battery industries will require vocational workers with skills in working with advanced, automated technology that incorporates machine learning and robotics to mine, refine and process and manufacture battery chemicals and products.

Tradesworkers, Technicians and Operators in all battery value chain industries will be working with or involved in maintaining equipment and machines involving advanced technologies.

Battery energy storage systems and EVs will be part of the Internet of Things and the role they play orchestrated remotely through digital communications technology.

There are many Commonwealth and State initiatives currently underway to develop digital skills training for vocational occupations. For example, Digital Skills Cadetship Trials, Industry 4.0 Higher Apprenticeships and Digital Skills Organisation Pilot.

The inclusion of battery industry contexts and workplaces in digital skills training development projects is another way to develop the battery vocational workforce.

GOAL:

To ensure the supply of vocational workers for future battery industries.

ACTION 3.4

Attracting students into battery and STEM courses

Australia's future battery industries will require vocational graduates from the mining, processing, laboratory, electrical, electrotechnology, energy supply, engineering, information and communications technology, automotive and manufacturing fields.

Interviewees consistently stressed the importance of maintaining graduates with skills in science, technology, engineering and mathematics (STEM).

There are existing initiatives at the national, State and local level by government and industry peak bodies focused on attracting people into STEM fields generally. For example:

- the Women in STEM Cadetships and Advanced Apprenticeships Program;
- the Attraction and Retention project hub led by the Minerals Council of Australia[73];
- Queensland Minerals and Energy Academy provides school students with a range of programs to sample, learn and experience the resources sector in Queensland including metal refineries; and
- the Kwinana Industries Council Education Development Program in Western Australia introduces school students to local refining and processing companies as part of a program to connect them into career pathways for the local industry.

Other initiatives such as the Schools Solar Challenge and electric car racing focus attention on electric vehicles.

Promotion of Australia's new and growing battery industries and the exciting career possibilities is needed to attract students into STEM courses relevant to the industries.

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