ELECTRICITY NETWORK TRANSFORMATION ROADMAP

Future Workforce Skilling Impacts

April 2017

Energy Networks Australia

CSIRO

energyskills queensland

Energy Skills Queensland is the leading, independent, not-for-profit organisation providing innovative solutions to enable a skilled and safe energy industry. Supporting the electricity, oil and gas, mining and telecommunications sectors, Energy Skills Queensland engages, researches and develops products and services that align to the current and future needs of stakeholders.

No part of this report may be reproduced by any means, or transmitted or translated into a machine language without the permission of Energy Skills Queensland. For more information, contact Energy Skills Queensland Chief Executive Officer, Penelope Twemlow via email:

ptwemlow@energyskillsqld.com.au

Energy Skills Queensland

70 Sylvan Road, Toowong QLD 4066

Phone: (07) 3721 8800

www.energyskillsqld.com.au

Disclaimer: Whilst all care and diligence has been exercised in the preparation of this report, Energy Skills Queensland does not warrant the accuracy of the information contained within and accepts no liability for any loss or damage that may be suffered as a result of reliance on this information, whether or not there has been any error, omission or negligence on the part of Energy Skills Queensland or their employees. Any projections used in the analysis can be affected by a number of unforeseen variables, and as such no warranty is given that a particular set of results will be achieved.

Contents

1 Executive Summary 8

2 Introduction 17

3 Methodology 18

4 The Current Workforce 19

4.1 Electrical Supply Industry 19

4.2 Electrical Transmission Sector 23

4.3 Electrical Distribution Sector 27

5 Critical Skills Analysis Observations 32

6 Technical/Business-Related Requirements, Skills Drivers and Workforce Enabler Groups 36

6.1 Technical and Business-Related Requirements 37

6.1.1 Integrating Emerging Technologies 37

6.1.2 Grid architecture and design 38

6.1.3 Customer Centric Networks 38

6.1.4 Organisational Structure 39

6.2 Critical Skills Drivers and Workforce Enabler Groups 40

6.2.1 Workforce Enabler Group: Engineering 40

6.2.2 Workforce Enabler Group: Engineering Technical Officer 46

6.2.3 Workforce Enabler Group: Technical Trades 49

6.2.4 Workforce Enabler Group: ICT Specialists 59

6.2.5 Workforce Enabler Group: Data Specialist 63

6.2.6 Workforce Enabler Group: Executive Management 65

6.2.7 Workforce Enabler Group: People, Culture, Communication and Change Officers 66

6.2.8 Workforce Enabler Group: Customer Services 69

7 Initiatives and Key Actions 71

7.1 Initiative 1: Annual Workforce Skills Report 71

7.1.1 Key Actions 72

7.1.2 Benefits 73

7.2 Initiative 2: Workforce Skilling Resource 73

7.2.1 Key Actions 73

7.2.2 Benefits 74
7.3 Initiative 3: Continuity and Prioritisation of Skills Investment 74
7.3.1 Key Actions 74
7.3.2 Benefits 75
7.4 Initiative 4: Education and Training Package Process and Design Review 76
7.4.1 Key Actions 76
7.4.2 Benefits 78
7.5 Initiative 5: Diversity and inclusion 78
7.5.1 Key Actions 78
7.5.2 Benefits 78
7.6 Initiative 6: Skills Awareness Campaign for ESI Workers 79
7.6.1 Benefits 79
7.7 Initiative 7: Skills Awareness Campaign for Consumers 80
7.7.1 Key Actions 80
7.7.2 Benefits 80
7.8 Initiative 8: Qualification and Licensing Reform 80
7.8.1 Key Actions 81
8 Bibliography 82

Index of abbreviations and acronyms

ABS	Australian Bureau of Statistics
ACPE	Australian Committee of Power Engineering Professors
AISC	Australian Industry and Skills Committee
ANZSCO	Australian and New Zealand Standard Classification of Occupations
ANZSIC	Australian and New Zealand Standard Industrial Classifications
API	Australian Power Institute
ARIMA	Autoregressive Integrated Moving Average
ASQA	Australian Skills Quality Authority
CEO	Chief Executive Officer
CFO	Chief Financial Officer
COAG	Council of Australian Governments
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DC	Direct Current
DER	Distributed Energy Resources
DNSP	Distribution Network Service Provider
EDTW	Electrical Distribution Trades Workers
EEDT	Electrical Engineering Draftspersons and Technicians
ENA	Energy Networks Australia
ENTR	Electricity Network Transformation Roadmap
ESI	Australian Electricity Supply Industry
ESQ	Energy Skills Queensland
ESWDT	Exponential Smoothing With Damped Trend
ICT	Information and Communication Technology
IED	Intelligent Electronic Devices
IoT	Internet of Things
IRC	Industry Reference Committees
IT	Information Technology
NCVER	National Centre for Vocational Education Research
National Workforce	Combination of total employment of all industries workforces
Network Workforce	Combined National Transmission and Distribution Workforce
NFD	Not Further Defined
OECD	Organisation for Economic Co-operation and Development
OT	Operational Technology
PV	Photovoltaic
PwC	PricewaterhouseCoopers
RET	Renewable Energy Target
RTO	Registered Training Organisations
SCADA	Supervisory Control and Data Acquisition
SSO	Skilling Service Organisation
STEM	Science, Technology, Engineering and Mathematics
Supporting Industries	Electrical contractors and technology hardware and software businesses
Total Employment	Combined full-time and part-time work-force
TNSP	Transmission Network Service Providers
VET	Vocational Education and Training
YTD	Year to date

List of Figures

Figure 1 - Relationship between workforce enabler groups and network requirements and workforce skill drivers 12
Figure 2 - Identified technical streams of skills (both engineering and non-engineering) ESI companies require from the future power engineers 13
Figure 3 – The combined national enrolments of VET qualified Electrotechnology occupations identified as critical within this research 16
Figure 4 - Comparative analysis of total employment within the national ESI and the national workforces 20
Figure 5 – Historical composition of the workforce by industry sector as a percentage of the total ESI 21
Figure 6 - Historical national ESI total employment trend and ESI total employment projections 22
Figure 7 - Plausible projections of Australia's changing energy mix to 2050 23
Figure 8 – National transmission sector total employment trend 24
Figure 9 - Electricity transmission sector by occupation by proportional size 26
Figure 10 - Distribution Sector - national total employment trend 27
Figure 11 - Electricity Distribution sector by occupation by proportional size 30
Figure 12 - Number of students completing degrees in STEM 35
Figure 13 - Higher Education - Engineering and related technologies course enrolments 41
Figure 14 - Higher Education - Engineering and related technologies course completions 41
Figure 15 - Electrical Engineers national employment trend across all industries 43
Figure 16 - Combined national enrolments and completions in subjects where the listed ANZSCO occupation group is Electrical Engineering Technician 47
Figure 17 – EEDT National employment trend analysis 48
Figure 18 – National commencement in Electrotechnology Electrician apprenticeships (includes training packages UEE30811, UEE30807, UEE30806 and UET 31199) 50
Figure 19 - National Completions in Electrotechnology Electrician apprenticeships (includes training packages UEE30811, UEE30807, UEE30806 and UET 31199) 51
Figure 20 – National average training times for completions in Electrotechnology Electrician apprenticeships (includes training packages UEE30811, UEE30807 and UEE30806) 51
Figure 21 – Electrical Tradespersons - National employment trend across all industries 52
Figure 22 - EDTW - National employment trend across all industries 55
Figure 23 – National commencements in Linesworker apprenticeship (includes data from UET30206, UET30209 and UET30612 training packages) 56
Figure 24 - National completions in Linesworker apprenticeship (includes data from UET30206, UET30209 and UET30612 training packages) 56
Figure 25 - Average National completion times in Linesworker apprenticeship (includes data from UET30206, UET30209 and UET30612 training packages) 57
Figure 26 - National commencements in Cable Jointers apprenticeship (includes data from UET30406, UET30409 and UET30812 training packages) 58
Figure 27 - Higher Education - Information Technology course enrolments 60
Figure 28 - Higher Education - Information Technology course completions 60
Figure 29 - Software and applications programmers - National employment trend across all industries 61
Figure 30 - Database and systems administrators and ICT security specialists - National employment trend across all industries 63

List of Tables

Table 1 - Fundamental characteristics of conventional electricity grids and smart electricity grids ... 19
Table 2 – National transmission sector workforce by educational attainment and age in comparison to the ESI and national workforce equivalents ... 25
Table 3 - National distribution sector workforce by educational attainment and age in comparison to the ESI and national workforce equivalents ... 28
Table 4 - National employment projections across all industries by skill level ... 33
Table 5 - Projected 2020 employment growth in ICT ... 59

1 Executive Summary

This research has been developed in collaboration with Energy Networks Australia (ENA), as a component of the national Electricity Network Transformation Roadmap (ENTR – referred to as 'the Roadmap'). In alignment with the greater roadmap objectives, a set of actions and measures have been developed in the form of initiatives.

If adopted, the below initiatives provide the electrical transmission and distribution sectors with a workforce skilling pathway for the 2017 to 2027 period.

Initiative 1: Annual Workforce Skilling Report

The continuous adoption of emerging technologies[1] between now and 2027, will require ongoing skill development and training requirements to be undertaken by employees of the network workforce (the combination of the transmission and distribution workforces). To mitigate the risks associated with skill gaps appearing within the network workforce, the commission of an Annual Workforce Skills Report (skills report) is highly recommended.

The annual skills report will provide industry, educational facilities and government organisations with ongoing evidence based workforce skills intelligence on national, state, territory and jurisdiction levels. To ensure this initiative provides maximum benefits to industry stakeholders, a high level of industry 'buy-in' is a must. Industry participation will include the provision of workforce data and communication of industry intelligence.

In addition the aggregated findings of the annual skills report will provide network organisations with continual and current workforce data that can act as a benchmark for both industry and individual organisation targets. For example, data provided can be analysed to determine if industry diversity and inclusion (initiative 5) targets are being met.

Initiative 2: Workforce Skilling Resource

A workforce skilling resource is required within all states, territories and jurisdictions to;

- Act as a workforce skilling conduit between industry, government and education facilities
- Create appropriate networks with government and education decision makers
- Support and assist other respected Industry Skill bodies that have established working relationships with educational and government organisations
- Oversee funding (see Initiative 3) for key skill sets and qualifications needed to upskill and re-skill the network workforce, electricity sector and supporting industries.

Extensive research will be required to be undertaken to identify existing entities that possess the relevant experience, skills and knowledge to achieve the objectives of this initiative within each jurisdiction. If it is identified that no entity exists or possesses the necessary capabilities to fulfil the requirements, industry will be required to collaborate with government and education institutes to create a suitably qualified body.

[1] For the purpose of this report, the term emerging technologies refers to the introduction of Distributed Energy Resources (DER), Electric Vehicles and other intelligent technologies entering the Electrical Supply Industry

Initiative 3: Continuity of Skills Investment

Continuity of skills investment is essential in ensuring that workforce skill gaps do not occur. To accommodate the complexity of embedding new technologies into operations and subsequently maintaining them, the skills investment process will be required to be responsive and flexible.

Through increasing the funding and priority of relevant identified skills from initiatives one and two, industry will be more effective in transitioning its workforce safely and competently through the industry transformation.

Initiative 4: Education and Training Package Process and Design Review

Accredited training packages and university courses are the core of industry and professional training in the network workforce. Continual review of the alignment between education content and industry skill needs is essential in ensuring the successful integration of emerging technologies and industry practises.

An in-depth review of elements affecting the future of skilled workers across all training packages related to the utilities industry will begin during 2017. It is only now that the electrotechnology training package can be constructed in a way that retains core requirements whilst embedding provisions for the Registered Training Organisations (RTO) to react flexibly and responsively to technological and industry change.

A key driver in the changes to the training package review processes is the requirement for Skilling Service Organisations (SSO) to directly engage with industry personnel through the newly formed Industry Reference Committees (IRC). Unfortunately, industry stakeholders have outlined that a number of trade qualified workers do not have an interest in engaging in content review, due to the barriers imposed by the inherent complexities and entirely foreign nature of the Vocational Education and Training (VET) industry as whole.

An agreed process will need to be developed to enable the SSO and IRC to identify relevant workers and employers in industry who will actively engage in the training package review and development process. The relevant persons identified during the expression of interest period require a mechanism to ensure that a high VET industry understanding is not a prerequisite of providing contemporary industry knowledge.

The higher education sector must continue to work with industry experts to redesign curriculum to address future skills needs. Currently, a relationship exists between power universities and industry which must be maintained to ensure that Power Systems Engineers of the future possesses skills that are reflective of industry needs.

Industry has reported that electrical engineering educational content is continuously guided by the industry through the Australian Power Institute (API), and proactively responded to by the Australian Power Education Academic sector through Australian Committee of Power Engineering Professors (ACPE).

To improve both the undergraduate skills and research/innovation the API, 2016 has identified that the following is required by power universities:

- *Research and innovation needs to be industry driven with a focus on deliverables of benefit to the industry and community/customers.*
- *Multi-disciplinary teams of academics/researchers from various disciplines and universities (electrical engineering, science, ICT, economics, social sciences) need to work collaboratively*

with industry professionals – teams with the best capability across Australia need to be established.

- *A significant financial and in-kind contribution is needed by industry to drive this innovation agenda (Australia ranks lowest amongst OECD countries in its collaboration and research efforts)*
- *Universities need to change their culture to improve the entrepreneurial and innovation skills of both their undergraduate and post graduate students*

Initiative 5: Diversity and Inclusion

A greater emphasis and awareness in the importance of achieving an inclusive and diverse workforce, has resulted in high profile initiatives such as BHP Billiton's target of a 50:50 gender diverse workforce by 2025 being established.

ESI business, industry, education and government stakeholders are encouraged to identify and develop measurable workforce diversity and inclusion goals and stretch targets. This requires implementing diversity of thinking within all business facets which are measurable through industry education and KPIs.

However, prior to industry initiating a holistic drive embracing diversity and inclusion within network organisations and the ESI, a unified approach to foster the initiatives within existing workforce cultures must first be established.

It is suggested that identified goals and targets become a reportable criteria in the annual skills report (initiative 1).

Initiative 6: Skills Awareness Campaign - Workers

A significant risk area (to the safety of the worker and the Australian community) is that the role, responsibilities and training requirements of the installer/maintainer of emerging technologies is not clearly defined within relevant standards and legislations. A lack of clarity can potentially lead to a gap being created in 'what type of worker' is required to be involved in particular steps of new technology installation and maintenance.

Additionally, a complementary worker awareness and education campaign needs to be developed to ensure that individual workers, especially those in micro, small and medium sized businesses, are made aware of the licences and additional training required to deliver work in these areas.

Initiative 7: Skills Awareness Campaign - Consumers

Development and investment in a national education campaign, tailored to specific regulations and legislations of each state, territory and jurisdiction must be conducted. The campaign will be required to clearly communicate information on the type of qualifications and skills required by the workforce to undertake installation and maintenance of emerging technologies at customer locations.

Initiative 8: Qualification and licensing reform

A national standard for VET coupled with national recognition of trade licenses affords a national consistency in the issuance of summative assessment tools (e.g. Capstone and the further issuance of licenses for the network workforce[2]).

[2] This also includes reference to the Australian New Zealand trans-Tasman licensing agreement

Extensive collaboration with relevant industry stakeholders was undertaken, to identify occupations (and their accompanying skill sets) considered critical in enabling the adoption of technologies within the transmission and distribution sectors.

During the consultation process, the desire to adopt a lifelong learning approach to work was identified as a key finding within this research. Lifelong learning will be a prerequisite to enable skills to evolve and remain current as new technologies are adopted. Based on current skills requirements, methodologies need to be established and actioned within the current workforce - such as initiative one to three of this report - to provide support with the ongoing learning needs. In addition, a second challenge will be how to take the emerging workers through the journey of education whilst responding to the speed of adoption of technologies.

AlphaBeta, 2016 identified a set of skills (referred to as enterprise skills) that will be critical for employees of all industries during the era of digitalisation. Industry collaboration acknowledged that enterprise skills will be essential for employees in all occupations within the network workforce, enterprise skills include;

- digital literacy
- creativity
- communication and c
- complex problem-solving.

The research identified that to enable the successful adoption of emerging technologies within the transmission and distribution sectors, the workforce will be required to embrace;

- Broader workforce groups and skills that will become essential
- Varying levels of workforce skills, training and professional development as required across several electrotechnology occupations

Within this report, workforce skill drivers have been categorised under four broad network organisation requirements:

1. Integration of emerging technologies
2. Grid Architecture and Design
3. Consumer Centric Networks
4. Organisation Structures.

Identified occupations that possess or will be required to possess the skills to achieve these broad network organisation requirements have been grouped into the following eight key technology enabling workforce groups:

1. Engineering
2. Engineering Technical Officer
3. Technical Trades
4. Information, Communication and Technology (ICT) Specialists
5. Data Specialists
6. Executive Management
7. People, Culture, Communication and Change Officers
8. Customer Services.

Identification of the broad network requirements highlight that skills required to enable the successful adoption of emerging technologies stem from not only the traditional ‘Electrotechnology workers’ but from wider workforce groups who may not have traditionally been seen as critical within the network workforces.

Figure 1 portrays the relationships of the identified broad network requirements and accompanying workforce enabling groups. Where the workforce enabler group is listed under the network requirement, it indicates that the future and/or current skill sets of that workforce enabler group are essential in assisting the network organisation meet that requirement.

Figure 1 - Relationship between workforce enabler groups and network requirements and workforce skill drivers

Whilst skill and training requirements will primarily be required within the Engineering, Technical Trades and Engineering Technical Officer workforce enabling groups, the current skills sets and knowledge for the remaining workforce enabling groups has also been identified as critical.

Within the Engineering workforce enabling group, the roles of the following Electrical Engineering qualified workers were identified as essential:

- Power System Engineers
- Network Planners,
- Protection Engineers
- Asset Managers
- Environmental Engineers.

Whilst the skill sets identified as essential include:

- Behind meter technologies (batteries, inverters and electric vehicles)
- Advanced Information Communication Technology (ICT) network knowledge including concepts such as Internet of Things (IoT) and IEC61850
- Ability to work with Big Data
- Working knowledge of big data software/programming such as R/Python
- Risk management

- Cyber security protocols.

The API is a highly regarded and respected engineering industry body that supports the Australian power industry. Bi-annually, the API undertakes a workforce planning survey with generation, transmission and distribution companies. The most current was undertaken in 2015 and consolidated responses form 14 ESI organisations identify the following five technical streams of skills (both engineering and non-engineering) as skills that were required for future power engineering workforces:

Figure 2 - Identified technical streams of skills (both engineering and non-engineering) ESI companies require from the future power engineers

(Australian Power Institute, 2015)

The overriding catalyst for reskilling/skills enhancement in the Engineering Technical Officer workforce enabling group, is the requirement for the Technician to transition from a traditional network approach to a system thinking mindset[3]. The skill required to work with emerging technologies that are interconnected and not stand-alone results in different approaches to repair and maintenance. Understanding the impact each technology can have on other interconnected equipment is vitally important. This mindset extends to a greater systematic approach to high level soft skills, including relationship management, collaboration and learning mindsets.

Critical occupations identified within the technical trade group were the Electrical Tradesperson (Electricians) and Electrical Distribution Trades Workers (Linesworkers and Cable Jointers). The systems nature of emerging technologies was identified as a key skills driver and a potential to cause a skills gap if left unaddressed. To work with such technologies, technical trade workers will also be required to develop a 'systems thinking' mindset.

[3] For the purpose of this report, a systems thinking mindset is defined as:

'The ability to understand the complexities of creating a connected network of products. Connectivity of devices through sensor technology, that transmits data feeds to the internet, will require a deeper knowledge of ICT and cabling. Skills also associated with this type of thinking include skills such as digital literacy, platform thinking, problem-solving and critical thinking.'

Skill requirements of occupations within the technical trade's workforce group will also be dictated by business models adopted by Distribution Network Service Providers (DNSP). Emerging technologies are presenting DNSPs with the opportunity to evolve business models into the provision of new energy services, for example electrical tradespersons will potentially become the installer/maintainer of emergent technologies, including residential battery storage systems.

In addition to the requirement to obtain the necessary ICT and cabling skills to install, configure, connect and fault find on emerging technologies (both onsite and through remote commissioning).The skill sets identified as critical for the electrical tradesperson to work with emerging technologies in a safe and efficient manner include:

- Increased telecommunication and associated protocols
- Network Integration Skills – capability to integrate emerging technologies into existing consumer networks
- Testing and commission skills
- A systems' thinking mindset
- Isolation of multiple electricity feeds
- Increased working knowledge of DC
- Increased chemical knowledge
- Product installation knowledge.

The skill sets of both the ICT and Data Specialist workforce groups are synonymous with the digitalisation mega trend impacting industries world-wide. A consequence of this is that specialists who operate within these fields are in high demand. As outlined in Figure 1, skill sets of these workforce groups will be essential across a range of network functions.

The demand for ICT and Data specialist occupations has the potential to drive a labour shortage, which is already being experienced within key occupations such as cyber security specialists across all industries. The recruitment of workforce specialists in these fields, who also have knowledge of the network and ESI, is already being reported as difficult, and this has potential to increase over time as the demand for these occupations grow. There are also questions over the currency of network organisations to attract and retain this workforce, posing further significant challenges for network businesses.

Data specialists will be critical for the future of the electrical workforce. Data availability is expected to continue to exponentially increase providing significant opportunities for network businesses in a time of transformation. The use of this data can be utilised throughout business operations, from providing executive management information on future business models to providing information on consumers' behaviours.

Executive management is a workforce enabling group that is already playing a critical role within the transformation period. The convergence of digitalisation, emerging technologies and increasing customer demands will provide opportunities for the traditional DNSP model to evolve through the provision of new energy services. For a successful transition, the expert industry knowledge and business acumen of the executive management team will be essential. New additions to the executive management team may be required to support new focusses of business operations including the need for a Chief Data Officer.

A significant challenge for network organisations is the requirement of embedding innovation and collaboration into the workforce, with workforce culture, politics and willingness all being identified as potential barriers to success. Critical occupations that possess the skills to continually encourage

and reinforce innovation and change requirements within the current network workforce were HR Professionals, People Strategy, Communications and Change and Technical Training Managers.

As network organisations progress to more customer centric business models, customer services offered to consumers will become increasingly important. Even though requirements for digitalised consumer services is increasing, in the short to medium term, traditional customer service methods must be maintained for less technical savvy consumers. Customer Service Operators will require a high level of technological expertise to provide appropriate guidance and information to consumers. This knowledge can be gained through propriety training.

In comparison to digitalised services, the traditional role and skills of customer services may change. According to CSIRO (2016), tomorrow's digitally enabled workforce report; 'online chaperone' may emerge as a job of the future. Responsibilities will range from identity theft, risk management to reputational damage and social media bullying.

In 2011, the tertiary educated Electrical Engineer accounted for 8% (2,420 employees) of the total network workforce. As a proportion of their respective workforces the Electrical Engineers was also particularly evident within the transmission workforce in whom persons classified within this ANZSCO code accounted for 23% (576 employees) of the total workforce.

A strong and effective link exists between the Australian power industry and Australian universities which deliver electrical engineering courses through their Electrical and ICT Engineering Schools. A result of this relationship is an industry driven curriculum for undergraduate power engineering courses, with a strong IT and renewable energy grid integration content. Content is continuously guided by the industry through the Australian Power Institute (API), and proactively responded to by the Australian Power Education Academic sector through ACPE (Australian Committee of Power Engineering Professors). The link between industry and education ensures that the skill requirements of tomorrow's engineers will improve and align with the requirements of the power system of the future.

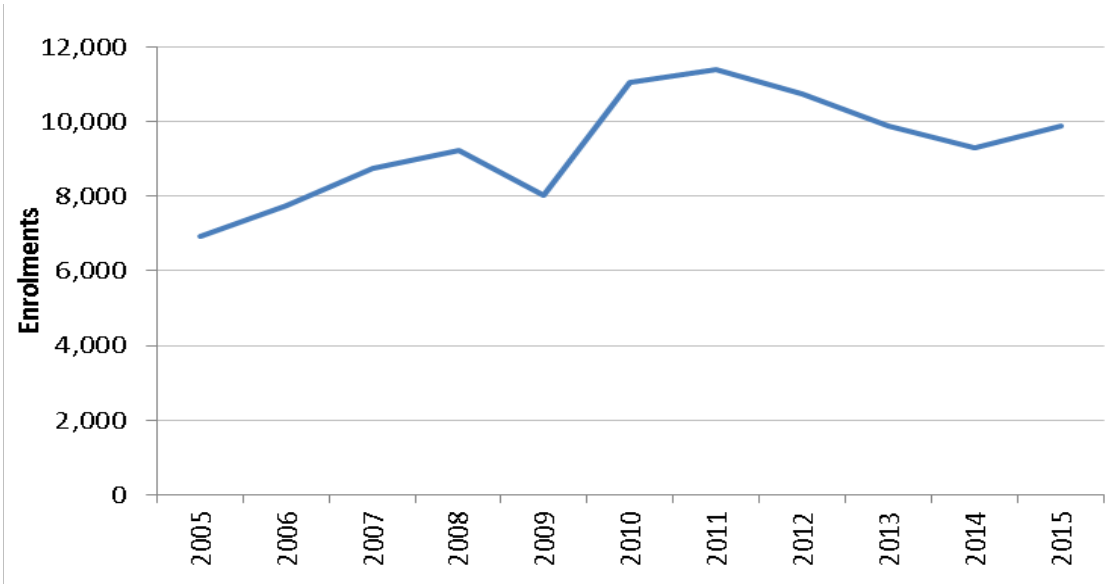
The sustainability of university electrical engineering schools depends on a critical mass of academics (professors, lecturers, post graduate researchers and PhD students). To improve both undergraduate skills and research/innovation the API has identified that the following is required:

- Research and innovation needs to be industry driven with a focus on deliverables of benefit to the industry and community/customers.
- Multi-disciplinary teams of academics/researchers from various disciplines and universities (electrical engineering, science, ICT, economics, social sciences) need to work collaboratively with industry professionals – teams with the best capability across Australia need to be established.
- A significant financial and in-kind contribution is needed by industry to drive this innovation agenda (Australia ranks lowest amongst OECD countries in its collaboration and research efforts)
- Universities need to change their culture to improve the entrepreneurial and innovation skills of both their undergraduate and post graduate students

Figure 3 illustrates a declining education trend for the combined national enrolments in training pathways of VET qualified occupations (Engineering Technician officer, Distribution Trade Workers (Linesworkers and Cable Jointers) and Electricians) that have been identified as critical in this

research. A decline of -18% (2,091 enrolments) was recorded when the 2014 comparative is compared to 2011. Encouragingly increased enrolments were recorded in 2015.

Figure 3 – The combined national enrolments of VET qualified Electrotechnology occupations[4] identified as critical within this research



(NCVER - VOCSTATS)

[5] ABS have advised that the NFD category includes workers that are employed for organisations that have cross sector functions within the ESI industry i.e. a worker that is employed for an organisation that has both distribution and retail functions

2 Introduction

The Australian electrical supply chain is experiencing an unprecedented transformation of the way in which electricity is generated, transmitted, distributed and consumed by the Australian public. The transformation is being driven by the emergence of new technologies, increased consumer demands, greater environmental awareness and government reforms. The industry is also being impacted by the global megatrend of digitalisation.

In a time of unprecedented change, it is difficult yet vitally important to gain an understanding of workforce impacts as, if left unaddressed, an under-skilled and under-trained network and wider electrical supply workforce could have a catastrophic effect on electricity supply. Such consequences range from compromised customer safety, an unreliable and unstable supply of electricity, increased consumer electricity bills and low consumer confidence and satisfaction, all of which will subsequently have adverse effects on the widespread adoption of emerging technologies.

Energy Networks Australia (ENA) – the peak national body representing electricity transmission and distribution network businesses within Australia – have partnered with Commonwealth Scientific and Industrial Research Organisation (CSIRO) to create an Electricity Network Transformation Roadmap (ENTR – referred to as 'the Roadmap'). The aim of the roadmap is to provide stakeholders and the Australian public with achievable actions and milestones as a pathway for the 2017-2027 period.

Energy Skills Queensland (ESQ) were commissioned to complete the Workforce Skills, Training and Personal Development work package paper within the scope-of-work of Domain D of the Roadmap structure. Domain D assesses the technological enablers that will require development to encourage a positive adoption of technology advances through the 2017 to 2027 period.

In collaboration with ENA, the key aims of the research were to:

- Develop proposed milestones and actions that will provide key stakeholders of the Roadmap with the confidence that skills of the future workforce can be enhanced to meet the demands of the new technologies
- Identify occupations within the transmission and distribution network sector that are critical to enabling the successful implementation of emerging technologies into the current grid
- Identify skill sets that critical occupations within the transmission and distribution network will need to develop to integrate emerging technologies within the grid and/or to operate and maintain new and emerging technologies
- To achieve these desired outcomes, this report has been designed in the following three sections.

The first section provides readers with an overview of the current state of the Electrical Supply Industry (ESI) and individual network sectors. This section provides detailed commentary of challenges, trends and opportunities that have the potential to impact workforce skill requirements within the transmission and distribution sector between the 2017 to 2027 period. This section also provides a high-level overview of the current workforce characteristics in each sector to establish a base for section two – the future desired state.

The second section documents the future desired state of the ESI and individual network sectors, providing an explorative analysis of what occupations and skills will become essential to encourage a positive and successful adoption of emerging technologies. Analysis and subsequent inferences were

formed using specialist knowledge of industry stakeholders and subject matter experts, relevant published literature and available quantitative data.

The third and final section draws together the findings of sections one and two to develop a set of actions and milestones.

3 Methodology

To establish trends, opportunities and challenges faced by current network businesses and workforces, qualitative research was gathered from an array of sources including consultation with industry, relevant published literature and specialised expert reports published under the Roadmap initiative.

Quantitative data was sourced from several government departments, namely the Australian Bureau of Statistics (ABS) and the Australian Government Department of Employment (DoE). Detailed workforce data by occupation was only available through census collections and, at the time of compiling this report, this data was over 5 years old.

The research provides two sets of Industry and occupation employment projections throughout the first and second sections of the report.

- Projections sourced from the DoE illustrate forecasted industry and occupation employment trends to 2020. The projections commenced at 2015 and have been based on detailed data from the ABS Labour Force Survey. The DoE website states that *Employment projections are derived from best practice time series models that summarise the information within a time series and then subsequently converted into a forecast. Projections are made by combining forecasts from Autoregressive Integrated Moving Average (ARIMA) and Exponential Smoothing With Damped Trend (ESWDT) models with some adjustments to take into account research undertaken by the DoE and likely future industry, occupational and regional developments.*

Forecasts to 2027 have been forecasted through historical trends. Industry forecasts have been based on trends experienced between November 2009 to November 2006 and occupations from trends experienced between November 2006 to November 2016. As outlined below, findings of section two of this report provide an explorative analysis of critical occupations and skill sets for technological enablement. Findings were generated using a stepped process, and designed to enable research-led inferences.

1. Step one involved extensive consultation with industry stakeholders including a workshop with transmission and distribution representatives, as well as the provision of industry survey questionnaires provided to wider industry stakeholders. Both forms of data collection required participants to rate the impact of emerging technologies on occupations that were sourced from the Australian and New Zealand Standard Classification of Occupation (ANZSCO) unit classifications.
2. Step two involved extensive desktop research of published literature which examined the requirements of the future workforce. This literature review was broad in nature and was not restricted to research within the electricity sector.
3. Step three involved the consolidation of data from steps one and two, identifying eight workforce enabling groups and their associated critical skill drivers.
4. Step four involved targeted industry consultation, predominantly in the form of research interviews, with subject matter experts to identify and reaffirm the critical occupations and skill set within each workforce enabler group.

The third and final section of this report identifies actions and milestones through the design of eight initiatives, developed in collaboration with ENA representatives.

This research has been designed to identify **critical** occupations and skill sets, both existing and required. If occupations are not mentioned, it does not signify their lack of importance for the future workforce and instead, signifies that they have not been identified within this research as critical to enabling emerging technology. No distinctions or assertions have been formed on whether the critical skill requirements recognised will be sourced internally or contracted out to third parties.

4 The Current Workforce

Prior to undertaking an explorative analysis of future skill requirements, it is first pertinent to establish an accurate interpretation and understanding of the current workforce characteristics, and industry trends that have potential to impact the skill requirements of the transmission and distribution workforces.

4.1 Electrical Supply Industry

The current ESI can be separated into four interconnected yet succinct industry sectors:

1. Generation
2. Transmission
3. Distribution
4. Retail.

These sectors form a relatively simple and centralised operating model that provides a secure and efficient supply chain structure. The consumer has traditionally been a passive 'end user' of the supply chain, and has very little communication with any sector other than retail organisations, except in cases of loss of supply and emergencies.

A convergence of trends, from deep regulatory reform and a transition from a centralised grid to a highly-distributed grid (high level differences summarised in Table 1) that accommodates disruptive emerging technologies such as Distributed Energy Resources (DER), are beginning to reshape the national ESI. These changes are unprecedented in their magnitude and imply a fundamental shift in how electricity is produced, distributed and consumed in Australia; other countries throughout the world are also experiencing similar changes.

Table 1 - Fundamental characteristics of conventional electricity grids and smart electricity grids

Conventional Grid	Smart Grid
Centralised generation	Distributed generation
Limited energy storage	Increased energy storage
Limited real-time data	Increased real-time data
One way power flows	Bi-directional power flows
Passive consumer	Active consumers

(Source: Agelidis, 2011)

In the 2015 Energy Skills Queensland's 'A Changing Industry and Changing Workforce' discussion paper. It was concluded through the extensive review of published literature that the emergence of smart technology was frequently considered the overarching catalyst of workforce and skilling impacts when compared to other trends driving the transformation. Inclusive in the paper's findings was that a smart grid will require new skills across the industry, skills deepening from traditional roles and a more diverse skills' requirement for those working alongside the industry.

The discussion paper summarised that the following three industry level workforce groups within the ESI had commonly been identified as the highest impacted because of smart technologies:

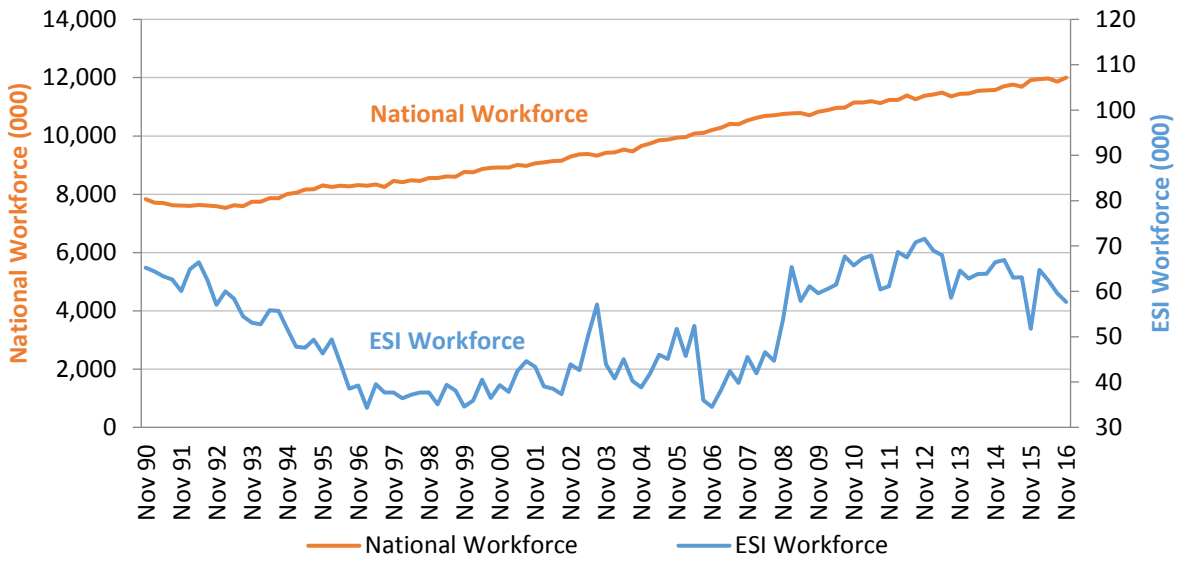
- DNSPs
- Supply chain organisations operating in areas such as telecommunications overlays or software integration
- Electrical contractors providing new 'smart' services to domestic, commercial and industrial markets.

In November 2016, total ESI employment (includes both full-time and part-time), was 57,700 persons, which equated to approximately 0.5% of the national workforce (total of all industry divisions reported within ANZSIC as a collective). Figure 4 provides a historical analysis of the employment trend within the ESI in comparison to the national workforce.

The national workforce has experienced a consistent, linear and sustainable growth since 1990. In stark contrast, the ESI has experienced sporadic peaks and troughs over the same period, indicating that employment levels within the ESI have been somewhat volatile. A significant depression of employment levels was evident during the prolonged 12-year period between 1996 to 2008. Encouragingly, subsequent and comparatively stable employment has been recorded post 2008.

It is noted that employment data, sourced from the Australian Bureau of Statistics (ABS) is based on employees by main industry of employment. It was commonplace for ESI companies in the late 1990's and early 2000's to hire contractors, which could potentially explain why the depression of employment was recorded.

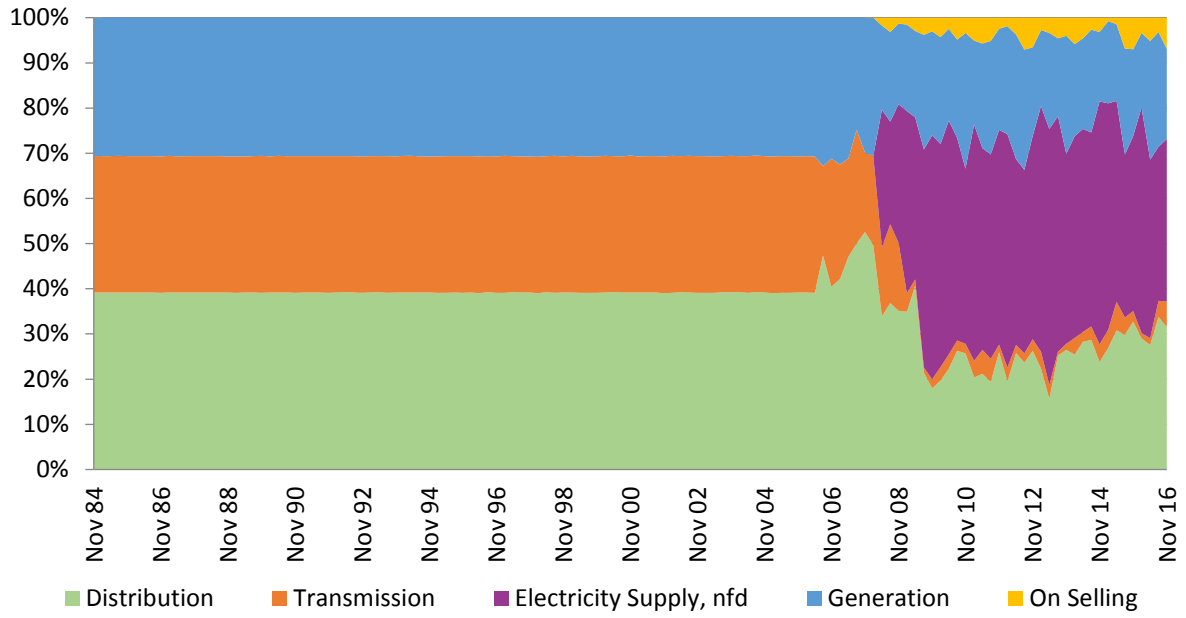
Figure 4 - Comparative analysis of total employment within the national ESI and the national workforces



(Australian Bureau of Statistics– Category 6291.0.55.003)

Figure 5 provides a visualisation of the historical composition of the four ESI industry sectors as a percentage of the total ESI workforce.

Figure 5 – Historical composition of the workforce by industry sector as a percentage of the total ESI



(Australian Bureau of Statistics– Category 6291.0.55.003)

During the November 1984 to November 2005 (21 years) period, the compositional share of each sector (only three sectors were reported on during this period – generation, transmission and distribution) as a percentage of the total ESI workforce experienced marginal, if any, change.

In 2008, a change to the ANZSIC classifications and data collection methodologies of the ABS was implemented. In the reclassification, two new reporting sectors were established:

1: On-selling and market operations
2: Electrical Supply Not Further Defined (NFD).

Shortly before the adoption of the new data collection methodology, the first noticeable change within the composition of the ESI workforce was experienced. Immediately after the reclassification, notable changes to the value of each sectors employment share occurred. Particularly, employment within the transmission sector which decreased significantly; the on-selling and market operations sector accounted for a minimal proportion of the total ESI workforce; and the increase in the Electrical Supply NFD sector was significant.

Since the introduction of the Electrical Supply NFD sector within ANZSIC, the average time series workforce size of this category has been 27,700 employees. This category accounts for a significantly higher average workforce than any other sector over the same period; for context, the distribution sector is the second highest with an average of 16,500 employees.

Subsequent growth within the Electricity Supply NFD category coincided with significant declines within the distribution and transmission workforces (i.e. in May 2006, the transmission workforce equated to 30.2% of the total ESI workforce, whereas the 2009 period equivalent was 1.4%).

In stark contrast to the pre-reclassification period, fluctuations within the compositional share within each respective sector's workforce have been evident post the implementation of new data collection methodologies.

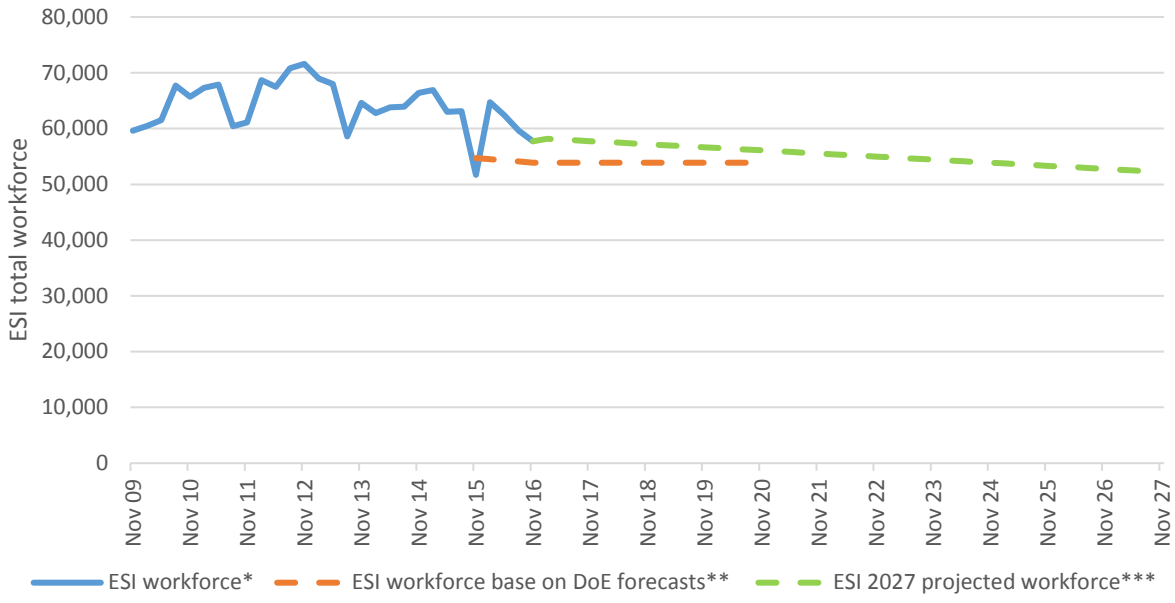
Clearly, the Electrical Supply NFD[5] category is a significant contributor to the ESI workforce. However, for the purposes of this report, the Electrical Supply NFD category will not form any further part of this research as there is no valid method to determine what proportions of the category fall within the transmission and distribution industry sectors. In addition, all further industry specific employment analysis was conducted using data from the November 2009 quarter in order to negate any changes to the ANZSIC classifications having an impact on the analysis.

At a time of complex change and transformation in the ESI, projecting the future workforce is difficult at best. With a view of providing a comprehensive analysis of forecasts, two sets of projections have been provided:

1. Projections undertaken and published by the DoE in 2016 through predictive modelling from 2015 to 2021
2. Forecasts to 2027 have been calculated based on the employment trends experienced between November 2009 to November 2016.

Figure 6 combines the ESI historical employment trend with both the forecasted 2027 and DoE 2020 projections. Predictive modelling undertaken and published by the DoE in 2016 predicts that total employment within the ESI will decrease by 7.6% or 4,200 persons during the five-year period ending November 2020, for the purpose of this report projections are assumed to decrease in a linear fashion.

Figure 6 - Historical national ESI total employment trend and ESI total employment projections



*(Australian Bureau of Statistics– Category 6291.0.55.003), ** (Australian Government: Department of Employment, 2016)
***Projected 2027 workforce has been calculated based on the workforce trend experienced between November 2009 and November 2016

[5] ABS have advised that the NFD category includes workers that are employed for organisations that have cross sector functions within the ESI industry i.e. a worker that is employed for an organisation that has both distribution and retail functions

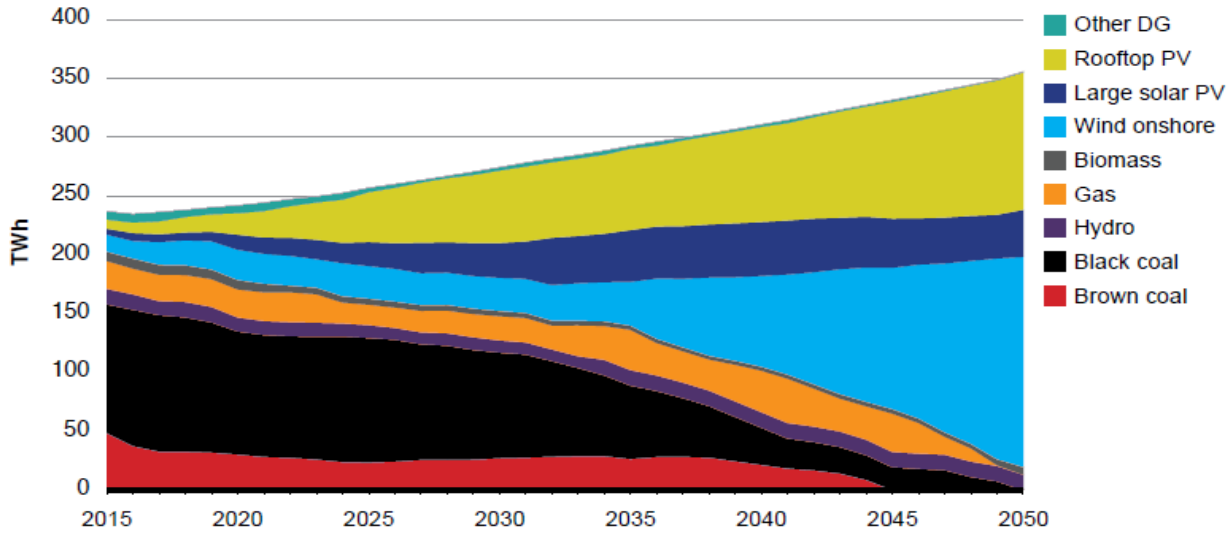
4.2 Electrical Transmission Sector

A Transmission Network Service Provider (TNSP) is responsible for the bulk movement of electrical energy from a generating site to an electrical substation. The interconnected lines which facilitate this movement are known as a transmission network. Transmission companies operate in highly-regulated environments, and are natural monopolies, meaning that each state has only one TNSP.

The significant challenge facing the transmission industry is that the network will require transformation from the traditional centralised model, where electrical energy is transferred from a relatively small number of fossil-fuelled power plants, which provide a reliable and constant supply of electricity, to a decentralised and more complex grid that transports electrical energy from a much higher number of sources. In the short-term, total generation requirements will be from a mix of traditional fossil fuel plants and renewable energy sources; however, the proportion sourced from renewable sources is projected to see growth as the nation progresses towards renewable energy targets such as the Australian Department of Environment and Energy's reformed Renewable Energy Target[6], published in 2015.

Figure 7 outlines plausible national energy generation projections for Australia to 2050.

Figure 7 - Plausible projections of Australia's changing energy mix to 2050



(Electricity Networks Australia , 2016)

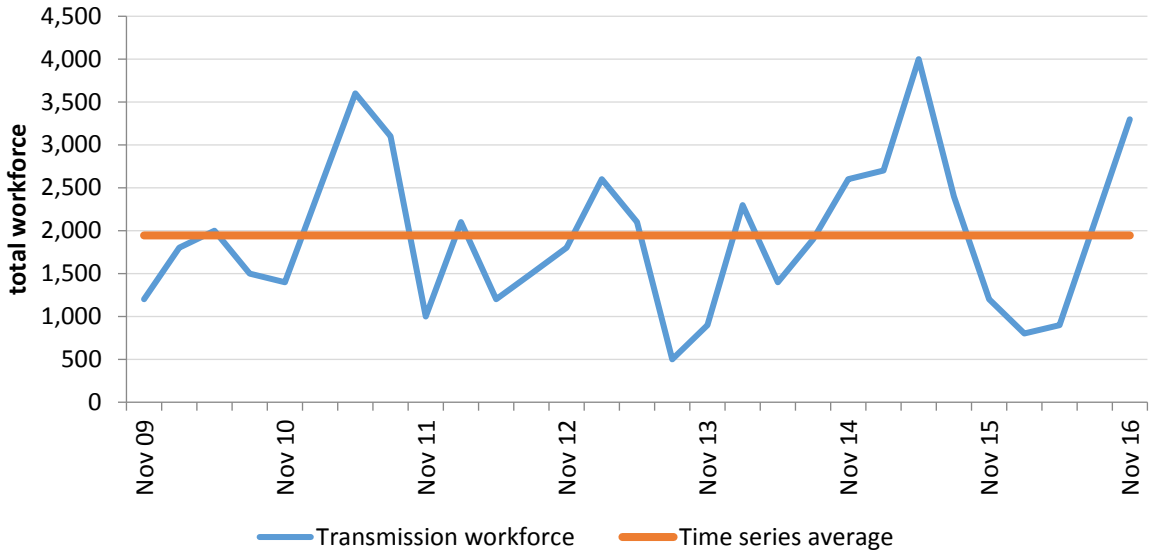
Transition from coal generated electricity to renewable generation is complex due to varying characteristics. A fossil fuel plant generates electricity and stable levels of system inertia to the grid through the burning of coal to create steam that subsequently generates electricity through the spinning of a turbine. In contrast, inertia is not as easily achieved with renewable energy due to its intermittent nature. For example, solar farms do not depend on moving parts whilst wind farm turbines will rotate in windy conditions but have lower inertia qualities when air is calmer.

The transmission workforce will also play a critical role in ensuring the security of power systems as the network progresses to a grid with smart assets that are more open to cyber-attack.

[6] "The new target for large-scale generation of 33,000 GWh in 2020 will double the amount of large-scale renewable energy being delivered by the scheme compared to current levels and means that about 23.5 per cent of Australia's electricity generation in 2020 will be from renewable sources".

The workforce supporting the transmission sector is relatively small in size and averaged 1,900 employees during the November 2009 to November 2016 period. During this period, as highlighted in Figure 8, two significant yet shortly lived spikes in employment levels were recorded, with the most recent and significant in May 2015 when the workforce accommodated 4,000 employees, over twice the time series workforce average. Depressions in the size of the workforce have been common as well. In February 2016, a workforce was recorded of 800 employees, over 1,000 fewer employees than average and a decline of 400% when compared to the significant spike that was recorded in the May 2015 quarter, 9 months previous.

Figure 8 – National transmission sector total employment trend



(Australian Bureau of Statistics– Category 6291.0.55.003)

The complex nature of the work performed within the transmission network requires a highly skilled and educated workforce to undertake its operations; this is highlighted in Table 2, where it is evident that a significantly higher proportion (43.6%) of the workforce have obtained a bachelor degree or higher qualification, in comparison to the ESI (25.8%) and national workforce (25.9%) equivalents. Table 2 also highlights that the proportion of the transmission workforce that are bachelor degree or higher qualified increased significantly by 5% when compared to the 2006 equivalent. This increase is again higher than both the ESI and national workforce counterparts.

The transmission workforce had a higher proportion of its workforce who were 45 years and over than both the ESI and national workforce equivalents. However, a significant proportion of the workforce, as outlined in Figure 9 are Electrical Engineers, and as discussed in section 6.1.1 of this report the average age of engineers has declined since 2015.

Table 2 – National transmission sector workforce by educational attainment and age in comparison to the ESI and national workforce equivalents

Sector	Qualification Attainment		Age			
	Bachelor degree or higher	VET qualification	15-29	30-44	45-59	60+
Transmission Sector	43.6% ▲5%	41.6% ▼-1%	18.5% ▲2.8%	36.4% ▲1.1%	38.0% ▼-3.9%	7.2% ▲0%
Electrical Supply	25.8% ▲4.9%	50.7% ▼-0.2%	21.4% ▲1.8%	37.9% ▲1.2%	34.3% ▼-2.2%	6.4% ▲1.5%
National Workforce	25.9% ▲3.7%	32.6% ▲2.1%	26.4% ▼-0.5%	33.7% ▼-1.5%	31.0% ▼-0.1%	9.0% ▲2.2%

(Australian Bureau of Statistics - 2011 Household Census), (Australian Bureau of Statistics - 2006 Household Census)

▲▼ - Proportional percentage increase/decrease recorded in the composition of the 2011 workforce when compared to the 2006 comparative

The transmission sector had 2,747 employees as at the 2011 census, which was comprised of a total of 94 ANZSCO unit level classifications. Figure 9 provides the following information for each ANZSCO unit classification that accounted for 1% or over of the transmission workforce[7] as at the 2011 census:

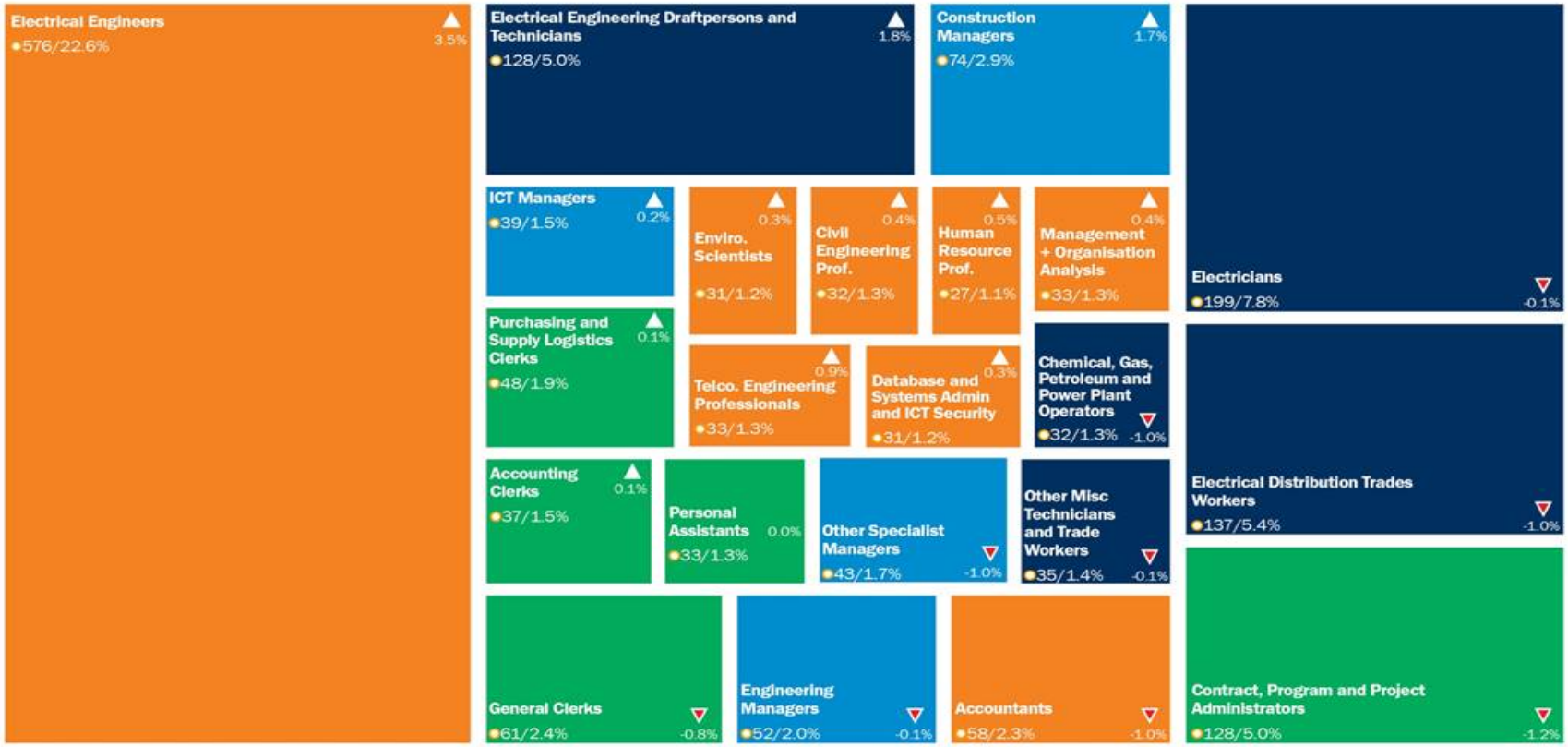
- What major ANZSCO category the unit occupation is categorised in
- The number of employees classified under the unit classification, and the percentage that the unit classification accounts for when compared to the total transmission workforce
- The proportional increase/decrease that the unit classification experienced between the 2006 and 2011 census

The following findings have been established from the tree diagram

- Electrical engineers account for a significant (23%) proportion of the transmission workforce; it was also the occupation that experienced the strongest growth when compared to the 2006 census comparison.
- Excluding a decrease in accountants (which make-up a small proportion of the total workforce), increases were recorded in all occupations within the professional category.
- The bulk of the transmission workforce comprises occupations that are classified within a range of major ANZSCO categories, predominantly professionals and technical and trades persons.
- Three of the five unit classifications categorised under the technical and trade major classification recorded small declines when compared to the 2006 equivalent. Electrical Engineering and draftspersons (Engineering technical officers) recorded the highest growth rate when compared to the 2006 equivalent of any technical and trade classification.

[7] ANZSCO classifications that were introduced after the 2006 census have been excluded from this diagram as comparisons cannot be made. In total, all occupations excluded accounted for 197 workers, no one occupation is considered significant in size – of the 197 workers 146 are classified in NFD occupation categories. All figures have been based on the 2550 workers employed within comparable occupations.

Figure 9 - Electricity transmission sector by occupation by proportional size



(Australian Bureau of Statistics - 2011 Household Census) (Australian Bureau of Statistics - 2006 Household Census)

☆ – The number of total workers under that unit classification and the percentage of the unit's value when compared to the total transmission workforce

△ ▼- Percentage increase/decrease recorded in the proportional value of the 2011 workforce when compared to the 2006 comparative

The ANZSCO major category that the unit classification belongs to under the ANZSCO structure

Professional Technical Trades Managers Clerical and Administrative Labourers

4.3 Electrical Distribution Sector

Electricity distribution is the final stage in the delivery of electric power; it carries electricity from the transmission system to individual consumers. Distribution substations connect to the transmission system and lower the transmission voltage through the use of transformers. Primary distribution lines carry this medium voltage power to distribution transformers located near customers' premises.

Distribution transformers lower the voltage to the utilisation voltage of household appliances and typically feed several customers through secondary distribution lines at this voltage. Commercial and residential customers are connected to the secondary distribution lines through service drops. Customers demanding a much larger amount of power may be connected directly to the primary distribution level or the sub-transmission level.

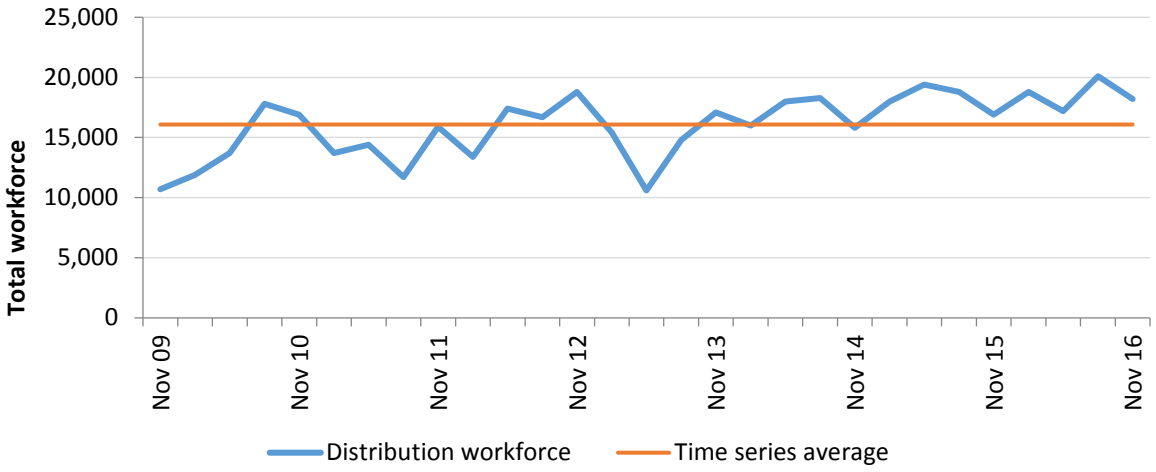
In 2015, ESQ's 'A Changing Industry, A Changing Workforce' discussion paper identified the distribution network workforce, as one of the most impacted industry workforce groups because of the demand for increased and more diverse skills required by smart technologies.

For distribution network operators, developing a smart grid means the integration of various technologies and devices on the grid-side of the network. These can improve the management of power supply, allow bi-directional network flows, and provide real-time data on system wide operations (Australian National Audit Office, 2014).

Emerging technologies are providing opportunities for DNSPs to evolve traditional operating model and offer new energy services. Such changes would see DNSPs becoming a lot more consumer focussed through offerings such as behind the meter services – including acting as the installer/maintainer of residential energy storage devices.

Figure 10 presents the historical national employment trend for the distribution network industry. Whilst an outlier is present at the commencement of the data set – which may be an overlay of the change to ANZSIC coding in 2008 - the DNSP total employment levels have been relatively steady when compared to its time series average (16,082). Workforce stability has been present in recent quarters, with above average recordings being evident since February 2015. However, significant employment reductions within the NSW distribution sector are expected before 2018.

Figure 10 - Distribution Sector - national total employment trend



(Australian Bureau of Statistics– Category 6291.0.55.003)

As at 2011, the majority of the distribution network workforce (55.9%) possessed VET qualifications, either an Advanced Diploma or Certificate. The proportion of the distribution workforce with VET qualifications is significantly higher than the national workforce average.

When compared with the 2006 equivalents, most growth within the distribution sector was recorded in the population of the workforce that had attained a Bachelor Degree or higher (a growth of 4.4%) as outlined in Table 3.

The distribution sector appears to have a healthy composition of employees in a cross sector of age brackets, and had a lower proportion of its workforce aged in the 60 and over bracket compared to the national workforce equivalent.

Table 3 - National distribution sector workforce by educational attainment and age in comparison to the ESI and national workforce equivalents

Sector	Qualification Attainment		Age			
	Bachelor degree or higher	VET qualification	15-29	30-44	45-59	60+
Distribution Sector	21.8% ▲4.4%	55.9% ▲1%	20.2% ▲0.5%	38.9% ▼-1.2%	34.3% ▼-1.2%	6.6% ▲1.9%
Electrical Supply	25.8% ▲4.9%	50.7% ▼-0.2%	21.4% ▲1.8%	37.9% ▲1.2%	34.3% ▼-2.2%	6.4% ▲1.5%
National Workforce	25.9% ▲3.7%	32.6% ▲2.1%	26.4% ▼-0.5%	33.7% ▼-1.5%	31.0% ▼-0.1%	9.0% ▲2.2%

(Australian Bureau of Statistics - 2011 Household Census), (Australian Bureau of Statistics - 2006 Household Census)
▲▼ - Proportional percentage increase/decrease recorded in the composition of the 2011 workforce when compared to the 2006 comparative

As at 2011 census, the workforce of the national DNSP sector was comprised of 29,803 workers, within 175 ANZSCO unit classifications. The following distribution sector workforce analysis can be deduced from Figure 11, which illustrates the following information for each ANZSCO unit classification that accounted for 1% or over, of the distribution workforce[8]:

- What major ANZSCO category the unit occupation is categorised in
- The number of employees classified under the unit classification, and the percentage that the unit classification accounts for when compared to the total transmission workforce
- The proportional increase/decrease that the unit classification experienced between the 2006 and 2011 census

The following findings have been established from the tree diagram;

- The workforce is heavily populated with technical and trade major classifications
- By volume of employees, electrical distribution trades workers (Cable Jointers and Linesworker) and Electrical Tradespersons (Electricians) were the most populated occupations. Whilst the proportion of the workforce employed as electrical distribution trades workers remained the same when compared to the 2006 comparative, electricians declined by -0.7% .
- A total of eight clerical and administrative major classifications were represented of which six recorded declines when compared to 2006

[8] ANZSCO classifications that were introduced after the 2006 census have been excluded from this diagram as comparisons cannot be made. In total, all occupations excluded accounted for 2,563 workers, no one occupation is considered significant in size – of the 2,563 workers 1,778 are classified in NFD occupation categories. All figures have been based on the 27,240 workers employed within comparable occupations.

- Electrical Engineers recorded the strongest growth when compared to 2006
- Excluding a insignificant decline in Accountants, occupations that fall under the professional and manager classifications experienced increases

Figure 11 - Electricity Distribution sector by occupation by proportional size

(Australian Bureau of Statistics - 2011 Household Census), (Australian Bureau of Statistics - 2006 Household Census)

☆ – The number of total workers under that unit classification and the percentage of the unit's value when compared to the total distribution workforce

△ ▼- Percentage increase/decrease recorded in the proportional value of the 2011 workforce when compared to the 2006 comparative

The ANZSCO major category that the unit classification belongs to under the ANZSCO structure

Professional Technical Trades Managers Clerical and Administrative Labourers

5 Critical Skills Analysis Observations

Demand for new skill sets is not an overnight requirement, yet forward planning is a must; particularly for job roles which can require up to 10 years of training and skill development to be fully competent

The introduction and adoption of emerging technologies is increasingly fast paced and fluid, yet mass adoption of technology by the Australian public does not occur instantly and without warning. This provides network organisations and the wider supply chain with an opportunity to plan. A key method of identifying required skills for technological advances is through technological trials. Trials are occurring throughout network companies nationwide and provide organisations with excellent insight into technical issues and skills gaps that must be addressed.

ESQ encourages and recommends these critical trials to identify workforce skill requirements needed to enable the successful and safe adoption of such technology.

The need for specialists

The skill set of specialist occupations will become more pivotal to the energy industry's progress. Specialists will be required to identify, analyse, develop, support, operate and complement digitalised technologies.

Specialist skill sets will play, and are already playing, an increasingly important part within the networks' workforce. As identified in Table 2 and Table 3, the proportion of the 2011 workforce that were degree qualified or higher in both the transmission and distribution workforces increased significantly when compared to the 2006 equivalent. These increases were higher than the national workforce equivalent. Figure 9 and Figure 11 identify that occupations requiring higher skill levels recorded a healthy growth when the 2011 equivalent was compared to 2006.

Consolidation of extensive industry consultation and research of literature has provided eight technological enabling workforce groups as a basis for further analysis (section 6.2 of this report). The critical occupations within the groups tend to be specialists in their fields and/or require higher education qualifications. A well-documented requirement for specialists within the network industry is the need for cyber security specialists who will be responsible for ensuring the integrity of grid assets and consumers' personal information.

Whilst this research concentrates on the network workforce, the need for specialist skill sets is increasingly evident within the wider Australian economy and documented in numerous literatures. In 2016, CSIRO concluded that the demand for occupations requiring specialist skill sets will double in 2019 when compared to the 1991 equivalent. Literature suggests that the introduction of digitalised technologies and services also requires a higher level of skills for entry level occupations, as workers will be required to operate and support more complex automated systems (CSIRO, 2016).

The data below, sourced from the DoE, highlights that the projected percentage growth within skill levels one (Bachelor degree or higher) and two (Advanced Diploma or Diploma) significantly outweighs projections for employment within skill levels three, four and five. Highlighting that the requirements for a skilled and educated workforce is expected to increase within Australia by 2020.

Table 4 - National employment projections across all industries by skill level

Skill Level	Employment level November 2015	Projected employment level November 2020	Projected employment growth five years to November 2020	
	('000)	('000)	('000)	(%)
Skill level 1 - Bachelor degree or higher qualification	3,723.0	4,205.9	482.9	13.0
Skill level 2 - Advanced Diploma or Diploma	1,363.8	1,514.4	150.5	11.0
Skill level 3 - Certificate IV or III (including at least 2 years on-the-job training)	1,733.2	1,805.7	72.6	4.2
Skill level 4 - Certificate II or III	3,043.1	3,257.8	214.7	7.1
Skill level 5 - Certificate I or secondary education	2,037.4	2,106.4	69.0	3.4
Total	**11,900.5**	**12,890.2**	**989.7**	**8.3**

(Australian Government: Department of Employment, 2016)

Both VET and University systems are critical to the future of the network sector. As illustrated in Table 2 and Table 3, the network sector relies heavily on VET and University sectors to provide training to their respective workforces.

Effective relationships between industry and these educational systems must be established, maintained and enhanced. Such relationships are proving fruitful in certain sectors of the network workforce. For example, Electrical engineering representatives have advised that the relationship developed between universities offering power engineering courses is demonstrating a healthy result on the national curriculum. In contrast, there appears to be a clear disconnect between industry and the VET sector over the design of the cable jointer apprenticeship, industry has reported that this has resulted in certain states establishing in-house pathways as opposed to VET accredited apprenticeship pathways. Analysis of apprenticeship data has revealed that minimal commencements have been recorded in Western Australia, South Australia, Tasmania, Northern Territory and the Australian Capital Territory in the last decade.

With the rapid and fluid nature of technological advances becoming the norm, robust and relevant course design requires urgent development.

Amalgamation of traditional network skills and digitalised skills

Emerging technologies will bring the requirement for new skill sets and the creation of new occupations that may not currently exist within the industry. This does not mean traditional skill sets necessarily become redundant, and they will need to remain, either wholly or in part, within the education syllabus.

Asset Management will require the blending of traditional and digitalised skills. New assets will have increased digital capabilities where Information Technology / Operational Technology systems amalgamate with increased capabilities. Legacy equipment with lifespans exceeding 30 years will require modernisation by the installation of new sensors and reporting capabilities.

The inspections of these assets will further require the adoption and leverage of current technologies, including the use of unmanned vehicles and drones as mechanisms to assist with asset inspection.

This will require Engineers to possess the necessary skills to manage this internetworking of physical devices and traditional asset management skills.

Traditional technical roles, such as engineering and trades, will be where the bulk of the skill gaps and skill supplementation requirements appear, yet the skill sets of other occupations such as data and ICT specialists will also be critical.

The ability and desire for continued lifelong learning is essential

The speed of implementation of new technologies is not expected to slow, and industry experts support the opinion that flexibility, adaptability and a desire for continuous lifelong learning are all seen as required attributes, regardless of the employee's occupation, skill level and age.

Important common skills for all employees to acquire include:

- Increased digital literacy
- Increased knowledge of cyber security protocols
- Intuitive knowledge of technology
- Increased Information Communication and Technology (ICT) skills
- Increased understanding of customers energy requirements.

The New Basics report (AlphaBeta, 2016) identified a set of eight transferable skills referred to as 'enterprise skills' which will become increasingly important in many jobs, and essential skills for the future workforce:

- Problem-solving
- Communication
- Financial literacy
- Critical thinking
- Creativity
- Teamwork
- Digital literacy
- Presentation skills.

The need for a Systems Thinking mindset' [9]

Emerging technologies have smart interconnected capabilities; the connected nature of new technologies will increase the requirement for systems thinking skills within the technical workforce. This skill set is required for the installation and maintenance of technology to ensure the equipment is configured correctly.

Science, Technology, Engineering and Mathematics (STEM)

The importance of STEM within the future world is well documented, with literature concluding that 75% of occupations experiencing the fastest growth require STEM skills (Becker & Park , 2011). In 2015, the Australian Government concluded that STEM skill sets are included in the skills universally accepted as necessary for the future workforce (Australian Government Productivity Commission, 2015).

When assessing the importance of STEM in the context of the Australian electricity supply sector, the Australian Government Productivity Commission highlights the ICT needs of the installer/maintainer of emerging technologies, who will be predominantly electrical contractors

[9] *'The ability to understand the complexities of creating a connected network of products. Connectivity of devices through sensor technology, that transmits data feeds to the internet, will require a deeper knowledge of ICT and cabling. Skills also associated with this type of thinking include skills such as digital literacy, platform thinking, problem-solving and critical thinking.'*

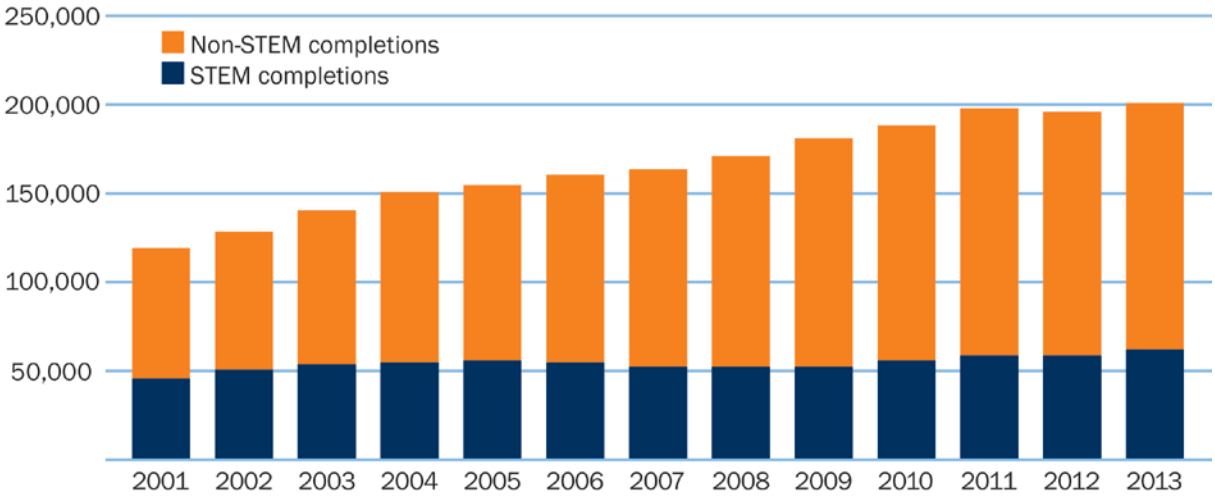
trained via the VET system. STEM encompasses a broad range of skills, but from observations of emerging technologies, there are areas of growing importance. Some examples include:

- *"In the energy sector, the emergence of household solar photovoltaic, battery storage and smart metering will require installation technicians for connection and maintenance of this infrastructure. Knowledge of new technologies, as well as skills in data analytics and information, and communications technology (ICT), will also be required*
- *The rapid collection of large data sets has led to the need for data scientists with skills in the manipulation and statistical analysis of big data*
- *Similarly, these big data sets have also given rise to the development of machine to machine learning and artificial intelligence — increasing the demand for high level maths and computer programming skills*
- *Certain computer software and have a greater understanding of material science and quality assurance systems."*

(Australian Government Productivity Commision, 2016)

Figure 12 highlights that whilst the number of students completing degrees in higher education has increased over the 2001 to 2013 period, the number of STEM course completions have largely plateaued over this period in Australian universities.

Figure 12 - Number of students completing degrees in STEM[10]



(Pricewaterhouse Coopers, 2015)

In 2016, CSIRO highlighted falling interest and performance in STEM subjects, with 11% fewer year 12 students studying mathematics today than in 1992 (Kennedy, Lyons, & Quinn, 2014).

A common misconception within community is that STEM qualifications are restricted to universities, however, as at the 2011 census there were 2.3 million STEM qualifications in Australia and approximately two-thirds of these were VET qualifications (Australian Government Office of the Chief Scientist, 2016).

[10] STEM qualifications include degree completions in natural and physical sciences (including mathematics), information technology, engineers and related technologies, architecture and building, and agriculture, environmental and related studies.

6 Technical/Business-Related Requirements, Skills Drivers and Workforce Enabler Groups

Four broad technical and business-related requirements were identified that network organisations must achieve to enable successful integration of emerging technologies. These are:

1. Integration of Emerging Technologies
2. Grid Architecture and Design
3. Consumer Centric Networks
4. Organisation Structures.

Identified occupations that possess or will be required to possess the skills to achieve these broad network organisation requirements have been grouped into the following eight key technology enabling workforce groups:

1. Engineering
2. Engineering Technical Officer
3. Technical Trades
4. Information, Communication and Technology (ICT) Specialists
5. Data Specialists
6. Executive Management
7. People, Culture, Communication and Change Officers
8. Customer Services

The relationships of the identified broad network requirements and accompanying workforce enabling groups are outlined in the below infographic (Figure 1). Where the workforce enabler group is listed under the network requirement, it indicates that the future and/or current skill sets of that workforce enabler group are essential in assisting the network organisation meet that requirement.

Figure 1 – Identified relationships between workforce enabler groups and broad network requirements/critical skill drivers

6.1 Technical and Business-Related Requirements

The following section provides an overview of each network requirement and their subsequent critical skills driver.

6.1.1 Integrating Emerging Technologies

Systems Integration and behind the meter technology

Emerging systems and design processes are stimulating an increase in integrated system design, driving a higher dependency on the technical capacities of installers, maintainers and designers alike.

Safety Requirement

Emerging technologies, such as battery storage devices, will pose new safety requirements. Installers/maintainers will require upskilling to manage different and/or increased safety requirements successfully. Management and operational staff will require education and rapid awareness of regulation and licensing changes due to the implications on workforce and safe systems of work.

Cyber Security

The emergence of smart technologies increases the risk of cyber-attack, and relevant workforce skills, security measures and protocols will be required to address this risk. Technologies such as smart meters will transmit a constant flow of data between the consumer and the network provider. If this information is unsecured, it will become a major deterrent to consumer adoption.

Furthermore, an unsecure national grid has the potential for detrimental impacts on the national economy.

6.1.2 Grid architecture and design

Power Systems Security and Reliability

Power systems security and reliability is considered a fundamental of the service that network businesses must provide to the Australian public. Traditionally, the supply of electricity has been from power plants, however with increasing volumes of generation sourced from renewables and rooftop solar, in combination with the emergence of DER that enable the bi-directional flow of electricity, new technical challenges arise. Such technical areas have been outlined in the EA Technology, Network Transformation Roadmap: Innovation Gap and Analysis Plan Report (2016) and include:

- Demand / Generation Response
- Dynamic ratings
- Electrical energy storage
- Network management
- Voltage management
- Fault Level Management
- Network simulation and modelling
- Energy efficiency
- Smart meters and Time of Use tariffs.

Asset Management

The characteristics of network assets are changing with the amalgamation of IT and OT systems, in combination with advanced digitalised assets which are more ICT based and have advanced capabilities such as IoT. Asset Management Engineers will be required to:

- Work with real time data and smart controls to ensure frequency control and loss prevention through automated infrastructure
- Undertake data driven maintenance through predictive maintenance and outage prevention tools
- Interpret advanced analytics to optimise grid development
- Positively manage regulatory revenues
- Increase consumer benefits through automated processes
- Improve field force efficiency
- Identify business opportunities through digital revenue streams and identify business activities based on insights.

6.1.3 Customer Centric Networks

Consumer Relationship Management and Collaboration Protocols

Consumers are considered a key catalyst of the wider electricity industry transformation, and are demanding to be more than just the end user. The Roadmap key concept report concluded that consumers and/or their agents will determine how $200 billion in system expenditure will be spent by 2050. The potential exists for DNSPs to evolve operating model which will require significant increases in customer contact. To enable a customer centric grid, businesses are going to be required to develop measures to establish these relationships and support their consumer needs.

Consumer Education Pathways

As part of the Roadmap, ENA developed four explorative scenarios depicting consumer behaviour:

a. Leaving the grid
b. Rise of prosumers
c. Set and forget
d. Renewable thrive.

Whilst projected consumer behaviours and characteristics differ within these scenarios and the level of interaction of consumers with technologies varies, increased understanding of emerging technologies will be required for all consumers. A lack of understanding will greatly impact on the adoption rate and efficient technology utilisation.

Digitalised Consumer Services

Digitalisation is a megatrend impacting all industries globally. A key characteristic of digitalisation is that technologies are blurring the lines between reality and digital spheres. Consumers' behaviours are changing and digital services are becoming the norm. Such services include applications (apps), social media and internet platforms which enable services such as peer-to-peer trading.

6.1.4 Organisational Structure

Business Operating Models

The evolution of the DNSP operating model will need to be established to be sustainable and support the emergence of new technology, whilst not compromising the networks' traditional services.

Innovation Change Management

A major challenge that network organisations face is the requirement to integrate innovative technologies and services into large organisations. Innovation will require change which may be met with some resistance by traditional workforces.

6.2 Critical Skills Drivers and Workforce Enabler Groups

This section of the research provides an overview of the skill requirements, in addition to an analysis of education and employment trends for occupations identified as critical within each workforce enabling group.

6.2.1 Workforce Enabler Group: Engineering

Engineers are highly skilled individuals that possess advanced mathematical, ICT and science skill sets. They are central to the design, planning, operation and maintenance of today's grid. The 2011 census showed that Electrical Engineers accounted for 7.4% (2,420 employees) of the networks combined total workforce. The broader discipline of engineering, including telecommunications, civil and industrial, mechanical and production engineers, accounted for 8.9% (2,909 employees) of the workforce.

The importance of Engineers in enabling the amalgamation of emerging technology within today's grid was consistently highlighted throughout both the industry collaboration and desktop research stages of this report.

In the 2015 "A Changing Industry; A Changing Workforce" discussion paper, Energy Skills Queensland concluded that the Engineering workforce within distribution network operators will experience a strong impact, as a result of the implementation of technologies contributing to the establishment of a smart grid. The catalysts for this impact were identified as the emergence of new types of integrative engineering skills, requiring a robust understanding of power engineering, electrical engineering, IT, bi-directional networks, intelligent networks, solar PV integration, data and telecommunications.

Seminal workforce skilling literature relating to smart grid technology, "The Smart Grid Workforce of the Future" (West Monroe, 2011), stated that across all smart grid sectors, Engineers require the highest competency levels.

The following roles and skill sets of Electrical Engineering have been identified as critical to the enablement of new or existing technologies:

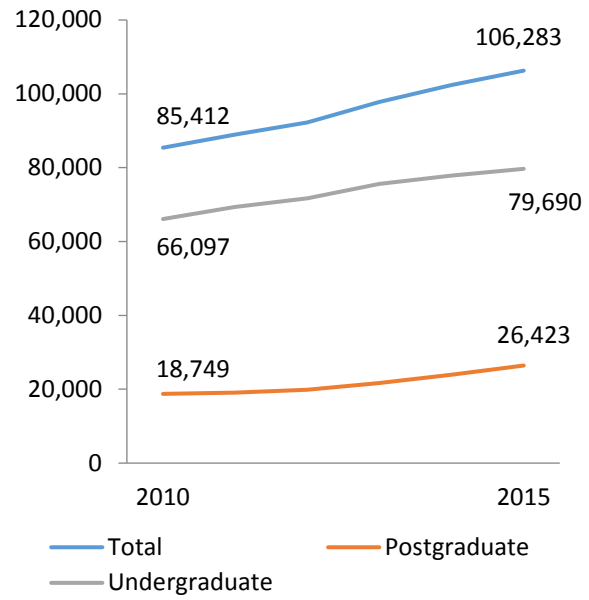
- Power Systems Engineers
- Network Planners: dynamic nature of power flows driven by DERs creating increased complexity
- Protection Engineers: increased DER and increased interaction of protection systems with SCADA and DMS functions
- Asset Management: Increased data and analytic requirements
- Environmental Engineers: DER integration and increased penetration of telecommunication requirements

6.2.1.1.1 Education: Engineering and Related Technologies

In Australia, to become a qualified Engineer, students are required to undertake a four-year tertiary undergraduate degree through an accredited university.

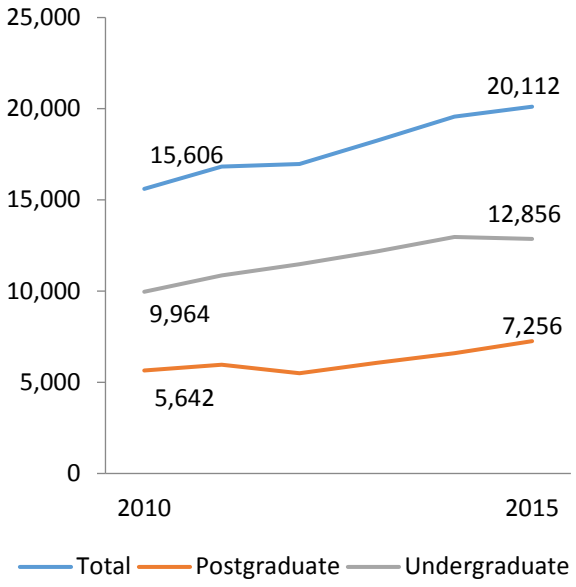
Trends highlighted in Figure 13 and Figure 14 indicate that key educational metrics - course enrolments and course completions – for engineering and related technologies in tertiary education have experienced positive cumulative growth since 2010. Education data is only available at the broad level of engineering; no specific data is available for engineering in electrical disciplines.

Figure 13 - Higher Education - Engineering and related technologies course enrolments



(Australian Government - Department of Education - UCube)

Figure 14 - Higher Education - Engineering and related technologies course completions



(Australian Government - Department of Education - UCube)

As is evident in the above figures, national course enrolments and completions have experienced increases from 2010 through to 2015. In the five-year period ending 2015, national course enrolments increased by 24% (20,871 enrolments). A relative percentage increase of 41% (7,474 enrolments) was particularly evident in postgraduate courses, whereas enrolments in the undergraduate equivalent were 21% (13,593 enrolments). Course completions between 2010 – 2015 experienced consistent relative percentage growth in undergraduate ranks - 29% or 2,892 course completions and postgraduate ranks - 29% or 1,614 course completions.

Whilst national education data specific to electrical engineering is unavailable, industry has reported that in the current environment, it is common for graduate vacancies to attract over 100 applicants. In addition API identified that in 2013 there were typically 165 applicants per graduate position advertised.

Industry has also reported that a strong and effective link has been established between the Australian power industry and Australian universities which deliver electrical engineering courses through their Electrical and ICT Engineering schools. This relationship has resulted in an industry driven curriculum for undergraduate power engineering courses, with a strong IT and renewable energy grid integration content. Content is continuously guided by the Industry through the Australian Power Institute (API), and proactively responded to by the Australian Power Education Academic sector through ACPE (Australian Committee of Power Engineering Professors). This link between industry and education ensures that skill requirements of tomorrow's Engineers will improve and align with the requirements of the power systems of the future.

The API is a highly regarded and respected engineering industry body that supports the Australian power industry through their organisational objectives, which are:

- Provide a sustainable supply of quality power engineering graduates to energy industry
- Facilitate a strong power engineering education platform
- Coordination of industry and university innovation initiatives.

The API undertake a bi-annual workforce planning skills and demand in industry report (skills and demand in industry report) to provide industry stakeholders with accurate information on both the supply and demand of power engineers. The most recent report undertaken found that, graduates who rated with 'average to strong skills' increased from 53% in 2013, to 83% in 2015 (Australian Power Institute, 2015). The positive response highlights that the healthy relationship with industry is benefitting the Australian curriculum.

Industry consultation reported that communication skills is an area of concern in graduate engineers, with industry leaders advising that improved communication skills will be a necessity for future Electrical Engineers within all associated disciplines.

API's 2015 workforce survey, based on responses collated from 14 companies, also concluded that the following improvements are required for graduate engineers entering the workplace:

- *"Personal attributes and non-technical skills: Enthusiasm, ability to think outside the square, problem solving skills, self-awareness, better safety awareness, inclusive and leadership behaviours, good communication and presentation skills.*
- *Work readiness: Preparation for working in the workplace (e.g. working in teams, basic influencing skills, appreciation of risk management, appreciation of business case application, etc.), technical report writing.*
- *Better technical skills: Deeper understanding, retention of theoretical fundamentals and appreciation of practical aspects of system analysis, net present value, and fundamentals of power engineering including circuit theory as applied to 3 phase systems, engineering electrical systems, network protection.*
- *Although the core skills of power system analysis and modelling appear to be strong, details associated with real power equipment and switchgear (rating and clearance times, etc.) could be better. Time needs be spent in a power station during studies; however, this is difficult given the large numbers of students, WH&S and security requirements and the shortage of vacation placement opportunities in industry.*
- *Project management: Project leadership, contract management, basic financial planning and control, stakeholder engagement and people management."*
  (Australian Power Institute, 2015)

It is vitally important that industry and education continue to work together on researching the future needs of Electrical Engineers, and developing future curriculum content around this information. A prime example of innovative training to meet skills gaps is the development of a new degree called the 'Internet of Things', which has been launched by James Cook University and provides an integration of computer science and electronics engineering.

To improve both undergraduate skills and research/innovation the API has identified that the following is required:

- Research and innovation needs to be industry driven with a focus on deliverables of benefit to the industry and community/customers
- Multi-disciplinary teams of academics/researchers from various disciplines and universities (electrical engineering, science, ICT, economics, social sciences) need to work collaboratively with industry professionals in order to establish teams with the best capability across Australia
- A significant financial and in-kind contribution is needed by industry to drive the innovation agenda as Australia ranks lowest amongst OECD countries in its collaboration and research efforts

- Universities should be encouraged to improve the entrepreneurial and innovation skills of both their undergraduate and post graduate students.

6.2.1.1.2 Employment: Electrical Engineers

Detailed data by occupation, within the distribution and transmission sectors is only available from the 2011 census collection, which highlighted that:

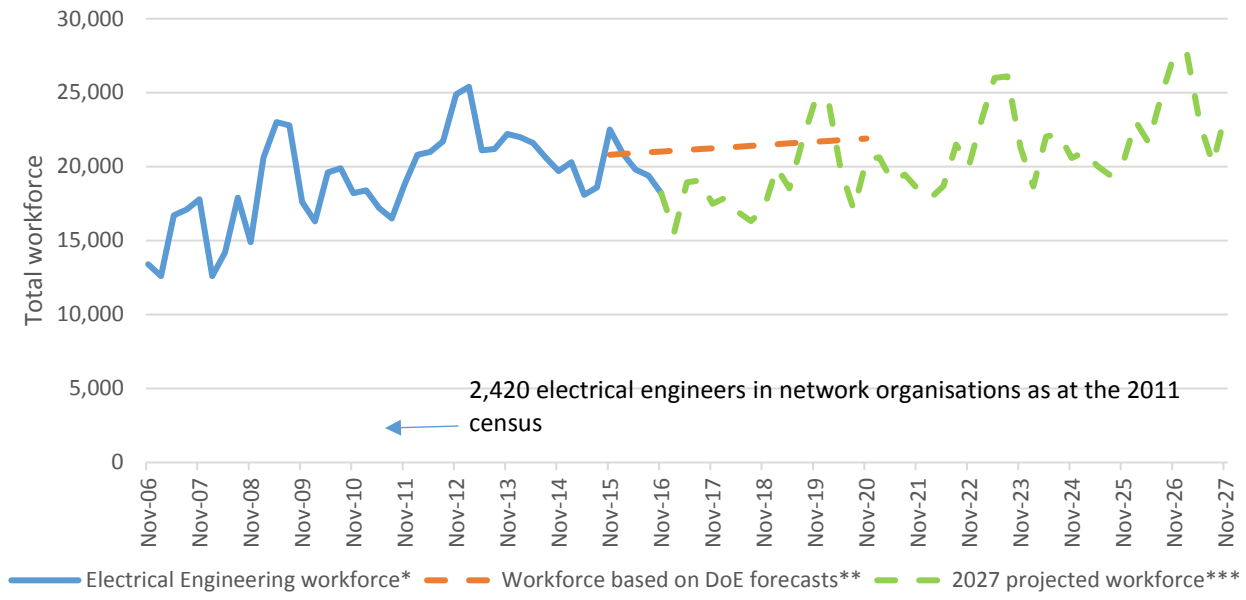
- Electrical Engineers are a significant proportion of both the transmission and distribution workforce, particularly evident in the transmission sector where they accounted for 22.6%
- As a proportion of both the transmission and distribution workforces, the number of Electrical Engineers experienced a healthy growth between the 2006 and 2011 censuses.

As illustrated in Figure 15, the national electrical engineering employment trend across all industries has experienced sporadic growth from November 2006 through to November 2013 where the workforce was 22,000 strong. Following this peak, gradual overall decline was experienced until 2016, which recorded a resultant workforce of 18,200.

Five-year occupational employment projections from November 2015 to November 2020, sourced from the DoE, project that by 2020, Electrical Engineering employment levels will be increased by 1,100 employees (or 5.4%) on the November 2015 equivalent, to 21,900. This projection is depicted in the graph. For purpose of this illustration, it has been assumed that the growth will occur in a linear fashion.

Also highlighted in Figure 15, is that as at the 2011 census, the network workforce employed a total of 2,420 Electrical Engineers, which equated to 15% of total Electrical Engineers employed across all industries. In the API 2015 workforce report, most companies which responded predicted the size of the workforce will remain steady.

Figure 15 - Electrical Engineers national employment trend across all industries



(Australian Bureau of Statistics– Category 6291.0.55.003), ** (Australian Government: Department of Employment, 2016)
***Projected 2027 workforce has been calculated based on the workforce trend experienced between November 06 and November 2016

As discussed in section 4.2, as at the 2011 census, the transmission workforce revealed a large proportion of its workforce are aged 60 years and over. In the 2015 API report, a significant decrease was recorded of professional Engineers within the workforce who were aged 50 and over (e.g. the 2015 data for employees over 50 (28% of Engineers) was compared to the 2013 equivalent (33% of Engineers)). The report also noted that, whilst the 40-49 group remained relatively unchanged from 2011 - 2015 (22%-24% respectively), these were significantly lower than in 2004 when this age bracket accounted for 30% of the workforce.

6.2.1.1.3 Critical Skills: Electrical Engineer

The skill sets of an Electrical Engineer are pivotal to enabling the successful adoption of emerging technologies. As the progressive and iterative nature of technological adoption becomes apparent, enhanced skill sets will be needed by Electrical Engineers to design and evolve network systems capable of embedding, supporting and maintaining such technologies.

Asset and Risk Management

As a network organisation's asset portfolio progresses from the traditional long lived (30-40 year) asset, to the more complex digitalised and smarter asset, broader skill sets will be required to manage both technologies side-by-side. The obsolescence of older assets and the risk management capabilities of the worker will require upskilling to ensure dangers to health, safety, environmental and corporate structures and public opinion remain as limited as reasonably practicable.

Emerging technologies will provide networks with assets that are smart, interconnected devices and, through technological advances such as the IoT, will provide Engineers with substantially increased data (big data) on the assets' systems and processes.

Engineers will be required to validate, interrogate and provide data driven inferences to effectively monitor the assets' status and condition, operating environment and automated processes. To manage this data and the assets effectively, the Engineer will need skills in data science including:

- Knowledge of advanced ICT concepts such as IoT
- Ability to work with Big Data
- Working knowledge of big data software/programming such as R/Python.
- Cyber security protocols.

Power Systems Security and Reliability

Engineers will be required to integrate emerging technologies within the national grid. The advancements in technologies such as self-generation, battery storage, smart homes and electric vehicles provide technical challenges. The following technical areas were identified in the EA Technology, Network Transformation Roadmap: Innovation Gap and Analysis Plan Report (2016).

- Demand / Generation Response
- Dynamic ratings
- Electrical energy storage
- Network management
- Voltage management
- Fault Level Management
- Network simulation and modelling

- Energy efficiency
- Smart meters and Time of Use tariffs.

API undertakes bi-annual workforce planning surveys within the Electrical Supply Industry, which provides industry intelligence from industry members on the current skill requirements and broader workforce matters. The following five technical streams of skills, both engineering and non-engineering, were identified in API's 2015 skills and demand survey, outlining what companies will require from their future engineering workforce:

Figure 2 - Identified technical streams of skills (both engineering and non-engineering) ESI companies require from the future power engineers

(Australian Power Institute, 2015)

Corporate and commerce Skills

A higher level of economic analysis skills will be required by Electrical Engineers in the future, particularly regarding investment in new equipment and technologies. Engineers will be required to identify business and financial opportunities.

With greater corporate responsibilities electrical engineers will require a high level of business and financial risk analysis and hazard mitigation skills.

Personal Skills

As new technologies enter the market and products are sourced from several suppliers and manufacturers, Engineers will increasingly be required to communicate with these parties.

The ability to learn, coupled with the desire for lifelong learning, is critical for Engineers. Management are required to cultivate an environment that encourages skills development to enable increased skills in areas such as relationship and stakeholder management and collaboration.

The skill impacts listed above are expected in the short to medium timeframe (2 to 6 years), and will be largely incremental in nature (i.e. stepped extensions of current skill sets as opposed to the requirement to learn completely new concepts). For example, Engineers possess high logical, scientific, mathematical, technical and analytical skills. Whilst working with big data will require knowledge of supporting software like R/Python, it is expected that big data analysis will be an extension of the mathematical component of their current role.

6.2.2 Workforce Enabler Group: Engineering Technical Officer

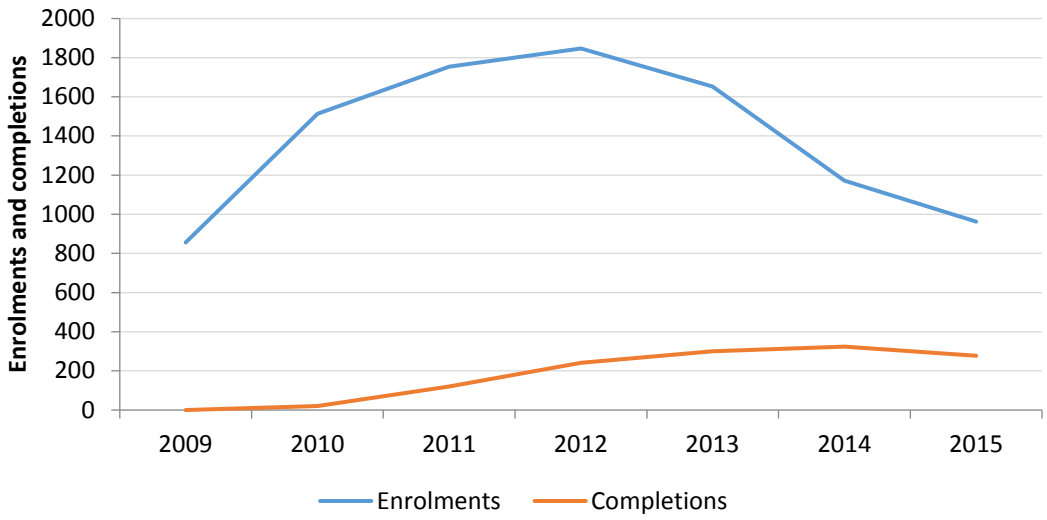
Under the Australian and New Zealand Standard Classification (ANZSCO), Engineering Technical Officers are classified within the Electrical Engineering Draftspersons and Technicians (EEDT) unit grouping. The prominence of workers within this ANZSCO unit classification are evident within both the distribution (1,391 employees or 4.7% as at the 2011 census) and transmission (128 employees or 4.7% as at the 2011 census) organisations.

Technical Officers generally come from a trade background having specialised in areas of operation. Responsibilities include "*conducting tests of electrical systems, preparing charts and tabulations, and assisting in estimating costs in support of electrical engineers and engineering technologists. Registration or licensing may be required.*" (Australian Bureau of Statistics - 2011 census & ANZSCO)

6.2.2.1.1 Education: Engineering Technical Officers

The pathway into a career as a Technical Officer is through the completion of an Advanced Diploma of Electrical Engineering or an Advanced Diploma of Engineering Technology – Electrical[11]. Figure 16 provides combined annualised data for the enrolments and completions of these qualifications.

Figure 16 - Combined national enrolments and completions in subjects where the listed ANZSCO occupation group is Electrical Engineering Technician



(NCVER - VOCSTATS)

Evidently, following a significant increase of 116% in enrolments from 2009 (856 enrolments) to 2012 (1,847 enrolments), a subsequent and continued yearly decline was experienced to 2015 where a total of 963 enrolments were recorded. In contrast, whilst a small decline was experienced between 2014 and 2015, completions have remained fairly consistent since 2012.

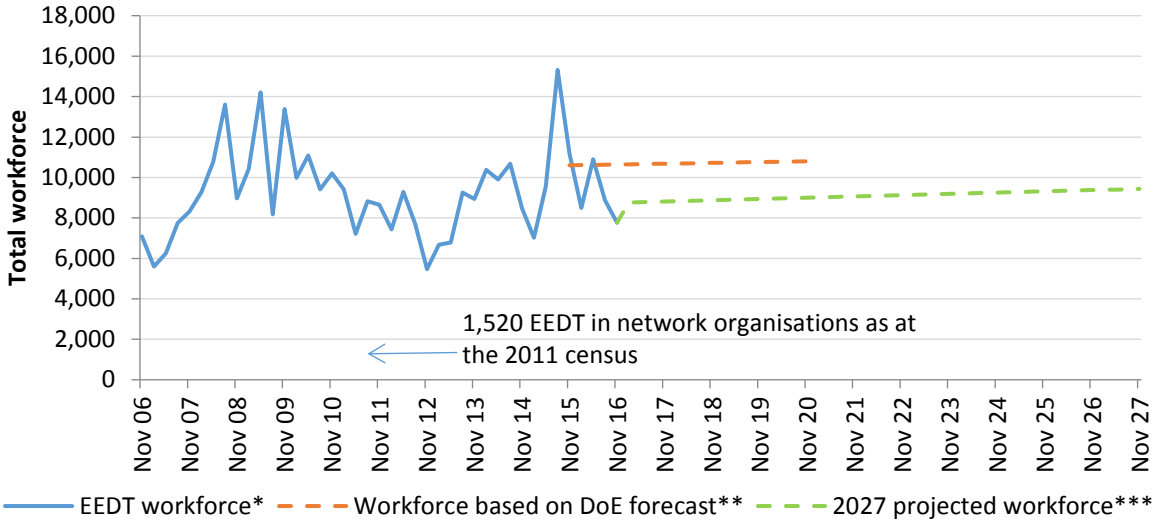
6.2.2.1.2 Employment: EEDT

Due to the unit ANZSCO classification of Engineering Technical Officers being combined with Draftspersons, employment trends are only available for EEDT. Employment within the national EEDT workforce has been sporadic with peaks and troughs recorded throughout the 10-year period ending November 2016.

As Technicians have been coupled with Draftspersons within the data collection, definitive conclusions specific to Technical Officer occupations are difficult to calculate. In saying this, as outlined in Figure 17, as at the 2011 census, the 1,520 EEDT workers within the network workforce accounted for 18% of total EEDT workers within Australia.

[11] The education pathway for an Electrical Engineering Technician has been identified through NCVER VOCSTATS government funded students and courses database. The 'occupation (ANZSCO) group' filter, which identifies the intended occupational outcome of a qualification was utilised to determine the pathway. The relevant training packages were determined as UEE62111 - Advanced Diploma of Engineering Technology - Electrical, UEE62110- Advanced Diploma of Engineering Technology - Electrical, UEE62211 - Advanced Diploma of Electrical - Engineering, UEE62311 - Advanced Diploma of Electrical Engineering - Coal Mining, UEP50206 - Diploma of ESI Generation (Operations)and UET50312 - Diploma of ESI - Power Systems Operations

Figure 17 – EEDT National employment trend analysis



*(Australian Bureau of Statistics– Category 6291.0.55.003),** (Australian Government: Department of Employment, 2016),***Projected 2027 workforce has been calculated based on the workforce trend experienced between November 06 and November 2016

6.2.2.1.3 Critical Skills: Engineering Technical Officers

The Technical Officer workforce has been identified as a workforce that will experience the need for re-skilling and skills enhancement to enable technological advances. As the main support for Electrical Engineers, the introduction of complex, smart and interconnected technologies will require the technician to have both a broader and increasingly specialised skill set.

The level and nature of skill requirements that are expected from Technical Officers will depend heavily on their area of specialisation. It is projected that the impacts of these skill requirements will occur in the medium term (2 to 6 years). This is particularly important given the training pathway to become a competent technician takes approximately 10 years.

The overriding catalyst for reskilling/skills enhancement is the requirement for the Technician to transition from a traditional network approach to a system thinking mindset. The ability to work with modern technologies that are interconnected and not stand-alone results in different approaches to repair and maintenance. Understanding the impact each technology can have on other interconnected equipment is vitally important. This extends to a greater systematic approach to high level soft skills, including relationship management, collaboration and learning mindsets.

Whilst protection relays are established within the industry, proliferation of Intelligent Electronic Devices (IED) and the requirement to create an intelligent network whilst managing the lifecycle of these assets is problematic.

In conclusion, the skillsets identified as critical for future Electrical Engineering Technicians are enterprise (as outlined in section 2) and ICT skills. The future Technical Officer will need to do the following:

- Take a systems approach to working - complex problem-solving skills will be needed to create models which are more sophisticated and digitally enabled
  Digital literacy will be needed for analysis and fault-finding using data networks and telecommunications products and services

- Maintenance of new technology is likely to see subject matter expert/niche workers in the short-term; however, it is anticipated that the Engineering professional will absorb these necessary skills into their role through ongoing professional development activities.

6.2.3 Workforce Enabler Group: Technical Trades

The skill sets and work performance of technical tradespersons is critical not only to the network sectors but also the wider ESI. The importance of this subset of workers is evident through their representation within network organisations which, as at 2011, equated to 40% (13,032 employees) of the total network workforce.

The training pathway into a technical trade career is typically through completion of a VET accredited qualification. Generally, such a qualification comes in the form of an apprenticeship. On completion of an apprenticeship, students are awarded a Certificate III within their chosen field of study and become a qualified trade's person.

The roles and responsibilities of a technical tradesperson will vary greatly depending on the nature of the trade undertaken. The importance of the acquired skill sets and skill sets required for the future will also vary greatly in the context of enabling technology advancements within the network sector. The skills of the following occupations are identified as critical:

- Electrical Distribution Trades Workers (Electrical Linesworkers and Technical Cable Jointers)
- Electrical Tradespersons (Electricians).

Electrical Tradesperson (Electricians)

Electricians within the network sector are referred to as Electrical Tradespersons, and will be referenced as such unless otherwise stated. Electrical Tradespersons may specialise in one or more specialist areas, and their roles have a strong focus on maintaining the safety of the work crew and members of the public.

Current responsibilities of Electrical Tradespersons within the network industry are:

- Perform construction, maintenance and repair of low voltage, high voltage and/or streetlight systems
- Support functions including workshop activities within a team environment
- Carry out a broad range of tasks that may be within the disciplines of Linesworkers and Cable Jointers
- Work on substations, high voltage switchgear, transformers and associated control equipment, installation and operation of mobile generation, control relays and associated equipment, high voltage and low voltage metering and switching, and investigation of abnormalities and faults on the electrical distribution network.

The future skill requirements of the Electrical Tradesperson may vary depending on the business models that are adopted by the DNSP. For example, there is potential for services such as battery installation to be offered.

New skill sets required by Electrical Tradespersons for a safe and reliable transition to a changing electricity sector will need to be adopted in the short to medium-term.

6.2.3.1.1 Education: Electrical Tradesperson

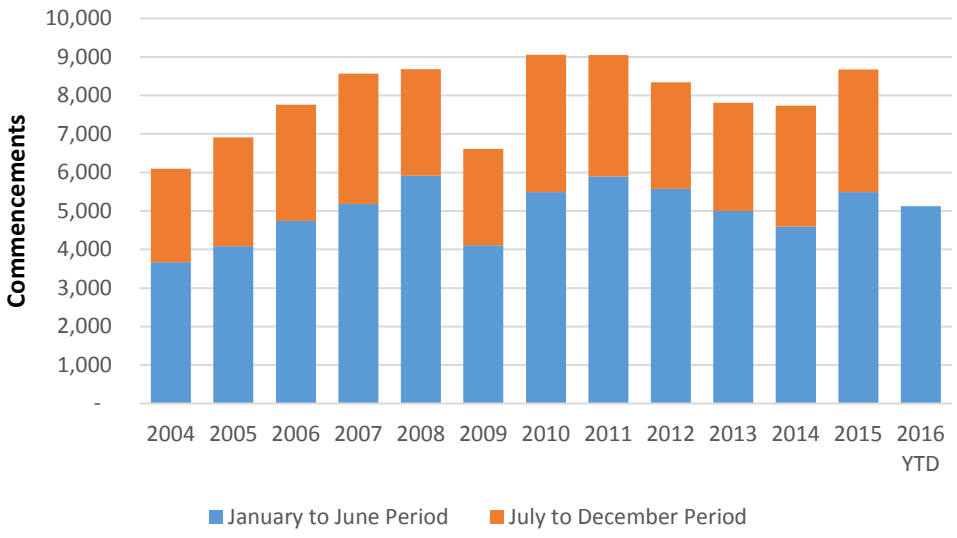
The primary training pathway within Australia into an Electrical Tradespersons career is through the completion of a Cert III VET accredited apprenticeship in Electrotechnology Electrician. Apprenticeships can be undertaken through direct employment with an employer and RTO, or through a GTO where the apprentice is employed under a training contract with the GTO, and placed with employers for various amounts of time. During an apprenticeship, the apprentice is required to undertake approximately 22 weeks per year of accredited theory based training.

Currently, no mandatory qualification/skill level prerequisites exist to enter an Electrotechnology Electrician apprenticeship. It is however, recommended that potential apprentices demonstrate a minimum Australian core skills framework skill level ability of five[12] in reading, writing and numeracy to ensure that an apprentice is best equipped to achieve competency in the more advanced units of the apprenticeship. There is an expectation that a skill level five in these areas could lead to higher apprenticeship completion rates.

Figure 18 highlights the national commencements within the Electrotechnology Electrician apprenticeship since 2004. Data is only available for the first two quarters of 2016. The data is visualised in a stacked bar graph to allow comparisons of the 2016 YTD (January – June 2016) with prior years' equivalents.

The 2004 to 2011 period experienced a continued healthy growth (except for the small decline in 2009) in commencements. Post 2011 a year on year decline was experienced until 2015, where an increase on the 2014 equivalent was recorded. 2016 YTD data highlight that commencements for this period are slightly below the 2015 equivalent.

Figure 18 – National commencement in Electrotechnology Electrician apprenticeships (includes training packages UEE30811, UEE30807, UEE30806 and UET 31199)

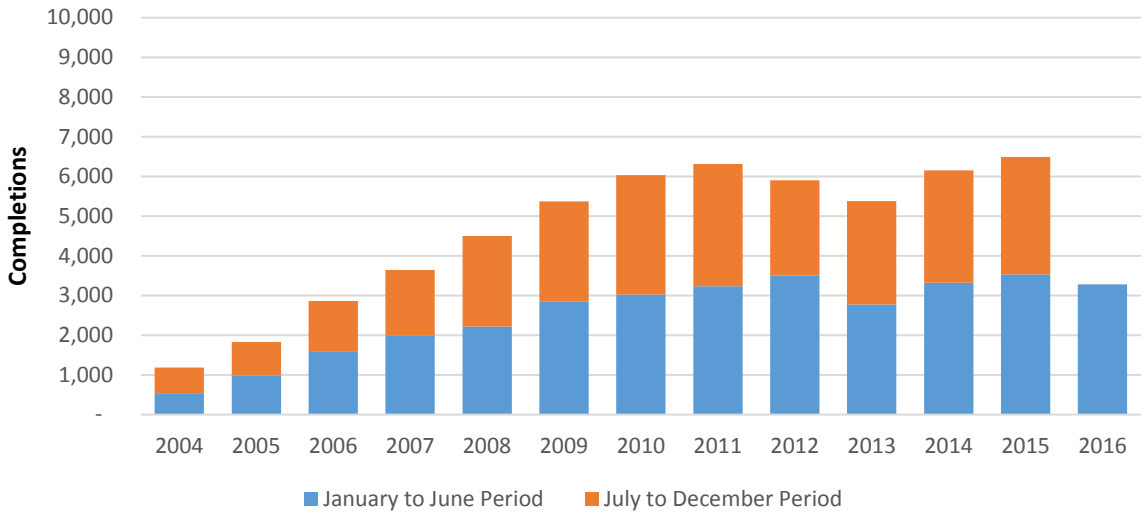


(NCVER - VOCSTATS)

Following year on year increases in the number completions between 2004 and 2011, declines were experienced in 2012 and 2013. The completions recorded in 2014 and 2015 are on par with the 2010 and 2011 equivalents.

[12] Level 5 is the highest level of skill ability in the AISC framework

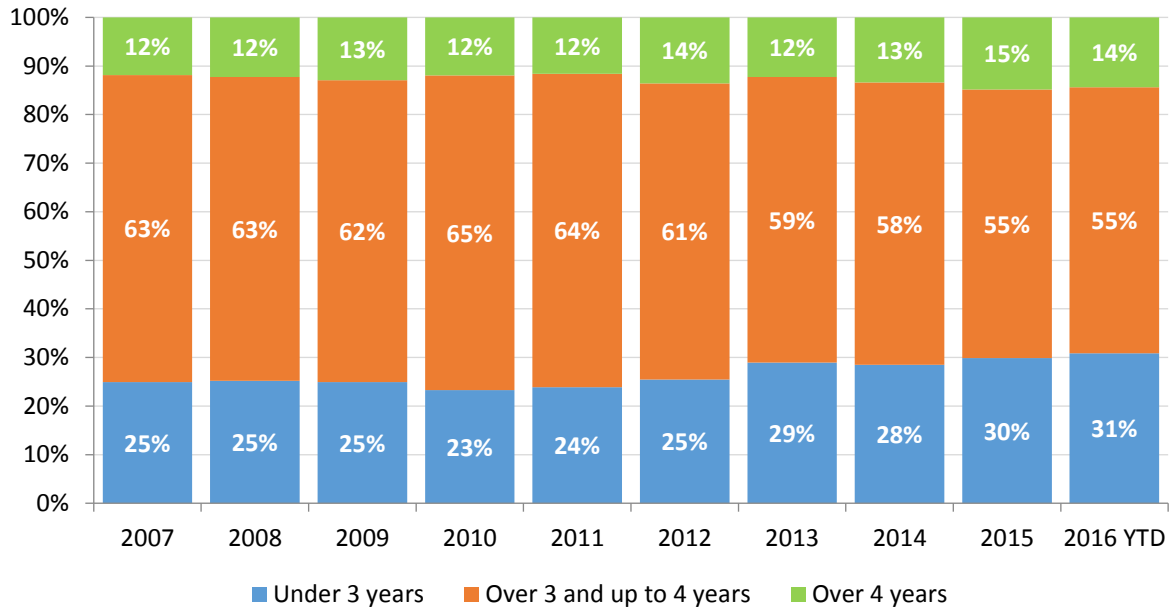
Figure 19 - National Completions in Electrotechnology Electrician apprenticeships (includes training packages UEE30811, UEE30807, UEE30806 and UET 31199)



(NCVER - VOCSTATS)

As outlined in Figure 20, from 2007 to 2012, the proportion of apprentices taking over 3 years and up to 4 years to complete the was consistently between 61% and 65%. Since 2012, this composition has decreased (55% by 2016 YTD) with larger increases being experienced in both under 3 years and over 4 years; the larger of which has been in under 3 years' completion time.

Figure 20 – National average training times for completions in Electrotechnology Electrician apprenticeships (includes training packages UEE30811, UEE30807 and UEE30806)[13]



(NCVER - VOCSTATS)

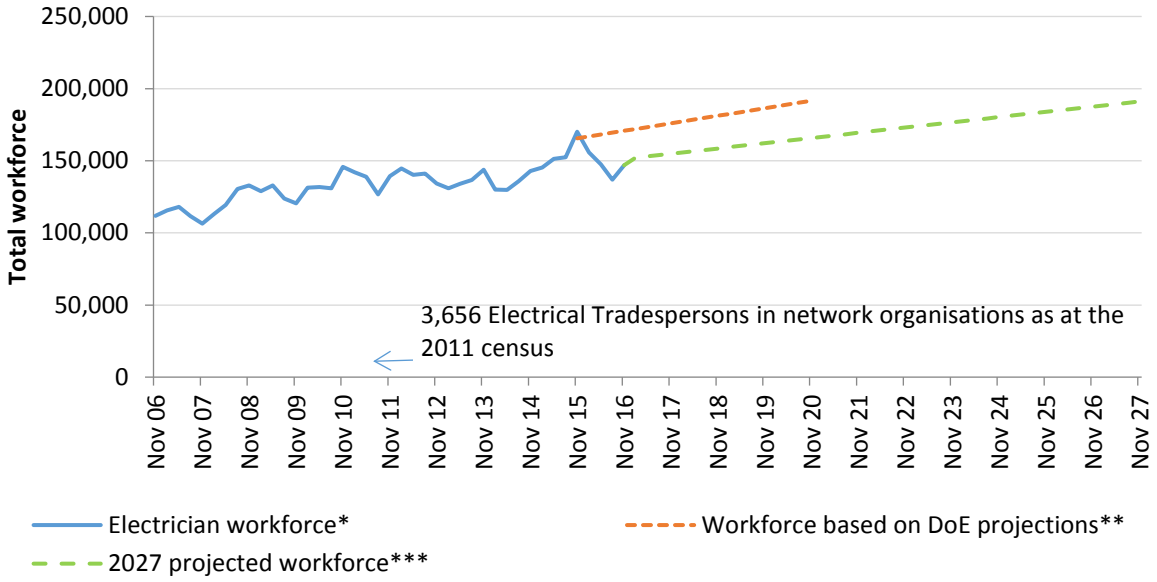
[13] It must be noted that the data presented for training contract duration may not necessarily indicate a trend in decreasing training periods. This data is representative of the duration of an apprentice's most recent training contract. Therefore, a candidate who re-commences a training contract in their third year due a previous cancellation will present in this data as having completed in 12 to 24 months.

6.2.3.1.2 Employment: Electrical Tradesperson

Electrical Tradespersons are in high demand within the Australian economy, evident in the occupation projections published by the DoE that predict an increase of 26,000 employees between November 2015 and November 2020, which would result in an Electrical Tradespersons workforce of 191,600 persons.

As at 2011, the 3,656 Electrical Tradespersons employed within the network workforces accounted for 2.9% of Electrical Tradespersons employed in the national economy.

Figure 21 – Electrical Tradespersons - National employment trend across all industries



*(Australian Bureau of Statistics– Category 6291.0.55.003), ** (Australian Government: Department of Employment, 2016),
***Projected 2027 workforce has been calculated based on the workforce trend experienced between November 06 and November 2016

A complexity that is faced by the Electrical Tradespersons workforce is an inconsistency in licencing requirements across the country. The opportunity for harmonisation of licensing regulations, licencing, and licence renewal, to play a role in supporting the requirements for initial up-skilling and ongoing professional development, needs to be explored. Initiative eight touches on areas for improvement in this area as raised by industry stakeholders however, this item was out of scope for this project.

6.2.3.1.3 Critical Skills: Electrical Tradesperson

Consumer Education

Through potentially becoming the installer and/or maintainer of residential DER, the Electrical Tradesperson may well become the conduit between the network, the consumer and the manufacturer of the technology. Depending on the level of technical knowledge of the consumer, the Electrical Tradesperson will need to provide varying levels of consumer education. This role will be critical in encouraging the adoption of DER, as a poor understanding and/or low confidence in technologies can lead to inefficient use and low adoption rates.

Required skills to enable efficient and effective customer education services include:

- Improved communication

- Consumer tailored andragogy
- Focus on soft skill development
- Advanced product knowledge.

Systems Integration

As the potential installer and/or maintainer of DER, such as smart meters and battery storage, the Electrical Tradesperson will be required to embed and connect the IT components of emergent technologies. This is expected to be at its highest and most significant as technologies emerge. As technologies evolve, the complexities are expected to decrease with the capability for the IT component to become 'plug and play'.

The interconnectivity of smart technology has resulted in the need for Electrical Tradespersons to have a systems' thinking mindset for the installation, maintenance and fault finding of technology, to ensure the equipment is correctly configured and interconnected.

Required skills to enable efficient and effective systems Integration include:

- Increased telecommunication and associated protocols
- Network Integration Skills – capability to integrate emerging technologies into existing consumer networks
- Testing and commission skills
- A systems' thinking mindset
- Isolation of multiple electricity feeds.

Safety Requirements

Given the high penetration of distributed solar generation, increased prevalence of electrical vehicles, and the predicted uptake of energy storage, requirements to work with Direct Current (DC) systems at reasonable voltages (from 48V to 1,000V DC) will be more prevalent for electrical tradespersons.

The current lack of training in DC will present a higher level of safety hazard and risk to consumers, workers and property. Currently, an electrical apprenticeship includes only minimal content of the work practices and hazards associated with working on DC installations and devices. New standards for these areas need to be written and embedded in VET, as well as ongoing professional development for existing workers.

The chemical characteristics of storage systems and inherent hazards demands increased knowledge of chemical safety and risk mitigation.

Required skills to enable maintainers/installers to work with emerging technologies safely include:

- Increased working knowledge of DC
- Increased chemical knowledge
- Product installation knowledge
- A system thinking mindset.

The creation of a specialist licence may also be required to address skill shortages in the short-term.

Personal skills

Skills and responsibilities of the Electrical Tradesperson have the potential to vary greatly, depending on models utilised by network organisations. Increased consumer interaction and the likely interaction between the Electrical Tradesperson and suppliers and/or manufacturers of technology will require increased communication skills. A critical requirement for future Electrical Tradespersons is the ability to learn and the desire for lifelong learning.

Required personal skills include:

- Soft skills: Communication, resilience, mental agility and stakeholder management
- Increased Enterprise skills[14]
- High general IT proficiency.
- Business skills: The increased consumer products delivered by small and medium employers will require a higher level of business acumen.

Electrical Distribution Trades Worker

The Electrical Distribution Trades Worker (EDTW) unit classification within ANZSCO incorporates two occupations: the Electrical Linesworker and the Technical Cable Jointer. Both occupations are abundant within the network workforce, and as at the 2011 census, employees classified within the EDTW category accounted for 5,146 (15.8%) of the network workforce.

Within network organisations the responsibilities of these occupations are as follows:

Electrical Linesworker

- Construction, maintenance and repair of low voltage, high voltage and/or streetlight systems, or support functions including workshop activities, within a team environment
- Tasks are primarily carried out on the overhead distribution network on conductors and cables supported by concrete, wood, steel or composite poles, cross arms and fittings
- The roles have a strong focus on maintaining the safety of the work crew and members of the public.

Technical Cable Jointer

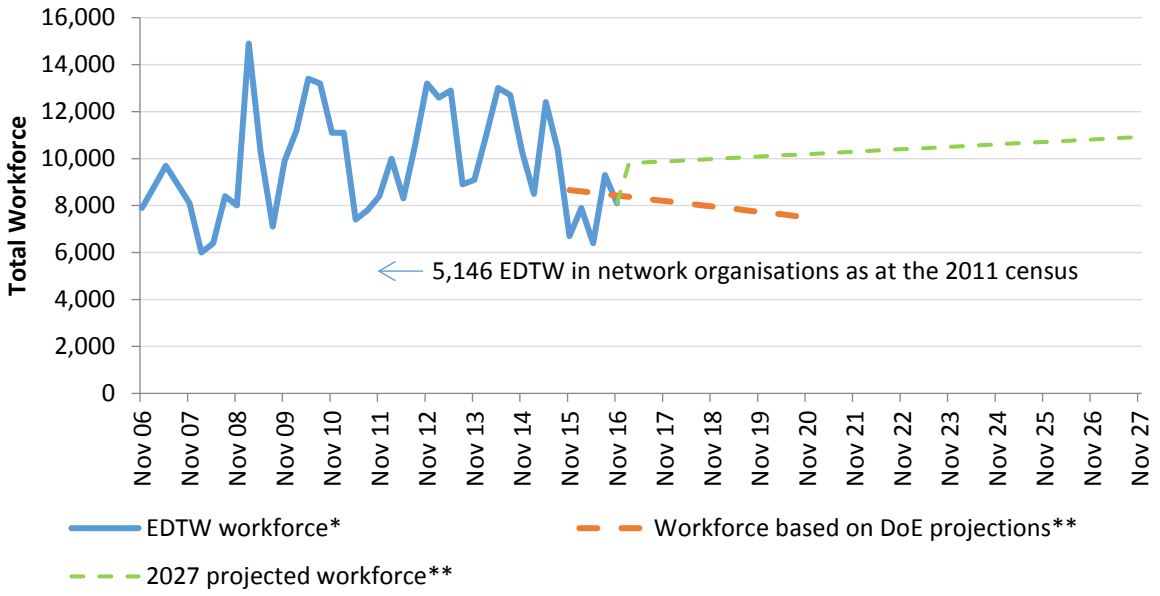
- Construction, maintenance and repair of low voltage, high voltage and/or streetlight systems, or support functions including workshop activities, within a team environment
- Tasks are primarily carried out on the underground distribution network on high voltage and low voltage cables installed in pipes, conduits, ducts and pits. Work may include elements of civil construction including trenching, backfilling and compaction
- These roles have a strong focus on maintaining the safety of the work crew and members of the public.

6.2.3.1.4 Employment - EDTW

Employment within the national EDTW workforce has been consistently sporadic with peaks and troughs recorded throughout the 10-year period ending November 2016. Projections sourced from the DoE project that the EDTW workforce will continue to decline to a workforce of 7,500 nationally by November 2020.

[14] Enterprise skills include problem-solving, communication, critical thinking teamwork, digital literacy, creativity and presentation skills (AlphaBeta, 2016).

Figure 22 - EDTW - National employment trend across all industries



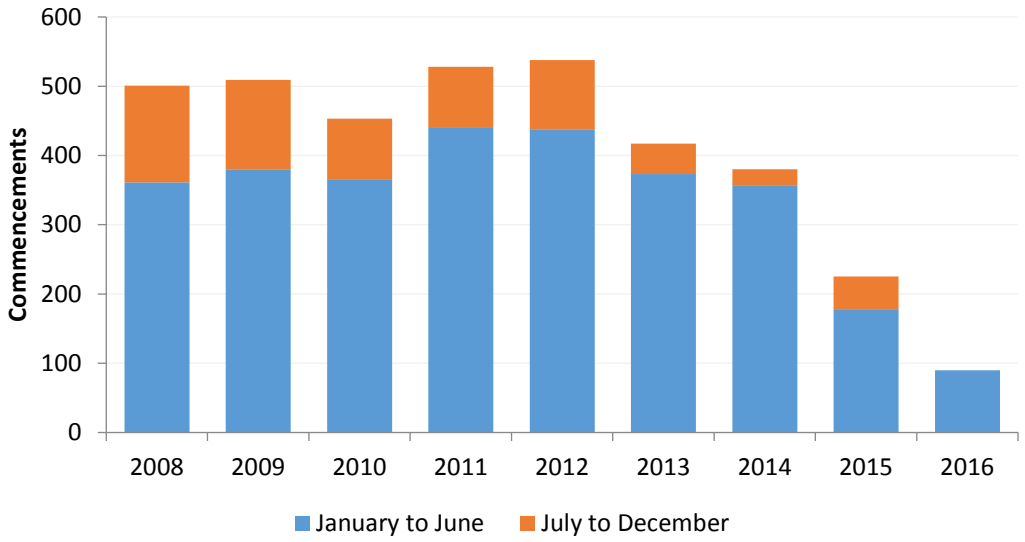
* (Australian Bureau of Statistics– Category 6291.0.55.003), ** (Australian Government: Department of Employment, 2016),
***Projected 2027 workforce has been calculated based on the workforce trend experienced between November 06 and November 2016

6.2.3.1.5 Education – Electrical Linesworker

The training pathway to become an Electrical Linesworker is through the completion of a VET accredited apprenticeship in UET30612 – Certificate III in ESI – Power Systems – Distribution.

As outlined in Figure 23, commencements in the Electrical Linesworker accredited apprenticeships peaked in 2012 following a period of relative stability between 2008 and 2012. Since 2012, consecutive annual declines have been experienced with significant declines being recorded in 2015 and 2016 YTD. When comparing 2012 commencements to the 2016 YTD period, a drop of 75% in national apprenticeship commencements was recorded, decreasing from 373 in 2012 to only 90 in 2016 YTD.

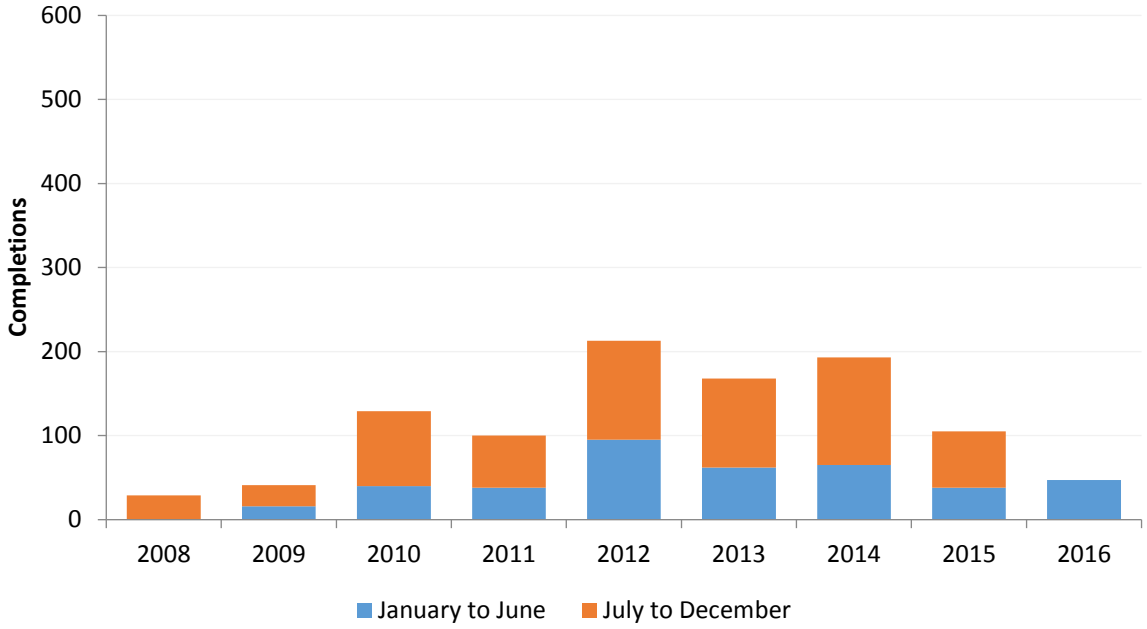
Figure 23 – National commencements in Linesworker apprenticeship (includes data from UET30206, UET30209 and UET30612 training packages)



(NCVER - VOCSTATS)

Figure 24 highlights that whilst completions spiked in 2012 as did commencements, a lesser decline in comparison to commencements was experienced in subsequent years. Encouragingly, the 2016 YTD figure has increased slightly on the 2015 equivalent.

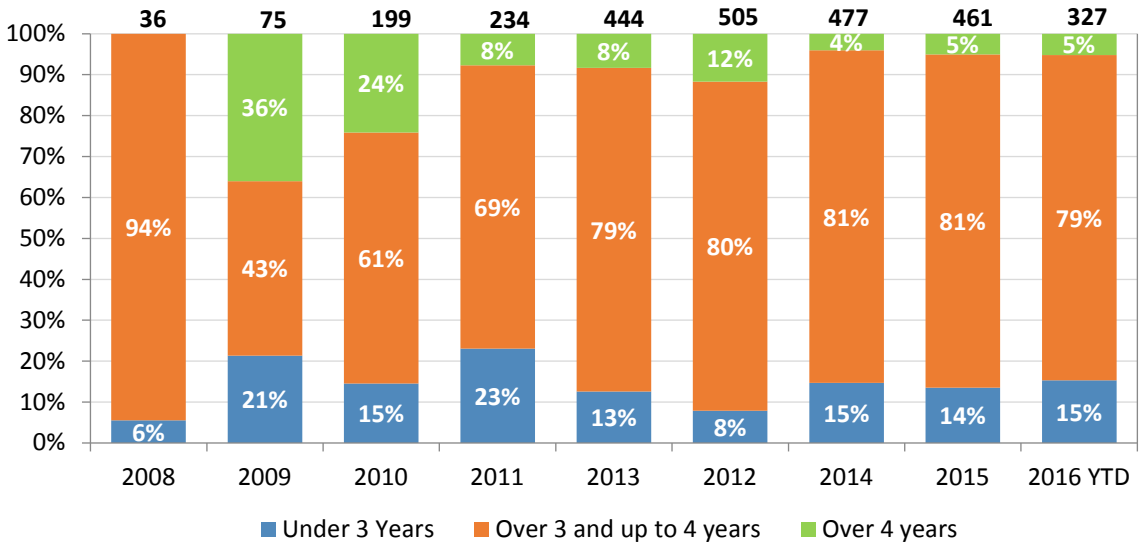
Figure 24 - National completions in Linesworker apprenticeship (includes data from UET30206, UET30209 and UET30612 training packages)



(NCVER - VOCSTATS)

Figure 25 highlights that since 2013, the average completion time of Electrical Linesworker apprenticeships has consistently ranged between 79% to 81% for the three to four year category.

Figure 25 - Average National completion times in Linesworker apprenticeship (includes data from UET30206, UET30209 and UET30612 training packages[15])



(NCVER - VOCSTATS)

6.2.3.1.6 Critical Skills – Electrical Linesworker

Consumer Education

Consumer engagement is expected to be a requirement of the future Electrical Linesworker. As networks progress to operating models that are more consumer focused, it will be a requirement of all Electrotechnology workers to become more consumer orientated.

Systems Integration and behind the meter technology

Electrical Linesworkers will be required to install new technologies, such as load monitoring transformers, and to configure this technology as part of a system and not a standalone piece of equipment.

In addition DERs such as rooftop solar panels will have the potential to increase the number of live Electricity feeds within a system. Linesworkers and cable jointers will require extensive knowledge of how to shut down multiple feeds of electricity prior to commencing work.

Required skills to enable efficient and effective DER Integration include:

- Systems thinking mindset
- Knowledge of network automation technologies
- Increased testing and commissioning skills

[15] It must be noted that the data presented for training contract duration may not necessarily indicate a trend in decreasing training periods. This data is representative of the duration of an apprentice's most recent training contract. Therefore, a candidate who re-commences a training contract in their third year due a previous cancellation will present in this data as having completed in 12 to 24 months.

- Isolation of multiple electricity feeds.

Personal Attributes

Historically, personal ongoing skill development has not been a major component of these occupations, however as technologies are adopted with increased ICT capabilities such workers will require skill deepening in ICT and new technologies.

Required personal skills:

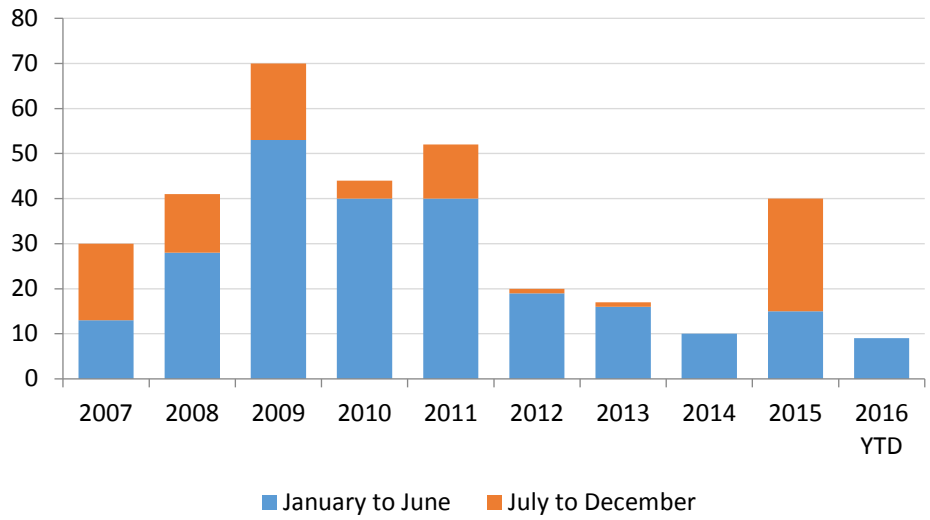
- Desire for ongoing learning
- Consumer/customer mindset
- Communication.

6.2.3.1.7 Education – Technical Cable Jointer

The training pathway into a Technical Cable Jointer position is through the completion of a VET accredited apprenticeship in a Certificate III in ESI - Power Systems - Distribution Cable Jointing.

As is evident in Figure 26, commencements into apprenticeships within cable jointing nationally are minimal. 2016 YTD data highlights that only nine apprenticeships have been commenced in the 6-month period of January to June. Further investigation into this by State highlights that of the 333 apprenticeships that have been commenced nationally between 2007 and 2016, 281 were in New South Wales, Victoria and Queensland. Industry believe that the lack of commencements is a result of network personnel and organisations feeling the apprenticeship does not provide students with the bare necessities and currency of Technical Cable Jointer training.

Figure 26 - National commencements in Cable Jointers apprenticeship (includes data from UET30406, UET30409 and UET30812 training packages)



(NCVER - VOCSTATS)

6.2.3.1.8 Critical Skills – Technical Cable Jointer

Technical Cable Jointers are expected to experience minimal impacts from the emergence of new technologies. However, due to the volume of employees within this occupation, the occupation itself is considered critical for the operation of the grid.

6.2.4 Workforce Enabler Group: ICT Specialists

The era of digitalisation, also referred to as the digital revolution (Scwab, 2016) due to its far reaching and extensive impacts, is being driven by the emergence of smart technologies that are blurring the spheres of the reality and digital worlds.

ICT worker skillsets are synonymous with digitalised technologies, and occupations within these categories are in high demand across a range of industries. As outlined in Table 5, forecasts project that approximately 100,000 additional workers will be required to service the demand for ICT requirements between 2014 and 2020 within Australia (Deloittes Access Economics, 2015).

Progression to a career within ICT can stem from numerous pathways, including both a VET and higher education accredited training. Throughout this research, specialist ICT workers with higher education qualifications were identified as being critical for future network requirements. This conclusion is also evident in data published by Deloittes Access Economics (Table 5), predicting the demand for ICT occupations will have one of the largest increases.

Table 5 - Projected 2020 employment growth in ICT

CIIER occupation grouping	2014	2020	Average Annual Growth
ICT management and operations	184,907	222,080	3.1%
ICT technical and professional	213,107	247,919	2.6%
Other ICT occupations	207,738	230,484	1.7%
Total ICT workers	**605,752**	**700,483**	**2.5%**

(Deloittes Access Economics, 2015)

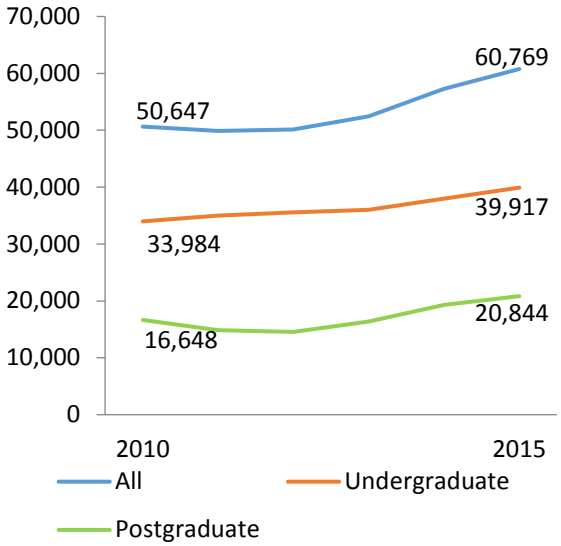
The positions identified as critical within this research are:

- Software and Programme Developers
- Cyber Security Specialist.

6.2.4.1.1 Education: ICT

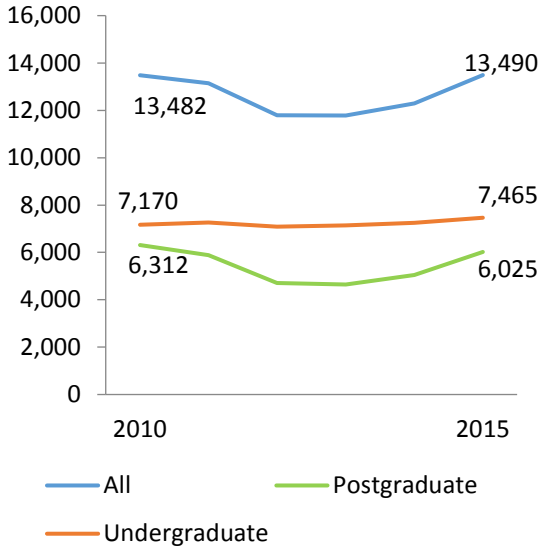
No data is available for higher education for ICT by course. As evident in Figure 27 and Figure 28, whilst enrolments into higher education ICT courses have increased, completions have plateaued in the five years to 2015, suggesting a high withdrawal rate. Whilst analysing enrolments within ICT subjects at universities since 2001 (CSIRO, 2016), CSIRO concluded that there has been a 35% decrease recorded in total enrolments into the course.

Figure 27 - Higher Education - Information Technology course enrolments



((Australian Government - Department of Education - UCube)

Figure 28 - Higher Education - Information Technology course completions



(Australian Government - Department of Education - UCube)

Fundamentally, the increased demand for ICT specialists will create a skills gap for existing workers who will be required to possess skills sourced through higher educational pathways. There will continue to be skill shortages for high demand positions such as Cyber Security Specialists where there is already a shortage of skilled professionals in the labour market.

Educational facilities and government bodies will be required to work closely with industry to understand why such an alarming decline has been recorded since the start of the century, and to develop strategies based on these findings to address any barriers that are identified. Designs of curriculum should be planned with this in mind, and be flexible to accommodate change if required.

Software and Programme Developer

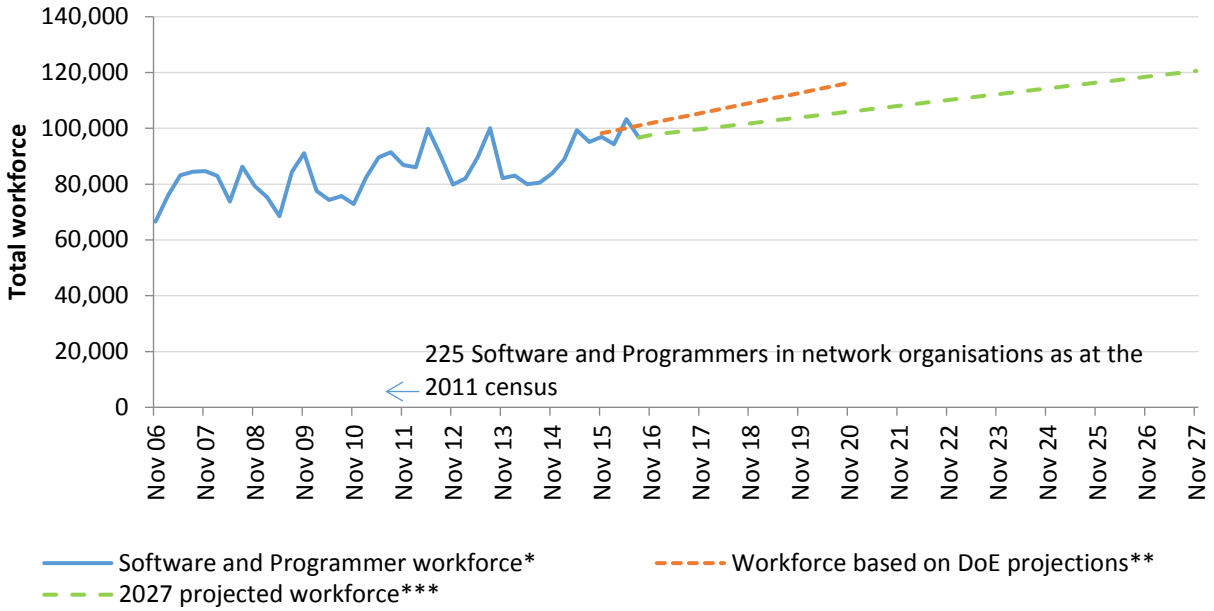
Recognised as a position in high demand, Programmers specialise in various coding languages, as well as fields of specialisation such as backend developers and user experience programmers. As at 2011, Software and Programme Developers represented 0.7% (225 employees) of the total network workforce. A Programmer is responsible for *the designing, developing, testing, maintaining and documenting program code in accordance with user requirements, and system and technical specifications."* (Australian Bureau of Statistics - ANZSCO)

6.2.4.1.2 Employment: Software and Programme Developer

As at the 2011 census, Programmers were 0.7% (225 employees) of the network workforce. A current shortfall of domestic ICT skilled workers is currently being addressed through the issuing of 457 skilled visas, with 10,000 visas being issued annually (Deloittes Access Economics, 2015) for workers with these skill sets. In recent years', persons classified as Programmers have contributed from one-third to half of the annual cohort of 457 visa workers entering Australia.

Figure 29 highlights that national demand is high for Software and Applications Programmers across Australia. The following graph highlights that an increase of 18,000 Programmers are projected to be in the workforce by November 2020 which equates to an increase of 18.4% when compared to November 2015.

Figure 29 - Software and applications programmers - National employment trend across all industries



*(Australian Bureau of Statistics– Category 6291.0.55.003), ** (Australian Government: Department of Employment, 2016),
***Projected 2027 workforce has been calculated based on the workforce trend experienced between November 06 and November 2016

6.2.4.1.3 Critical Skills: Software and Programme Developer

Consumer Education

Whilst not client facing, the skill sets of Programmers have the potential to be important in the design, construction and delivery of educational material between digitalised services that utilities offer consumers. An example of this is the use of gamification – application of game theory through digitalised means – as an educational tool which is becoming increasingly common. Such a platform has already been utilised in the ESI with excellent results through the 'Reduce you Juice' City Smart initiative, which improved users' energy consumption by 12.3% on the previous year's equivalent and equated to an average saving of $54.82 on quarterly electricity bill.

Digitalised Consumer Services

Consumers are increasingly demanding digitalised services, with preferences changing from the customers wanting to pick up the phone and communicate directly with their service provider, to wanting to be able to use smart devices and social media channels to communicate with companies. Digitalised services predicted to become important within the network sector include internet platforms. The design and build of these digitalised service systems and their usability for consumers will be critical in order to attract and retain consumers.

Certain specialisations are in higher demand than others. For example, one respondent during consultation advised that in Melbourne, high quality user experience developers can demand daily wages more than $1,000 AUD.

Cyber Security Specialist

Throughout this research, the requirement for skills of cyber security specialists has consistently been identified by industry and literature as one of the most critical for the future.

Risks associated with cybercrime will increase as networks such as the Australian electricity grid become more dependent on digitally connected information systems. The increasing sophistication of cyber-attacks requires skill sets of highly trained individuals to protect not only a consumer's personal information but also grid infrastructure.

Within ANZSCO classifications, the cyber security workforce are categorised as Database Systems Administrators and ICT Security Specialists. The responsibility of these roles are *to plan, develop, maintain, manage and administer organisations' database management systems, operating systems and security policies and procedures to ensure optimal database and system integrity, security, backup, reliability and performance."* (Australian Bureau of Statistics - 2011 census & ANZSCO)

A weak security system can have catastrophic impacts on the Australian economy and become a substantial barrier to the implementation of emerging technology. A successful attack will result in consumer confidence decreasing and a reduction in households opting to utilise 'smart' technology.

Referring to the status of the electricity supply cyber security, Pricewaterhouse Coopers (PwC) Power and Utilities Leader, Mark Coughlin, stated that whilst corporate systems within utilities are well prepared, operational systems remain unprepared. Mr Coughlin also concluded that utilities are less well protected against cyber threats than many of those in the retail, banking and defence industries.

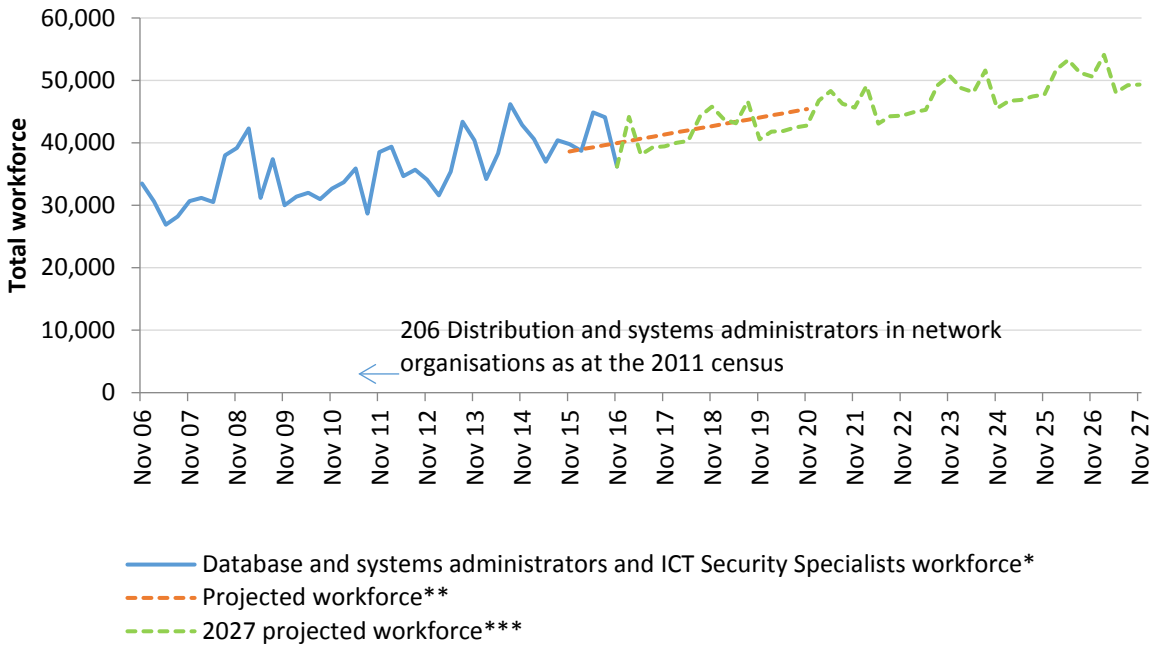
6.2.4.1.4 Employment: Cyber Security Specialist

A critical shortage of qualified cyber security specialists is already being experienced in Australia. The profession requires long lead times to train and develop the skills and knowledge required and has been identified as a major concern within the Australian economy. To effectively respond to this, the Australian government have:

- Established the Australian Cyber Security Centre in 2014 which is a hub for private and public sector collaboration
- Announced a cyber-security strategy in 2016 that, amongst other objectives, aims to address the shortage of skilled professionals in this area.

An employment increase of 34% (11,400 employees) was recorded for Database and Systems Administrators and ICT Security Specialists between November 2006 and May 2016 before a decline was recorded in November 2016. This substantial employment growth highlights that demand for this skill set is still evident in today's economy. DoE projections predict that a 17.6% increase in growth will be recorded in the five-year period that ends in November 2020.

Figure 30 - Database and systems administrators and ICT security specialists - National employment trend across all industries



* (Australian Bureau of Statistics– Category 6291.0.55.003), ** (Australian Government: Department of Employment, 2016),
***Projected 2027 workforce has been calculated based on the workforce trend experienced between November 06 and November 2016

Cyber security fundamentals are a skill that will be required across a number of job roles in order to obtain a deeper level of understanding than currently exists. This is also a skill set that consumer/prosumers will be required to embrace, as after installation, the consumer will be responsible for their household networks and will be required to maintain certain security standards.

6.2.5 Workforce Enabler Group: Data Specialist

Data Specialists apply their skills and expertise to plan, integrate, operate, maintain and leverage business insights from "big data" management systems. Such insights will provide the basis for models incorporated by network organisations in consumer relationship processes and business operating models.

As with the ICT workforce, the increasing requirement for Data Specialists is synonymous with the digitalisation of goods and services due to the exponential growth of data availability and technological advances to accommodate such an increase. It is estimated that as at 2016, 90% of the data in existence was created in the two-year period prior.

6.2.5.1.1 Education: Data Specialist

Data specialists are highly educated and qualified professionals, that tend to have advanced skills within the mathematics, ICT and business skill disciplines and qualifications form higher education.

In response to demand for data specialist's Australian universities are increasingly adding data driven courses to their course portfolios.

No data on educational achievement is available at the time of writing.

6.2.5.1.2 Employment: Data Specialist

Consultation has been made with the ABS to determine what classification Data Specialists are categorised under the ANZSCO coding. However, due to the complexities of the data recording methodologies and data occupations being relatively new, no definite answer could be provided.

The Data Specialist occupation cluster includes the occupations listed below. All specialist occupations within this field are required to possess strong to advanced levels of mathematical, business and ICT skills.

- **Big Data[16] / Data Analysts**: interrogates, processes and manipulates data sets to provide narratives and conclusions
- **Data Scientists**: create inferences from data that commonly originate from raw unstructured datasets using algorithms. Data scientists have a broad remit of skills including advanced mathematics, technological and business acumen. High level Business acumen is required to develop strategy from the analysis.
- **Data Architects: s**pecialises in designing, creating, deploying and managing data systems. Data Architects are required to be skilled in data warehousing, querying languages and data storage solutions and policies.
- **Data Engineers:** develop, test and maintain data architectures to keep data accessible
- **Economists/Econometrics**
- **Mathematicians/Statisticians.**

6.2.5.1.3 Critical Skills: Data Specialists

The skill sets of the Data Specialist will become critically important across multiple areas of network organisations as the adoption of emerging technologies increases and the availability of data becomes abundant.

Consumer Relationship Management and Collaboration

Data Specialists will provide network organisations with insights into consumer behaviour from data that has been sourced from technological areas such as digital services and emerging technologies. These insights will provide executive management with an extensive understanding into consumer behaviours that have not been available previously. Such insights will enable network businesses with a platform to tailor consumer design relationship processes.

Business Operating Models

Data Specialists will be able to interrogate manipulate and analyse data that will become available to networks through the integration of emerging technologies and DERs to enable networks to optimise investments and make data based decisions.

[16] There are several definitions for "Big Data". For the purposes of this report, Oxford English Dictionary defines it as *"data of a very large size, typically to the extent that its manipulation and management present significant logistical challenges"* (OED, 2014)

6.2.6 Workforce Enabler Group: Executive Management

Skill sets of Executive Management will be critical to enabling the emergence and adoption of technological advancements within the network sector. Furthermore, business acumen of Executive Management during the period of significant change will become pivotal.

Executive Management is responsible for the formation and the development of strategic pathways to ensure future viability. In an environment in which the traditional delivery of products and services to consumers is in a rapid state of change, such strategic plans and ability to change, predict and understand future environments is essential, not only to the future of business operations but also the business workforce.

Successful implementation of risk management will be a key deliverable of the Executive management team. Whilst emerging technologies present opportunities to diversify services, the executive management team will be responsible for ensuring such opportunities do not undermine other areas of business operations. There is potential for existing Executive Management positions to develop necessary skill to undertake this function, however there is also potential for the inclusion of a Risk Officer within the organisations c-suite.

To manage future network requirements, industry expects that additional roles will be created on the Executive Management team, including the addition of the Chief Data Officer. The roles of the Customer Experience Officer (CXO) and/or the Chief Customer Officer (CCO) were identified by CSIRO as being occupations of the future (CSIRO, 2016).

The CCO and the CXO key focus would be to create a consumer centric organisation which is pertinent given that consumers are a catalyst for the transformation. The Harvard Business Review concluded that such an executive position would be charged with the responsibility to design, orchestrate and improve customer experiences across the increasing number of customer interactions. CSIRO, 2016 concluded that the CXO/CCO will be supported by teams with skills in psychology, marketing, design and a depth of understanding about what consumers and society really want.

The education process will be ongoing throughout the transformation period and beyond. Board members, Chief Executive Officers (CEO), and Executive Managers will be required to have a deep understanding of industry trends and emergent technologies.

6.2.6.1.1 Critical Skills: Executive Management

Business Operating Models

CEO's tend to possess extensive knowledge of the industry that the business is operating within coupled with expert business acumen. In the coming decade, CEOs within transmission and distribution organisations will be required to draw upon these skill sets to develop a robust strategic direction for the company that encourages change and innovation.

The skill of the Chief Financial Officer (CFO) is also critical to any Executive Management team. As outlined by Pricewaterhouse Coopers (PwC), the role of the CFO within the power utilities sector is transforming and progressing from a fiducial centric position to a position that is focused on strategy as opposed to stewardship (Pricewaterhouse Coopers, 2015). PwC listed the following as key areas for future CFO focus within the utilities sector:

- *Strategic direction: requires the skill to create models for future strategy in a changing industry (risk vs reward).*
- *Governance model: effective alignment and decision-making within the enterprise are fundamental to both strategic and financial success. The CFO is at the centre of designing how to increase collaboration and transparency within the business to support decision-making and reinforce accountability.*
- *Inorganic growth: organic business expansion will need to be complemented by targeted inorganic growth to support future enterprise success. In addition to creative transaction structuring, the CFO has to display a dispassionate corporate conscience over valuation and priority among options.*
- *Portfolio optimisation: the selected strategies also lead to a more diverse portfolio of businesses and assets, many of which do not co-exist. The CFO needs to be both the custodian and craftsman of all sources of shareholder value, instilling the discipline to optimise the parameters and composition of the current portfolio.*
- *Capital allocation: CFOs need to sharpen the criteria employed to assess alternative investment uses so that allocation of capital flows to the most attractive blend of available options and projects.*
- *Market positioning: once the enterprise has selected 'where and how to play', a requirement still exists to communicate the strategy in a compelling manner. The CFO is the face of the company to the market and will need to articulate positioning and value in a distinctive and differentiating manner.*
- *Risk management: the future utility competitive environment and market model are redefining the nature of industry risks and uncertainties. These emerging challenges require the CFO to rethink how to frame relevant risks and to reassess how to evaluate and mitigate their impacts.*
- *Performance management: after the corporate strategies and deployment decisions are executed, outcomes become the yardstick for whether results conformed to expectations. The CFO performs a vital role in not simply tallying the resulting metrics, but in shaping the overall assessment framework.* (PWC, 2015)

Innovation Change Management

Thought leadership and a strong commitment to embracing change were identified as key risk areas for company board members, CEO's and General Managers working in the electricity industry. Specifically, leadership for network operators and electrical contractors will continue to be high risk areas driven by the complex and rapidly changing business models, and the safety risks associated with incorrectly or insufficiently skilled workers carrying out high-risk work.

6.2.7 Workforce Enabler Group: People, Culture, Communication and Change Officers

A significant potential barrier for technology enablement within network organisations is the culture, politics and willingness to change of the current workforce.

This workforce enabler group clusters several identified functions into one, including human resource, people and culture, training and development, communication and stakeholder engagement and change management.

6.2.7.1.1 Education: People, Culture, Communication and Change Officers

Due to the people, culture, communication and change officer's workforce enabling group incorporating a cluster of occupations, data is unavailable to enable an analysis of educational trends.

6.2.7.1.2 Employment: People, Culture, Communication and Change Officers

Due to the people, culture, communication and change officer's workforce enabling group incorporating a cluster of occupations, data is unavailable to enable an analysis of employment trends.

6.2.7.1.3 Critical Skills: People, Culture, Communication and Change Officers

Today's global markets will continue to evolve and demand more. Occupations within the People, Culture, Communication and Change arena will need to change to be able to address the needs of these changing markets, consumers and employees. They will be required to be:

- Collaborative
- Influential
- High levels of emotional intelligence
- More culturally aware
- More sensitive to the needs of local consumers
- Flexible.

These skills reflect a more collaborative and collective style of leadership, which are minimum requirements of the future workforce to meet the demands of the new technologies.

Innovation Change Management

The People, Culture, Communication and Change Officers workforce enabling group will be responsible for assisting the current workforce to adapt to innovative change and the continued adaption of technology required to meet customer needs. The following eight skills have been identified by (Chamberlain, 2010):

Personal resilience: Provision of support to workers who require a safe place to vent. A network example is the potential for emerging technology to automate jobs, potentially reducing the size of the workforce.

Trust-building: In a time of change, the businesses ability to renew trust from its existing workforce is essential in ensuring the continued efficiency of employees. Workers require knowledge of how changes will impact them.

Networking: Networking with other change management employees within the organisation is critical in ensuring that a consistent message is being communicated business wide.

Coaching: People react to change in different ways - some are able to adapt quickly and learn new processes, whilst others may struggle. Employees of the People, Culture, Communication and

Change workforce enabling group will require the necessary coaching skills to assist such staff in transitioning during the change process.

Forcing clarity: Clarity is required to be provided as soon as possible for any change that will occur within the organisation.

Managing uncertainty: During a time of change, various levels of worker's uncertainty are going to occur. The People, Culture, Communication and Change workforce enabling group will be required to manage this uncertainty with sensitivity.

Organisation: The People, Culture, Communication and Change workforce enabling group will need the ability to work with the organisations change plan in order to understanding how aspects of the plan will impact on the workforce.

Follow-through: The People, Culture, Communication and Change workforce enabling group will need to ensure that any workforce initiatives that are started are also finished, providing confidence to the workforce.

Emotional Intelligence

Emotional intelligence (EQ) is defined as the ability to understand other people, what motivates them and how to work cooperatively with them (Gardner, 2017). Employees of the People, Culture, Communication and Change Officers workforce enabling group will be required to demonstrate high levels of EQ when working with the wider network workforce who will experience rapid change in a transforming industry. Five categories of emotional intelligence are recognised (Porter., 2016)

- Self-awareness
- Self-regulation
- Motivation
- Empathy
- Social skills.

The network workforce is comprised of multiple generations. Workplace consultant, Stan Kimer, (2015) stated that "people from different generations in general have different views of the workplace, motivations, and communication preferences." To effectively manage such diversity, workers within the People, Culture, Communication and Change Officers workforce enabling group will be required to have the ability to tailor their management and communication style to different individual requirements.

As workforces become increasingly diverse, knowledge of cultural differences becomes essential within the People, Culture, Communication and Change Officers workforce enabling group. Caligiuri (2016) stated that whilst CEOs identified cultural competence as one of the most critical leadership skills, managers highlighted it as one of the weakest.

To address the skill deficiency, Claigiuri (2016) stated that *"Developing cultural agility is more of an active process requiring social learning in a novel context with opportunities to practice new culturally appropriate behaviours, make some mistakes, receive feedback, and question one's own assumptions."*

Due to the evolving workforce needs, requirements and motivations, a willingness to learn will be a critical skill of this workforce group.

Strong Communication Skills

As technical skills continue to be in high demand, an ability to pair them with communication skills will be critical to advancing your career, says Daniel Alexander Usera, career consultant and professor at Arkansas State University.

“A lot of times degree programs and employers focus on the hard skills, but then end up with employees who do not know how to work with other people or can’t communicate a complex thought in an effective manner,” he says. “Although STEM degrees will continue to be in high demand, those skills are not as impactful if the person can’t function in a team-based, information-sharing context.”

This is the most fundamental people skill because it encompasses your persona and ability to get along with other colleagues, persuade others to listen to your ideas, and much more, Taylor says. “If you have a gift for the spoken and written word, you will always put your best foot forward. Being articulate is highly prized in today’s workplace, when time is at a premium and technology requires constant communication.”

6.2.8 Workforce Enabler Group: Customer Services

The consumer will no longer be just the end user of electricity within the electricity supply chain. The Roadmap has identified the need to make network organisations become customer centric.

6.2.8.1.1 Education: Customer Services

Due to the Customer Service enabling group incorporating a cluster of occupations, data is unavailable to enable an analysis of educational trends.

6.2.8.1.2 Employment: Customer Services

Due to the Customer Service enabling group incorporating a cluster of occupations, accurate data is unavailable to enable an analysis of employment trends.

6.2.8.1.3 Critical Skills: Customer Services

Personal Attributes

The ways in which customer service is delivered is evolving to a more digitalised medium with social media channels and/or apps being increasingly utilised as communication mechanisms.

Data will be able to provide insights into a range of business activities, including how to service customer needs to a higher standard, through analysing consumer trends.

Required personal skills:

- Increased digital literacy
- Working knowledge of social media
- Empathy.

Consumer Education

Whilst the requirement for digitalised consumer services is increasing, it is also important to note that in the short to medium term, the traditional customer service methods will be important for the less technical savvy consumers. The skill set to listen, understand and communicate effectively will

remain essential to this workforce enabling group. As costumer services do become more digitalised, written communication skills will become increasingly important.

Customer Service Operators will require a high level of product understanding to provide consumers with:

- Faster troubleshooting
- Smarter product recommendations (cross sells and upsells)
- Clearer communication of benefits and value
- Confident customer interactions.

It is expected that this knowledge can be gained through propriety training.

Digitalised Services

In context to digitalised services, the traditional role and skills of customer services may change. In the (CSIRO, 2016), tomorrow's digitally enabled workforce online chaperones were identified as a job of the future. The responsibilities of an online chaperone range from risk management of identity theft to reputational damage and social media bullying.

7 Initiatives and Key Actions

A key objective of this report is the development of pathways through the identification of key initiatives and actions that will provide Roadmap stakeholders with the confidence that the skills of the future workforce can be enhanced to meet the demands of the new technologies. Initiatives detailed have been developed using industry-led inferences and in collaboration with ENA. The following initiatives will assist industry in creating a competent workforce up to 2027:

- Initiative 1: Annual Workforce Skilling Report
- Initiative 2: Workforce Skilling Resource
- Initiative 3: Continuity of Skills Investment
- Initiative 4: Education and Training Package Process and Design Review
- Initiative 5: Diversity and Inclusion
- Initiative 6: Skills Awareness Campaign for workers
- Initiative 7: Skills Awareness Campaign for consumers
- Initiative 8: Qualification and Licensing Reform.

A coordinated effort from all levels of government, industry, and the training sector is needed to ensure the electricity sector and supporting industries have the right workforce, with the right skills, at the right time, in the right place and at the right cost. Focus on education mechanisms, core critical skills, skilling pathways and raising awareness of what will be different for the worker and consumer provides a complementary approach to up-skilling and re-skilling the workforce.

Assumptions that underpin the outlined initiatives are:

- The initiatives directly address the barriers to enabling a skilled workforce outlined throughout the report
- Each initiative can be developed with a national focus, as well as be tailored to the specific needs of each State/Territory
- Bi-partisan support is anticipated to successfully support the broader ENTR program.

7.1 Initiative 1: Annual Workforce Skills Report

As emerging technologies are adopted over the coming decade, the skill requirements of the network workforce must continuously adapt to ensure network and workforce needs align with technological requirements. To enable a true and current reflection of the workforce requirements over the transformation period, it is highly recommended that an Annual Workforce Skills Report (Skills Report) is commissioned. The publication will provide a fully integrated workforce management plan at every level in every jurisdiction across Australia.

The Skills Report will assist in preventing skill gaps through providing network organisations, educational facilities and government organisations with ongoing consolidation of national industry led inferences on potential skills requirements. To achieve this initiative, the network industry and relevant stakeholders must be provided with:

- An ongoing and relevant examination of current and future workforce skills needs and associated risks.
- Continual detailed analysis is currently unavailable[17], so ongoing data-driven insights into key network workforce trends is highly sought after by industry. Such data insights include analysis into occupation and employment trends and other key workforce metrics including length of service, average age, retention rates and turnover rates.

[17] Detailed employment data by occupation at a transmission and distribution level is only available on release of census data (every five years). This research has the opportunity to provide such insights on an annual basis with a continuing evolution of understanding of collaboration with participants and stakeholders.

- A platform of industry knowledge that acts as the conduit between government, industry, education and training organisations and individuals to provide insights on a national, state and territory level.
- Provision of knowledge to assist industry in implementing strategies to meet skills needs and mitigate workforce risk.
- Development and communication of recommended strategies to address network workforce skills needs and associated risks.
- Consolidation of wider relevant workforce skilling research, including industry specific literature from industry experts and wider trends (i.e. impacts of digitalisation).

The key measure to enabling this initiative is a high level of industry 'buy-in' which will enable a holistic national analysis to be undertaken and permit conclusions by state, territory and jurisdiction breakdowns. It is essential that all industry organisations work with research bodies for the provision of workforce data and communication of industry intelligence. Prior to the initial report being completed, it is recommended that a session is held with the research body, ENA and their members, and other relevant stakeholders to scope the body of work. This will not only promote the purpose of the report, but will also ensure maximum benefit for industry.

The lack of information sourced from an ongoing structured and coordinated National Skills Report results in a lack of benchmarked data for network organisations, which has the potential to lead to an uncoordinated and somewhat uninformed approach to skilling the future workforce. The lack of available data (i.e. every five years) presents a challenge given the fast-moving nature of technological developments.

7.1.1 Key Actions

Action 1:

It is recommended that ENA endorse the need for a Skills Report and explore funding opportunities available for this seminal work. It is acknowledged that the funding application process can take over 12 months so whilst the funding application is in process, it is suggested that an initial pilot report be completed in 2018. The pilot report would then act as a benchmark for future reports.

Action 2:

The research body employed to undertake research will be required to collaborate with industry to form data collection methods and publish the Skills Report within agreed timeframes. Industry relationships will be established and/or reinforced during the research phase of the initial pilot report in 2018.

Action 3:

ENA would be responsible for promoting the initiative to their members and encouraging stakeholders to be involved. Following the promotion of the initiative, ENA must provide appropriate connections between the research body and ENA members to ensure collection of data and information collection is effective. Any data provided will be aggregated and desensitised where required to form published conclusions.

Action 4:

To ensure the research is nationally available to relevant stakeholders, a series of State and National knowledge distribution events will be held to present and promote the findings. Such events would include audiences from industry bodies, education, government and council organisations, as well as the wider electrical supply chain.

7.1.2 Benefits

The success of such an initiative could be formally evaluated by;

- High level of industry buy-in, which includes active participation of every stakeholder in every jurisdiction nationally. The participation will enable the research to evolve over time, and produce a coherent workforce planning dataset.
- The national knowledge share events are attended by relevant educational, industry and government representatives in each State, Territory and Jurisdiction
- Findings of the research are used by education facilities as part of the education review (initiative 4)
- Industry adopt the report as a key annual business intelligence report

7.2 Initiative 2: Workforce Skilling Resource

A national network workforce skilling resource is to be established to represent the skills requirement of the network and wider ESI workforces. The key purpose of this resource is to become a formalised lead entity between industry, government and education facilities.

The establishment of the resource will provide network organisations and the wider ESI with a skill focused entity that will represent and act on the industries behalf, as the formal conduit between industry, government and educational institutes. Responsibilities of the resource will include:

- Forming and maintaining appropriate relationships with government and education decision makers
- Supporting and assisting respected industry skill bodies that have established working relationship with education facilities
- Overseeing funding (initiative 3) for key skill sets and qualifications needed to upskill and reskill the network workforce, electricity sector and supporting industries
- Communicating, endorsing and recommending the findings of the Annual Workforce Skills Report and research (initiative 1)
- Being a member of the education and training package process and design review in collaboration with relevant stakeholders (initiative 4).

7.2.1 Key Actions

Action 1:

Research to be undertaken with the objective to identify whether an appropriate entity to support the initiative is already established within each State, Territory and Jurisdiction within Australia. If no entity exists that has the necessary experience and capabilities to fulfil the requirements to meet the objectives, industry will be required to collaborate with government and education institutes to create a relevant body.

Action 2:

Support and funding for the resource should be sought from a number of different parties including Federal and State Governments, educational institutes and customer representative groups. Setup and ongoing funding would be required for both the establishment and maintenance of this initiative so bi-partisan support would be required. It is suggested that support for this initiative be established by 2018 and aligned with the publication of the initial Annual Workforce Skills Report.

Action 3:

A formalised structure for the resource must be established and an operational agreement signed. The structure must support network organisations throughout all States, Territories and jurisdictions.

7.2.2 Benefits

The success of such an initiative could be formally evaluated to ensure:

- Increased intakes and completions of existing workers in identified qualifications and skill sets (this would be realised through initiative 1)
- Relevant industry skill bodies provide full financial and collaborative support
- Existing workers have access to additional skills development funding
- Increased value add for consumer - The correct installations and maintenance of electrical technologies such as DERs will lead to the consumer experiencing the full benefits of technology, including full functionality and more affordable electricity which is a major driver of the transformation and continuity of delivery.

7.3 Initiative 3: Continuity and Prioritisation of Skills Investment

The speed at which emerging technologies are entering the market, coupled with the critical nature of the network and wider ESI workforces to the national economy, highlights a clear need for the continuity of skills investment to ensure that skill gaps do not create an unsafe and unreliable future workforce and an inefficient supply of energy to consumers. To accommodate the complexity of embedding new technologies into operations and subsequently maintaining them, the skills investment process will be required to be responsive and flexible.

By increasing the funding and priority of relevant identified skills from the initiatives above, industry will be more effective in transitioning its workforce safely and competently to 'the new world of work'. It is pivotal that the existing workforce have access to potential additional funding for training in the short term to address these complexities.

It is anticipated and expected that industry and the individual worker will hold responsibility for funding ongoing skills development. The rapid transformation of a workforce is not able to happen without significant intervention and a coordinated approach from government and industry. Increased up-front investment will be required to ensure there is consistency and transparency in skills development to avoid incorrectly skilled workers performing high risk tasks.

The required characteristics of such training would need to ensure that pathways are clear and transparent to all interested parties and will need continual reinforcement of how the benefits of high quality training outcomes will aid all consumers and industries as a whole and.

7.3.1 Key Actions

Action 1:

By 2022, State, Territory and Jurisdiction VET investment plans must be updated annually (to align with initiative 1 findings) to include recommended skill sets and qualifications with adjustment to funding parameters that currently rule out eligibility for existing workers who have received financial assistance to for relevant training to meet occupation and industry needs (e.g. workers who have already received funding for a VET qualification or higher education degree).

Action 2:

Decision making processes must use current data (from previously outlined initiatives) to ensure investment is prioritised to the correct skills at the correct time. If such information is unavailable, disconnect may be created between industry needs and workforce skills. In addition, the skills investment process cannot be allowed to become a lengthy practise were it will fail to reflect the speed of advancements in emerging technology.

Action 3:

The Workforce Skilling Resource (initiative 2) must ensure training provider rules are established to adhere to strict guidelines to access funding. Training provider rules would be set in line with industry expectation as the majority of workers will be already employed.

Action 4:

Ongoing audits of training providers who access funding must be conducted to ensure they are complying with the funding guidelines.

Action 5:

A key emphasis of this initiative is the requirement for it to be a continual process. It is essential that the initiative has bi-partisan support in order to prevent uncertainty with the longevity of policy and regulation.

Action 6:

The skill investment must be available to workers that can clearly demonstrate a need. Highly restrictive training funding rules for existing workers who already hold qualifications must be decreased. It is suggested that a pilot program be delivered in each State and Territory to contextualise each region's rules and regulations, and ensure that the integrity of the funding is maintained and targeted to core critical skill sets and qualifications. Pilot qualifications could vary from state to state dependant on the immediate workforce requirements.

7.3.2 Benefits

This initiative will provide the following benefits:

- Benchmarking of ongoing knowledge of skills to the energy industry and the nation
- Greater alignment between the cost of training and relevant employment outcomes, measured through completion and employment rates
- Increased electrical safety - a competent electrical supply workforce will lead to correct safety procedures being followed on the installation and maintenance of electrical products which will, in turn, increase the safety of electrical consumers and the workforce from a reduction in electrical fault related injuries and deaths.
- Increased value for consumer - the correct installation and maintenance of electrical technology leads to the consumer experiencing benefits of full functionality and more affordable electricity which is a major driver of the transformation.

The success of this initiative would be measured through:

- The number of current workforce accessing additional skills development funding
- Increased intakes and completions of existing workers in identified qualifications and skill sets

- Low reported rates of prolonged skill gaps after adoption of emerging technologies
- Availability of appropriate funding support for existing workers and new entrants
- An increase in investment in critical qualifications and skill sets
- Management of funding for critical qualifications and skills sets is managed by a central body.

7.4 Initiative 4: Education and Training Package Process and Design Review

Accredited training packages and higher education (university) courses are the core of industry and professional training in the network workforce. Continual review of the alignment between education content and industry skill needs is essential to ensuring the successful integration of emerging technologies and industry practises.

The reform of the VET national system experienced a prolonged delay in establishing relevant Industry Reference Committees (IRC). These lengthy delays have resulted in current training packages, some of which are related to the network workforce, lagging behind current industry practises, Australian standards and relevant legislation.

An in-depth review of elements affecting the future of skilled workers across all training packages related to the utilities industry will begin during 2017. It is only now that the electrotechnology training package can be constructed in a way that retains core requirements whilst embedding provisions for the Registered Training Organisations (RTO) to react flexibly and responsively to technological and industry change.

A key driver in the changes to the training package review processes is the requirement for Skilling Service Organisations (SSO) to directly engage with industry personnel through the newly formed IRC. Unfortunately, industry stakeholders have outlined that a number of trade qualified workers do not have an interest in engaging in content review due to the barriers imposed by the inherent complexities and entirely foreign nature of the VET industry as whole.

The alternative to this initiative would be to let the market adjust of its own accord which is likely to result in an increased skill gap that has potential to increase safety risks from an under-skilled workforce. A market led approach could also lead to inconsistency of education and training curriculum development and quality of educational outcomes.

An inconsistent development and delivery of new training products nationally and in particular non-accredited training for licensed products and technologies is seen as a key risk to this initiative. It is recommended that mandated standards, supported by industry and government, are developed.

7.4.1 Key Actions

Action 1:

An agreed process will need to be developed to enable SSO and IRC to identify relevant workers and employers in industry who will actively engage in the training package review and development process. The relevant persons identified during the expression of interest period require a mechanism to ensure that a high VET industry understanding is not a prerequisite of providing contemporary industry knowledge.

Action 2:

The higher education sector must work with industry experts to redesign curriculum to address future skills needs. Currently, a relationship exists between power universities and industry which

must be maintained to ensure that the Power Systems Engineer of the future possesses new skill sets that are not currently being widely taught in Australia.

The sustainability of university electrical engineering schools depends on a critical mass of academics (professors, lecturers, post graduate researchers and PhD students). To improve both undergraduate skills and research/innovation, the API, 2016 has identified that the following is required:

- *Research and innovation needs to be industry driven with a focus on deliverables of benefit to the industry and community/customers.*
- *Multi-disciplinary teams of academics/researchers from various disciplines and universities (electrical engineering, science, ICT, economics, social sciences) need to work collaboratively with industry professionals – teams with the best capability across Australia need to be established.*
- *A significant financial and in-kind contribution is needed by industry to drive this innovation agenda (Australia ranks lowest amongst OECD countries in its collaboration and research efforts)*
- *Universities need to change their culture to improve the entrepreneurial and innovation skills of both their undergraduate and post graduate students*

Action 3:

Review of existing research needs to be undertaken to determine if there are vocational training models in other jurisdictions which manage changing external factors whilst maintaining levels of rigour, ensuring industry is satisfied with the outputs of RTOs.

A specific example is to review the current vocational document standards[18] and methodologies to determine if there are unnecessary constraints in the ability for an RTO to make reasonable adjustment if and when required by the evolving needs of industry.

Action 4:

An engagement model must be developed to encourage and support the collaboration of industry with SSOs, IRCs and other relevant committees. The model must be inclusive to all relevant industry parties and actively promoted by entities represented by employers and employees.

Action 5:

A series of concise, relatable education articles is required to provide communications around the AISC, SSO, and IRC business model. Education will provide transparency to relevant industry stakeholders on the training package reform process. This action will provide:

- Greater alignment between the demands of industry and the training of the network workforce, ensuring the continual demand of the VET sector
- Reduced time to review and redesign training packages with a framework enabling RTOs to react separately of training package reform, ensuring industry needs are met
- A suitably skilled and ready workforce to ensure the successful rollout of new and emerging technologies which will see Australia becoming a leading player in the industry, providing numerous economic benefits.

[18] Standards for Training Packages

-

Action 6:

To understand the skill requirements to work with emergent technology, supply chain manufacturers are encouraged to collaborate with the education sector to develop appropriate training. Such collaboration could be facilitated through the Workforce Skilling Resource outlined previously in initiative.

7.4.2 Benefits

The success of this initiative can be measured through

- New training products are endorsed and available for delivery within one year were required of the ENTR report release
- Development of a framework that enables technological change to be represented in training package design and content
- A quantifiable increase in the engagement of industry within the training reform

7.5 Initiative 5: Diversity and inclusion

A number of organisations operating across all Industries within the Australian economy have identified the importance a diverse workforce provides. It is essential organisations across the ESI embrace diversity and inclusion in future training, employment and workforce strategies.

Diversity in workforce begins with diversity in thinking, laying the foundations for acceptance of an individual based on their merit and capacity to perform their duties irrespective of perceived limitations based on disability, ethnicity, age, gender and any other irrelevant discerning factors.

7.5.1 Key Actions

Action 1:

To initiate a holistic drive embracing diversity and inclusion within network organisations and the ESI, there first needs to be a unified approach to foster the initiatives within existing workforce culture.

Action 2:

Business, industry, education and government stakeholders will be required to identify and develop measurable goals and stretch targets for diversity and inclusion. This requires implementing diversity of thinking within all business facets and be measurable through industry education and KPIs.

Action 3:

Promotional material documenting measurable outcomes of the progressively diverse nature of the ESI is publicised within national media. Communicating the message with the Australian public that the ESI is committed to this initiative will make the industry more attractive to future workers.

7.5.2 Benefits

The key benefits of this initiative of workplace diversity are:

- ***Increased Productivity****: Diversity and Inclusion brings in diverse different talents together working towards a common goal using different sets of skills that ignites their loyalty and increases their retention and productivity*

- ***Increased creativity and Problem solving****: With so many different and diverse minds coming together many more solutions will arise as every individual brings in their way of thinking, operating and solving problems and decision making*
- ***Attract and Retain talent*** *that add a competitive edge to any organisation. Feeling included and appreciated increases loyalty and feeling of belonging. Language skills pool is increased and propels organization forward either to compete in the International global world or to increase its diverse customer base*
- *Help to* ***build synergy in teams*** *and enhances communication skills that brings in new attitudes and processes that profit the whole team*
- ***It increases market share*** *and create a satisfied diverse customer base by relating to people from different backgrounds. It does propel the United States and its status to claim its place and success in the global business world of the 21st century*

(Andrade, 2010)

7.6 Initiative 6: Skills Awareness Campaign for ESI Workers

A significant risk area (to the safety of the worker and Australian community) is that the training requirements, responsibilities and the role of the installer/maintainer are not clearly defined within relevant standards and legislations. A lack of clarity can potentially lead to a gap being created in what type of worker needs to be involved in particular steps of new technology, which has the potential for unskilled and unlicensed work to undertaken.

Additionally, a complementary worker awareness and education campaign needs to be developed to ensure that individual workers, especially those in micro, small and medium sized businesses, are made aware of the licences and additional training required to deliver work in these areas.

The alternative option to this initiative would see an uncoordinated approach in the rollout of awareness campaigns across Australia. Whilst there will need to be some contextualisation across the States and Territories, a national approach will reduce the ambiguity and potential health and safety risks associated with work being carried out by unskilled workers.

Action 1:

Development and implementation of a Worker Skills Awareness campaign that highlights the skills needed to deliver quality outcomes for the ENTR. Campaigns should be contextualised to each State and Territory to align with individual regulatory and licensing frameworks. These campaigns are the responsibility of the Commonwealth, State and Territory Departments of Education.

Noting the current technological environment, development of this campaign must commence in 2017 and begin to be implemented by 2018.

7.6.1 Benefits

The key benefits of this initiative are:

- Increased Electrical Safety – a competent electrical supply workforce will lead to the correct safety procedures being followed on the installation and maintenance of electrical products which will, in turn, increase the safety of electrical consumers and the workforce from a reduction in electrical fault related injuries and deaths.
- Increased value add for consumer - the correct installation and maintenance of electrical technologies such as DERs will lead to the consumer experiencing the full benefits of

technology including full functionality and more affordable electricity which is a major driver of the transformation

7.7 Initiative 7: Skills Awareness Campaign for Consumers

Development and investment in a national education campaign, tailored to specific regulations and legislations of each State, Territory and Jurisdiction must be conducted to enable consumers to be informed about the type of qualifications and skills required by the workforce to undertake installation and maintenance at the customer's location.

7.7.1 Key Actions

Action 1:

Development and implementation of a consumer skills awareness campaign which educates consumers on what the 'right' worker is for specific tasks. The campaign is required now (2017) and must continue as new technologies are introduced and adopted.

A range of entities are expected to be responsible for implementing the initiative including skills and training committees, consumer advocate groups such as Energy Consumers Australia, relevant regulatory bodies and State Government Consumer Ombudsman.

7.7.2 Benefits

The key benefits of this initiative are the enablement of mass adoption of emerging technologies which will boost consumer satisfaction and the experience consumers have with initial products will impact on purchase of further technologies.

7.8 Initiative 8: Qualification and Licensing Reform

A national standard for VET coupled with national recognition of trade licenses affords a national consistency in the issuance of summative assessment tools (e.g. capstone and the further issuance of licenses for the network workforce[19]). The recent release of the 'Review of Regulatory Requirements for Queensland Licences' addressed, in-part, the recommendations made by the central coroner, magistrate David O'Connell.

The Review of Regulatory Requirements for Queensland Licences report identified three key focus areas including:

1. Contactor license eligibility requirements
2. Administration of the Capstone test
3. Impact of a tiered electrical contractor license.

The future implications of this reform are as yet unknown however, it is understood that this could see the biggest reform to a State licensing regime in over 30 years.

The report identifies four major groups of recommendations including the:

1. Administration of the Capstone assessment
2. Requirements for the electrical contractor license
3. Licensing renewal
4. Compliance.

[19] This also includes reference to the Australian New Zealand trans-Tasman licensing agreement

Although out of scope for this research, a number of stakeholders identified and aligned with the findings of the Review of Regulatory Requirements for Queensland Licences.

7.8.1 Key Actions

At the time of writing, actions on recommendations are still pending with multiple stakeholders working collaboratively to implement mechanisms that will address the intended outcomes and goals of the report.

8 Bibliography

AlphaBeta. (2016). *The new basics: Big data reveals the skills young people need for the New Work Order.*

Andrade, S. (2010). *Sahar Andrade*. Retrieved from Saharconsuting's Blog: https://saharconsulting.wordpress.com/2010/03/26/6-advantages-of-workplace-diversity/

Australian Bureau of Statistics - 2006 Household Census. (n.d.). *www.abs.gov.au*. Retrieved from www.abs.gov.au.

Australian Bureau of Statistics - 2011 census & ANZSCO. (n.d.). *ABS*. Retrieved from ABS.

Australian Bureau of Statistics - 2011 Household Census. (n.d.). *www.abs.gov.au*. Retrieved from www.abs.gov.au.

Australian Bureau of Statistics - ANZSCO. (n.d.). *Australian and New Zealand Standard Classification of Occupations, 2013*. Retrieved from http://www.abs.gov.au/ANZSCO.

Australian Bureau of Statistics– Category 6291.0.55.003. (n.d.). *Australian Bureau of Statistics – Category 6291.0.55.003*.

Australian Government - Department of Education - UCube. (n.d.). *https://www.education.gov.au/ucube-higher-education-data-cube*. Retrieved from https://www.education.gov.au/ucube-higher-education-data-cube.

Australian Government Office of the Chief Scientist. (2016). *Australia's STEM workforce.*

Australian Government Productivity Commision. (2016). *Digital Disruption: What do governments need to do?*

Australian Government Productivity Commission. (2015). *Business Set-up, Transfer and Closure.*

Australian Government: Department of Employment. (2016). *http://lmip.gov.au/default.aspx?LMIP/EmploymentProjections*.

Australian National Audit Office. (2014). *Administration of the Smart Grid, Smart City Program.*

Australian Power Institute. (2015). *Skills and demand in industry report.*

Becker, K., & Park , K. (2011). Effects of integrative approaches among STEM subjects on students' learning. *Journal of STEM Education Volume 12 – Issue 5 & 6*.

Chamberlain, L. (2010). *http://www.personneltoday.com/hr/eight-key-skills-for-effective-change-management-for-line-managers/*.

CSIRO. (2016). *Tomorrow's Digitally Enabled Workforce.*

CSIRO. (2016). *Tomorrow's Digitally Enabled Workforce.* Commonwealth Scientific and Industrial Research Organisatio.

Deloittes Access Economics. (2015). *Australia's Digital Pulse: Key challenges for our nation - digital skills, jobs and education.*

Electricity Networks Australia . (2016). *Electricity Network Transformation Rodmap - Key concepts report.*

Kennedy, J., Lyons, T., & Quinn, F. (2014). *The continuing decline of science and mathematics enrolments in Australian high schools.*

NCVER - VOCSTATS. (n.d.). *NCVER - VOCSTATS*. Retrieved from NCVER - VOCSTATS.

OED. (2014). *Oxford English Dictionary.*

Paula Caligiuri. (20). Professor of international business and strategy at Northeastern University.

Porter., M. A. (2016). What is Emotional Intelligence (EQ)?

Pricewaterhouse Coopers. (2015). *A Smart move: Future-proofing Australia's workforce by growing skills in science, technology, engineering and maths.*

Pricewaterhouse Coopers. (2015). *The changing role of the CFO How energy transformation is shifting the CFO focus.*

PWC. (2015). *Future-proofing Australia's workforce by growing skills in science, technology,.*

Scwab, K. (2016). *https://www.weforum.org/*. Retrieved from https://www.weforum.org/.

West Monroe. (2011). *The Smart Grid Workforce of the Future.*