Changing Industry, A Changing Workforce

Electricity Network Transformation Roadmap Workforce Skilling Impacts

October 2016

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Energy Networks Australia

CSIRO

ELECTRICITY NETWORK TRANSFORMATION ROADMAP 2017-27

Connecting industry with skills

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.

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Index of abbreviations and acronyms

AC	Alternating Current
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
AMI	Advanced Metering Infrastructure
AERI	Australian Energy Research Institute
ANZSCO	Australian and New Zealand Standard Classification of Occupations
API	Australian Power Institute
ASQA	Australian Skills Quality Authority
AVVC unit	Active Volt-Var Control unit
COAG	Council of Australian Governments
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DC	Direct Current
DER	Distributed Energy Resources
DSP	Demand Side Participation
DNSP	Distribution Network Service Provider
EMS	Energy Management System
ENA	Energy Networks Australia
ENTR	Electricity Network Transformation ENTR
ESQ	Energy Skills Queensland
EPIA	European Photovoltaic Industry Association
FDIR unit	Fault Detection, Isolation and Restoration unit
GW	Gigawatt
ICT	Information and Communication Technology
Industry	Australian Electricity Supply Industry
IT	Information Technology
kW	Kilowatt
kWh	Kilowatt hour
NEM	National Electricity Market
NER	National Electricity Rules
OT	Operational Technology
PoC review	Power of Choice review
PV	Photovoltaic
ENTR	Electricity Network Transformation ENTR
SSO	Skilling Service Organisation
STEM	Science, Technology, Engineering and Mathematics
Supporting Industries	Electrical contractors and technology hardware and software businesses
ToU tariff	Time of Use tariff
VET	Vocational Education and Training
Workforce	Australian Electricity Supply Industry Workforce

1. Introduction

Australia's national science agency, CSIRO and the peak national body representing electricity transmission and distribution businesses in Australia, Energy Networks Australia (ENA) have partnered to develop the Electricity Network Transformation Roadmap (ENTR).

The ENTR seeks to achieve the following objectives through setting out a sustainable pathway for the transition of electricity networks:

- Position network businesses and the whole energy supply chain for the future
- Support the evolving needs of the Australian electricity customer
- Innovate and develop new services that customers value to foster the long-term resilience and efficiency of Australia's energy system.

In 2015, Energy Skills Queensland published the 'A Changing Industry, A Changing Workforce' discussion paper, summarising the characteristics of converging trends driving workforce transformation within the Australian Electricity Supply Industry. Following this, ENA engaged Energy Skills Queensland to assist with the delivery of the skills, training and professional development ENTR work package.

> *"It is difficult, yet important, to gain an understanding of the long-term workforce impacts of the substantial industry and market change occurring in the Australian electricity industry. Successful industry change depends on skilled labour, and a correct assessment of the workforce implications of impending change can help ensure a properly skilled workforce is available when needed. Given the long lead times and highly skilled nature of the electricity workforce, combined with the importance of a reliable power supply to the national economy, understanding these skill needs is of even higher significance for the electricity industry, its stakeholders and state and federal governments."* (Energy Skills Queensland, 2015)

The workforce skills, training and professional development work package is located within domain D (technological enablers) of the ENTRs structure. The objective of this paper is to identify **key mechanisms which enable sustainable workforce skill development pathways for the Australian electricity sector and supporting industries**. These mechanisms are recognised in the recommendation section of this report as key initiatives and have been developed by Energy Skills Queensland through collaboration with ENA.

Such pathways have been designed to deliver competent workforces in the transmission and distribution network sectors, through providing the workforce with the right skills, in the right place at the right time to ensure the Australian electricity consumer is provided with a reliable, safe and affordable supply of electricity throughout the next decade.

In achieving this objective, this paper will provide the network sector and supporting industries, governmental agencies and educational facilities/institutions with the following outcomes:

- Identification of critical skills and occupations that will be prominent by 2027
- A determination of the impact of emerging technologies on the workforce sector between 2017 and 2027
- An assessment of what digitalisation of the industry will mean for its workforce from 2017 to 2027

- Identification of workforce critical skill gaps and training requirements, including the time to train skilled workers, that will need addressing to ensure the Australian public are provided with electricity in a safe and reliable manner.

In line with the ENTR values, if implemented successfully, these pathways will assist industry to produce a skilled and competent workforce that will enable:

- Safe implementation of new technologies, that will reduce the cost of electricity to the consumer, deliver a reliable and efficient supply of electricity and enable the greater demand requirements of the Australia consumer to be met
- Increased Electrical Safety – A competent electrical workforce will lead to the correct safety procedures being followed on the installation and maintenance of electrical products. In turn this will increase the safety of electricity consumers and the workforce from a reduction in electrical fault related injuries and deaths
- A greater alignment between government investment in training and relevant employment outcomes, measured through completion and employment rates
- A framework to reduce the time to review and redesign training packages that meet industry needs
- Increased value-add for the consumer – The correct installation and maintenance of electricity technologies such as Distributed Energy Resources (DER) will lead to the consumer experiencing the full benefit of the technology, including full functionality and more affordable electricity - a major driver of the transformation
- Enabling mass adoption of DERs – Consumer satisfaction will largely be created through the success of the above points. The experience consumers have with initial products will impact on purchase of further technologies
- Australia considered a global test bed for renewable energy; a skilled and ready workforce is imperative to ensure the successful rollout of such technologies. Successful outcomes will see Australia becoming a leading player within this industry leading to numerous economic benefits.

2. Executive Summary

Emergent technologies driving change in the electricity sector and supporting industries are already shifting the profile and skill requirements in the workforces of Distribution Network Service Providers (DNSPs), Transmission Network Service Providers (TNSPs), electrical contractors and workers in other electricity supply industry sectors.

The demand for such skill changes can be summarised through categorising critical skills and occupations into two workforce clusters:

- The digitally enabled workforce
- The traditional network workforce.

Key occupations within the 'digitally enabled workforce' have skill sets which will be essential to develop, maintain and compliment emerging digitalised technologies such as DERs which are entering the electricity industry.

The skill sets of this workforce will be synonymous with the era of digitalisation and will be in high demand across the majority of industries in Australia. Attracting and retaining this workforce will pose significant challenges for the TNSP and DNSPs. Recruitment of digitally enabled workforce specialists who also have knowledge of the electricity supply industry is already being reported as difficult, and this has potential to increase over time as the demand for these occupations grow. Critical job roles identified within this cluster include:

- Data Specialists - Analytics and Visualisation
- Cyber Security Specialist (reported in this report as database systems administrator and ICT security specialist in accordance with the Australian Bureau of Statistics ANZSCO coding)
- Software and Application Programmers.

The 'traditional network workforce' includes occupations that have habitually been prominent within TNSP and DNSP businesses, and subsequent skill sets are currently critical in the day to day function of network organisations. This workforce will experience skill, training and personal development opportunities to work with, integrate and compliment emerging technologies.

The following occupations identified within the 'traditional network workforce' will experience significant impacts on their current role, and will also be prominent occupations during the coming decade:

- Electrical Tradespersons[1]
- Electrical Engineers
- Electrical Engineering Technicians
- Executive Management.

The electrical tradespersons will be the primary installer/maintainer of emergent technologies such as battery storage systems. Technologies entering the market in the coming decade will have advanced componentry enabling the interconnectivity of these devices to the internet. As such, the electrical tradesperson will be required to obtain the necessary Information and Communication

[1] For the purpose of this report and to be consistent with the Distribution and Transmission industry terminology Electricians will be referenced as Electrical Tradespersons. These include lines workers, underground electricians, electrical fitter mechanics and electrical contractors.

Technology (ICT) and cabling skills to install, configure, connect and fault find, both onsite and through remote commissioning.

Whilst the introduction of new hardware will require a level of product knowledge which could potentially be addressed through propriety training, the primary skill gaps will be the ability to embed this equipment into an interconnected system and the related ability to learn technologies such as the Internet of Things (IoT). It is anticipated that these skills will be met using the best available, non-accredited training resources in the short term, with a shift to accredited pathways over time as standards are developed and embedded in industry.

The integration of renewable energy and the introduction of technologies that can feed electricity back into the grid, which was originally designed to carry energy in a one-way direction, are key drivers of skill deficiencies for electrical engineering professionals. The Australian Power Institute (API), through consultation with 14 Electricity Supply Industry organisations, identified that the skills required by electrical engineers to meet the future need of industry can be categorised into five technical fields (both engineering and non-engineering disciplines):

- *Systems engineering*
- *System planning, design and analysis*
- *Engineering management*
- *Intelligent networks and protection*
- *Renewable and alternate technology.*
  (The Australian Power Institute, 2015)

Energy Skills Queensland's research supports API's findings, and also finds the role of electrical engineering technician, as a position that will be highly impacted in the coming decade. Similar to the electrical tradesperson, the emergence of technological advancements that have embedded ICT capabilities will require the technician to adopt a systems thinking skill set. As described by one respondent, technicians will no longer be able to fault find and diagnose faults with a multimeter and screwdriver but will require an ICT skill set to do so. Energy Skills Queensland defines 'systems thinking', for the purpose of this report 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.'*

Executive management is a workforce cluster that is already playing a critical role within the transformation period. The convergence of digitalisation, new technologies and increasing customer demands will require that business models adapt to accommodate such changing consumer behaviours through the integration of new services and technologies. Expert business acumen will be required to position companies strategically; a fundamental aspect of this is ensuring that the businesses have a workforce that has the necessary skills to succeed in the changing environment.

Identification of transferrable skills which are referred to as 'Enterprise Skills'(AlphaBeta, 2016), including digital literacy, creativity, communication, enthusiasm for learning and complex problem-solving skills, will become a requirement for all workforce clusters. Enterprise skills will become critical for workers to adopt, and organisations to encourage within the electricity sector and supporting industries. These skills have not traditionally been embedded within vocational and higher education pathways and it is expected that organisations will develop in-house, non-accredited training to compensate.

Governments will need to develop technology and workforce skilling enabling policies that are robust enough to meet safety and compliance needs, but adequately flexible to continue to adapt to ongoing change and innovation. For example, the influx of interconnected technologies entering the market will require a higher level of ICT skills from occupations where this skill set has not previously been essential, new policies will need to be implemented to assist educational institutions in ensuring relevant skills are being taught.

The Vocational Education and Training (VET) and higher education sectors will face critical skill shortages of their own. The ability to source appropriately skilled trainers has been identified as a challenge for both industry and the VET sector. If there is an industry skill shortage, there will be a corresponding education and educator shortage, and this will need to be addressed as a priority in order for the sector to remain a viable training pathway for industry. As new technologies are introduced within the industry, educators will be required to obtain a comprehensive knowledge of not just stand alone technology but also how each device interacts within a network.

The VET sector will also be required to address image and reputation issues. The VET sector is viewed by some as an inferior educational pathway, when compared to the higher education alternative. This is driven by a number of reasons; including University degrees becoming more affordable and accessible than in the past due to government loan schemes and the uncapping of university places. The issues that have surrounded VET FEE-HELP scheme have also had a negative impact on the perception of the quality of VET qualifications.

A coherent and collaborated approach must be taken by industry, government, and the training and education sectors to respond. This research identified two key themes impacting critical job roles and skill sets:

- The industry will need to respond to both a 'skills shortage' and a 'labour shortage'[2]. Skill shortages will be seen in critical job roles identified as the traditional and technical workforce who will require additional training to upskill and/or re-skill in order to adapt. Labour shortages are likely to be felt in the job roles identified with the digitally enabled workforce. Current labour shortages have been reported throughout this research in critical roles such as data analysts and cyber security specialists.
- 'Enterprise skills' that have not traditionally been embedded in vocational and higher education pathways will play an increasingly important role in the electricity sector and supporting industries.

Throughout the coming decade, as new technologies emerge, industry will need to understand how these technologies interact with their current systems and business models, and rapidly upskill and/or re-skill existing workforces to accommodate. Digital and data literacy will not only become a skill set that will become a necessity in specialists but increasingly required within employees from all areas of the business.

[2] For the purposes of this report a skill shortage refers to an existing workforce that will require additional skills or knowledge in order to perform the occupation/role they have traditionally worked in. A labour shortage refers to there not being enough of a particular type of worker, driven by a lack of qualified professionals commencing and completing education and training in specific roles.

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. The initiatives required over 2017-27 to achieve the 2027 objectives are:

- Initiative 1 - A coordinated approach to higher level skills/skills deepening investment and prioritisation needed to educate and train the existing workforce, particularly for technicians, maintainers, and electrical workforce
- Initiative 2 - Education and training package process review to ensure there are ongoing mechanisms to support rapid change and new technologies in curriculum design and delivery
- Initiative 3 - Skills Awareness Campaign for both the consumer and the worker to increase awareness on what the ‘new world’ worker will look like. The consumer will need greater education to make informed decisions for their energy choices, and regulation needs to be strengthened to enable this.

Importantly, all parties, including the electricity sector, supporting industries, government and education, will need to develop and implement strategies that enable their workforces to continually adapt to change, embrace life-long learning, and remain engaged and motivated through a prolonged period of disruption and change.

3. Transformation Drivers and Workforce Impacts

The key drivers of change identified during this research for the electricity supply and supporting industries are summarised into three distinct yet interconnected categories:

- The emergence of technology with digitalised capabilities
- The integration of large-scale renewable energy
- Increased consumer demands /rise of the prosumer.

The following section provides an overview of these drivers and the impacts that they will have on the network industry and wider electricity supply workforces.

Emerging technology with digitised capabilities

A so-called 'perfect storm' of technological advances (computer power, data storage capacity, interconnectivity and mobility) have converged to witness the introduction of the fourth revolution – the digital revolution (Schwab, 2016). The digitalisation of products and services is changing the way in which businesses service consumer needs (Hajkowicz et al., 2016). Digitalised technologies are manifesting themselves within the electricity supply industry in the form of Distributed Energy Resources (DERs).

> *"Distributed energy resources (DER) are smaller power sources that can be aggregated to provide power necessary to meet regular demand. As the electricity grid continues to modernize, DER such as storage and advanced renewable technologies can help facilitate the transition to a smarter grid"* (Electric Power Research Institute)[3].

There are a number of technologies driving workforce skilling change (further detailed in addendum one):

- Battery storage
- Smart meters
- Electric cars
- Home energy management systems
- Solar photovoltaic with advanced technologies
- Internet of Things (IoT)
- Smart appliances such as Demand Response Enabling Devices (DRED)
- ICT enablement.

The IoT is connectivity of devices to the internet through embedded sensors, and is an important technology driving the digital revolution. The digital revolution is advancing rapidly and exponentially, with the steeper change curve expected to occur in the coming years. For example, the number of connected devices in 2006 totalled 2 billion and in 2016 there were 15 billion (Hajkowicz et al., 2016). By 2020 there is anticipated to be 200 billion (Intel, 2015).

The Australian electricity sector and supporting industry workforces will keenly feel the impacts of digitalisation through the introduction of DERs which have interconnectivity capability. The sector will experience not only the workforce challenges that are specific to the era of digitalisation, but

[3] It is noted this definition of DER refers to DERs being a small power source. In Australia it is widely accepted that DER can constitute sizes from 1MW to 100 MW

also the impacts on traditional occupations through the introduction of new services and products and contraction of roles in more traditional areas.

The majority of skill discrepancies that will be created from the emergence of such goods and services for the traditional network workforce are as follows:

- Systems thinking – DERs are not stand-alone pieces of equipment; the installer of this equipment will need to adopt a systems thinking mindset to create networks. To achieve this competent digital literacy, critical thinking and creative skills will be required
- Asset Management – Life cycles of 'smart technologies' are more reflective of computer technology. New technology has a lifespan of 5-10 years, whereas traditional grid assets have lifespans of 30+ years. The discipline of asset management to maximise value and performance whilst managing risk will become more prominent
- DERs enable opportunities such as distributed generations, localised storage of electricity and the ability to feed energy back into the grid which has not traditionally been available to consumers. The existing grid was constructed and designed to carry a one-way flow of electricity and skills will now be required to establish systems that enable a two-way flow of electricity
- The introduction of DERs and new technologies will fundamentally change the methods in which electricity is generated, transmitted and supplied to consumers. The skill of executive management, responsible for setting the strategic direction of an organisation operating in the industry, will be essential in defining business models. With the role of the DNSP of the future is yet to be defined, skill sets of CEO and general management within these organisations will be pivotal.

Integration of large-scale renewable energy

The Australian Government committed to the Renewable Energy Target (RET) in 2001, which in its current state after the Australian parliament passed the Renewable Energy (Electricity) Amendment Bill in 2015, aims for 33,000GWh to be produced from renewable sources by 2020; post 2020 targets are to be adjusted accordingly.

Traditionally, the Australian grid is predominantly powered by coal resources which are generated from a select number of power plants. The integration of renewable energy, which will be generated from numerous large-scale renewable plants, will require new systems to be established and configured to transmit and distribute energy to the Australian consumer.

The progression from traditional coal-fired generation to large-scale renewable generation will require a skills mix change. The renewable generation sector was identified within our research as a sector that will experience significant skills gaps, in particular within the wind generation sector where maintainers will be a critical workforce role.

Increased consumer demands / rise of the prosumer

Technological advances and the era of digitalisation have enabled the consumer to become more than just the end user within the electricity supply chain. The increasing choice, flexibility and independence that electricity consumers now possess, has seen the rise of the 'prosumer'[4]. As

[4] Producer/Consumer

consumers evolve into prosumers, through generating portions of their own electricity needs, knowledge of how to monitor, assess and modify their use of electrical energy will be required.

The technical customer service skills of the installer of DERs will become increasingly important as the role of the prosumer evolves. DERs and their supporting functionalities will require that the consumer is provided with an education of their capabilities and additional functionalities such as applications (apps) and local area network (LAN) integration. The digital literacy level of consumers will vary greatly and will require the educator to communicate effectively with a wide range of consumers.

Progression into the digital world is fundamentally changing not only products but the methods, services and interactions that consumers demand from businesses within all economies. Consumers no longer expect to have to pick up a phone to communicate with their network provider; instead information is expected to be available online and through multiple social media channels.

4. The Digitally Enabled Workforce

A workforce that possesses the right skills, to develop, support and maintain digital technologies, as well as providing the required skill sets to complement the additional functionality that such technologies provide, is critical for network operators and supporting industries.

The emergence of digitalised technologies and services will require digital literacy and the ability to work with data (skill level will be dependent on position) being a prerequisite for an increasing proportion of the network and electricity supply industries workforces.

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 of the future workforce:

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

A potential challenge that is faced by the network industry and the wider electricity industry is that Australia has an ageing workforce with the number of Australia's population over 65 expecting to double by 2035 (Hajkowicz et al., 2016). Workers will be required to remain in the labour force for longer, in an environment of ongoing disruption, making enthusiasm for lifelong learning essential for all workers.

The introduction of digitalised technologies and services is also requiring a higher level of skills for entry level occupations, as the worker will be required to work with more complex automated systems (Hajkowicz et al., 2016).

The skill set of specialist occupations will become more prominent and critical. Specialists who are highly educated professionals within their fields of expertise will be required to develop, maintain, support, operate and compliment digitalised technologies. A well-documented and prime example for the network industry is the cyber security specialist who will be responsible for ensuring the integrity of the grids assets and consumers personal information. The demand for occupations that require specialist skill sets will be double in 2019 than when compared to 1991 (Hajkowicz et al., 2016).

The challenges the network industry faces in sourcing workers from the highly skilled digitally enabled workforce are:

1. Attracting skilled workers in a market where there is largely an undersupply of such workers
2. Making the electricity industry appear an attractive proposition for skilled workers
3. Retaining high-quality employees in a competitive market
4. Contextualising the needs of the electricity sector and supporting industries for workers with required skill sets and occupations
5. Providing appropriate training and training accreditation to meet the diversified skill requirements in this new energy paradigm.

The following outlines the digitally enabled occupations/skill sets that will be critical to the electricity supply industry.

Data Specialists

In recent years the exponential growth of data availability has seen businesses become more data-driven, a trend that is expected to continue in the coming decade. The increased volume and availability of data has seen the expansion of existing job roles and creation of new ones that specialise in data science, analysis and visualisation. Data specialists possess the analytical skill sets required to process, extract value from, visualise and communicate with data.

The data specialist occupation cluster includes the following occupations:

- Big Data[5] Analysts
- Data Scientists
- Data Architects
- Data Analysts
- Data Visualisation.

With the introduction of digitalised technologies TNSP and DNSP organisations will be able to utilise data specialist skills to plan, integrate, operate, maintain and leverage business insights from big data management systems. These skills will become essential in assisting network businesses in understanding a range of insights from consumer needs to energy consumption trends.

Data specialists are already in high demand across most industries in the Australian economy. A current shortage of data specialists has been reported, and specialists are often attracted to industries that offer substantial salaries and share options such as the technology and financial sectors.

Whilst data specialists have been identified as a key occupation, the increased ability to work with, process, manipulate and understand data will become a requirement not only of specialists but the workforce as a whole. A number of occupations within the electricity supply and supporting industries, ranging from engineers to sales personnel, will be exposed to increasing volumes of data and will require varying levels of data literacy to manage these substantial data flows.

[5] There are a number of 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).

Database Systems Administrators and ICT Security Specialists

“The role of a database systems administrator and ICT security specialist is 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, 2013)

The threats 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 is requiring skill sets of highly trained individuals to protect not only consumer’s personal information but also the grid infrastructure.

The implication of a security system that is not robust can have catastrophic impacts on the Australian economy and become a substantial barrier to the implementation of technology. A successful attack will result in consumer confidence decreasing, and a reduction in households opting to utilise ‘smart’ technology.

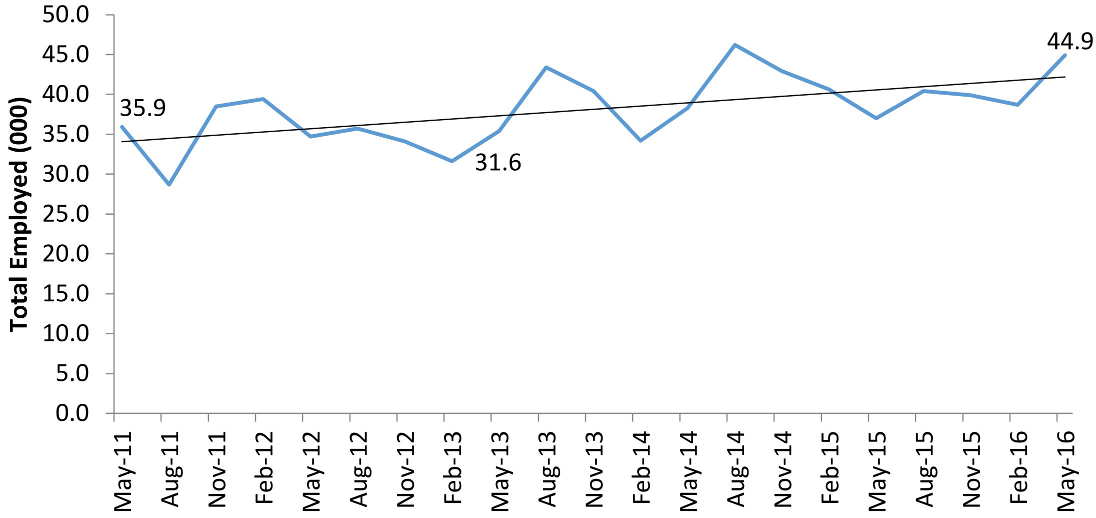
Referring to the current status of the electricity supply cyber security status, PricewaterhouseCoopers (PwC) power and utilities leader, Mark Coughlin, stated that utilities are “well prepared in their corporate systems…but are still underprepared when it comes to the security of their operational systems.” Mr Coughlin also concluded that utilities are less well protected against cyber threats than many of those in the retail, banking and defence industries.

A critical shortage of qualified security specialists is already being experienced within Australia, and the long training times to develop the skills and knowledge required for this profession is a major concern. 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.

An employment increase of 20% (9,000 employees) was recorded for database and systems administrators and ICT security specialists over the five year period to May 2016. The substantial employment growth highlights that demand for this skill set is evident in today’s economy. It is expected that as the exponential increase in the number of connected devices enters all markets, demand for this skill set will follow suit.

Figure 1 - National employment trend analysis - Database and systems administrators and ICT security specialists



(Australian Bureau of Statistics, 2016)

Whilst a clear need for specialised professionals exists within the cyber security discipline, cyber security fundamentals is another 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 networks and will be required to maintain certain security standards.

Software and Application Programmers

"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, 2013)

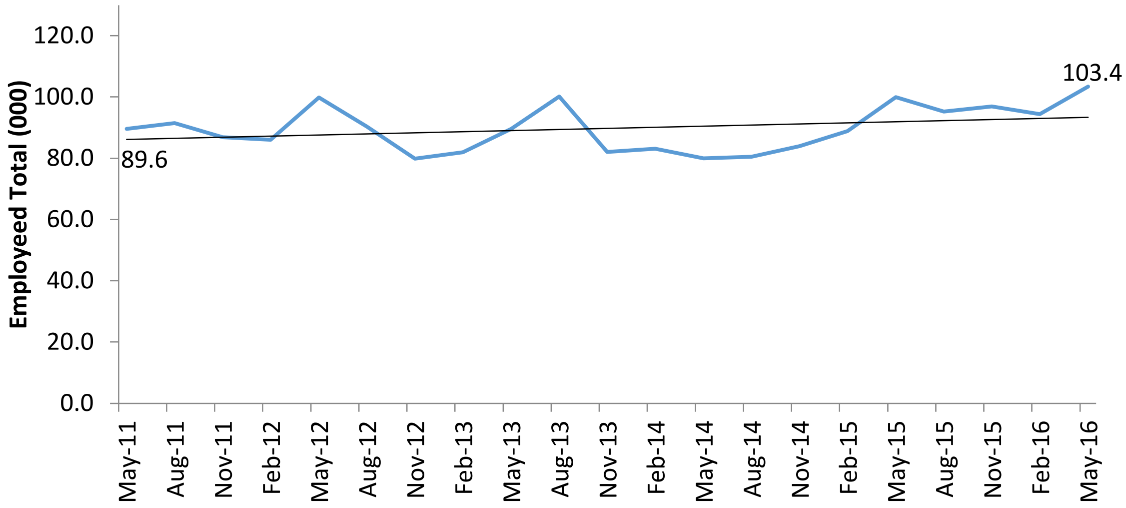
Recognised as a position in high demand, programmers specialise in various coding languages, as well as fields of specialisation such as backend developers and user experience programmers.

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.

Whilst classified within the 'digitally enabled workforce', programmers also have a presence within the traditional workforce. As at the 2011 census, programmers were 0.7% (205 employees) and 0.8% (226 employees) of the DNSP and TNSP workforces respectively. Programmers will be important to network sector and supporting industries as they will be responsible for developing and maintaining a range of online services, such as internet platforms and applications.

National demand is high for software and applications programmers across the Australian economy and these positions are no longer restricted to the ICT industry. The following five-year employment trend analysis outlined in figure 2 highlights a steady growth rate of 13.3% or 13,800 employees when the May 16 reporting period is compared to the May 2011 period.

Figure 2 - National employment trend analysis - Software and applications programmers



(Australian Bureau of Statistics, 2016)

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 in excess of $1,000 AUD.

Education of the Digitally Enabled Workforce

The importance of STEM (Science, Technology, Engineering and Mathematics) qualifications for the digitally enabled workforce is widely regarded as critical. Literature concludes that 75% of occupations experiencing the fastest growth require STEM skills (Becker, 2011). Furthermore, in 2015, the Australian Government concluded that STEM skill sets are included in the skills universally accepted necessary for the future workforce (Australian Government Productivity Commission, 2015).

The education of STEM is not restricted to universities. There were 2.3 million STEM qualifications in Australia as at the 2011 census, and approximately two-thirds were VET qualified (Australian Government Office of the Chief Scientist, 2016).

When assessing the importance of STEM in the context of the Australian electricity supply sector the Australian Government Productivity Commission summarised the following. The research highlights the ICT needs of the installer/maintainer of 'smart technologies', which will be predominantly electrical contractors who are 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 the following:

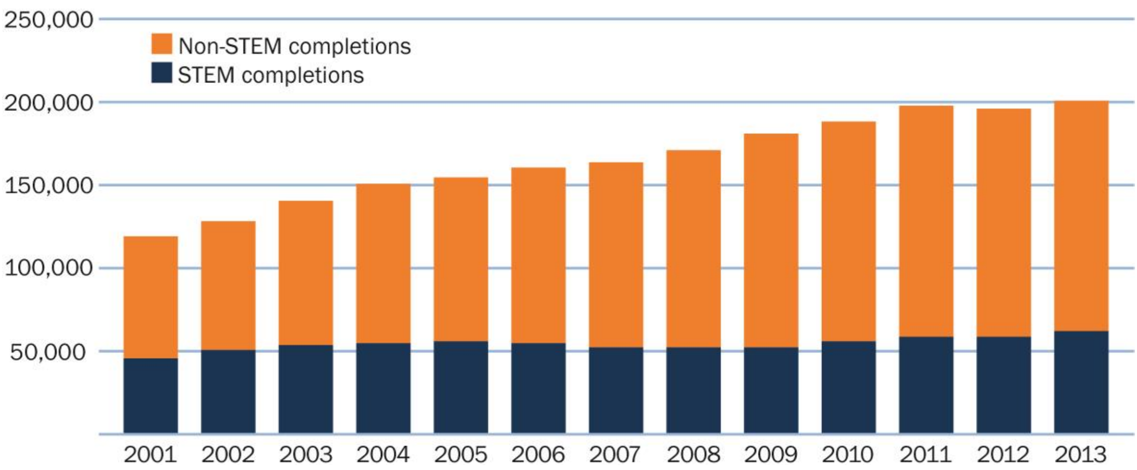
- *"In the energy sector, the emergence of household solar photovoltaic, battery storage and smart metering will require installation technicians for connection and maintenance of this infrastructure. Knowledge of new technologies, as well as skills in data analytics and information and communications 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 programing skills*
- *Certain computer software and have a greater understanding of material science and quality assurance systems."*

  (Australian Government Productivity Commission, 2016)

Figure 3 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 largely plateaued over this period in Australian universities.

Figure 3 - Number of students completing degrees in STEM[6]



(Pricewaterhouse Coopers, 2015)

In addition Haljkowicz et al (2016) concluded that falling interest and performance in STEM subjects is being recorded within Australia, this statement was formed on educational analysis that 11% fewer year 12 students study maths today than in 1992 (Kennedy, 2014)

Two of the three identified key occupations from this research of the 'digitally enabled workforce' derive from ICT educational pathways (ICT is incorporated in the STEM collective).

Forecasts project that close to an additional 100,000 workers will be required to service the demand for ICT workers between 2014 and 2020 within Australia (Deloittes Access Economics, 2015) as outlined in figure 4. The majority of this demand is anticipated to be for specialist occupations with approximately 72,000 additional employees required in the ICT management and operations and ICT technical and professional groupings.

[6] 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.

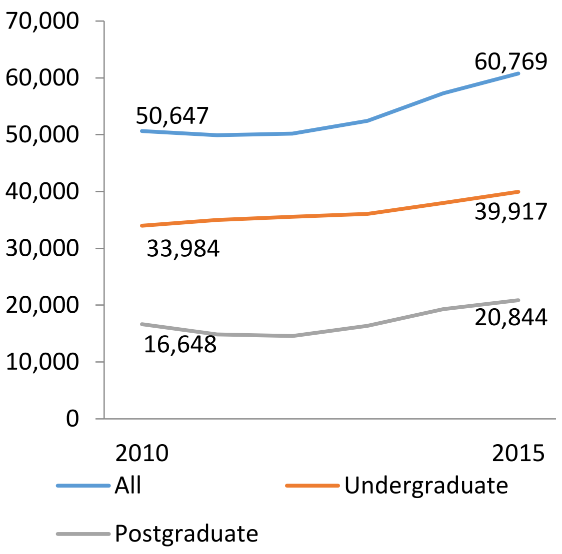
Figure 4 - Projected 2020 employment growth in ICT[7]

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)

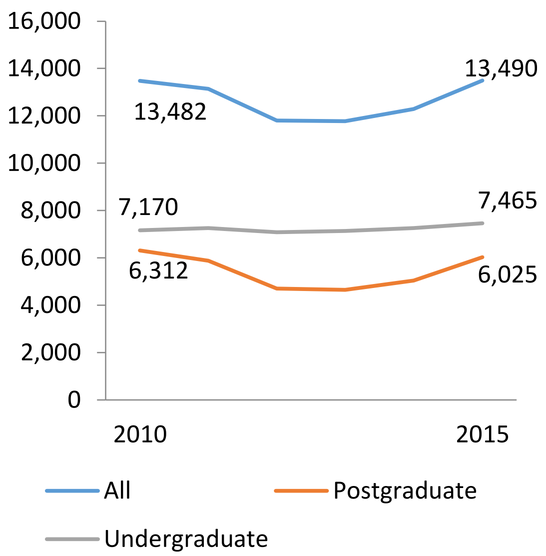
It is evident from Figure 5 and Figure 6 that whilst enrolments into information technology courses within higher education have increased, the completions have plateaued in the five years to 2015 suggesting that there is a high fall-out rate, (Hajkowicz et al., 2016) took this data further and concluded that a 35 percent drop in enrolment within Information Technology subjects at universities since 2001 has been recorded.

Figure 5 - Higher Education - Information Technology course enrolments



(Department of Education and Training - Australian Government, 2016)

Figure 6 - Higher Education - Information Technology course completions



(Department of Education and Training - Australian Government, 2016)

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.

[7] CIIER definition as used in ACS ICT Statistical Compendia 2008-2013. In order to maintain continuity with previous ACS published reports, the workforce analysis in this report draws upon definitions and nomenclature developed by the Centre for Innovative Industries Economic Research Inc. lead researcher, Ian Dennis FACS, and used in ACS ICT Statistical Compendia 2008-2013 and other CIIER analysis.

5. The Traditional Network Workforce

Significant proportions of occupations throughout the traditional network and electricity supply industry will be impacted in varying ways and by various levels from the introduction of emerging technologies and services. Occupations that have been identified as occupations that will experience skill deficiencies within today's network industry are as follows:

- Electrical Engineers
- Electrical Distribution and Trades Workers
- Electrical Tradespersons
- Executive Management.

The complex and varied nature of skill requirements in TNSPs, DNSPs and electrical contractors result in varying educational and training pathways into the sector. As is evident in the analysis below, both the VET sector (54.7% network industry) and Higher Education (23.7% network industry) sectors play important roles in educating the network industries workforces with the required skills and knowledge required to work within the industry.

Due to the significantly higher numbers of persons employed within the distribution sector when compared to the transmission sector the overall make-up of the network sector (transmission and distribution) largely follows the trend of the distribution sector, however, it is important to understand the sectors as individuals as the skill/educational attainment varies largely.

Table 1 provides a snapshot of the transmission and distribution workforces by level of educational attainment[8]. Whilst the landscape of the industry may have changed since 2011, the overriding key trends outlined are expected to have remained true and relevant.

[8] Data has been sourced from the 2011 Census of Population and Housing, which is the most current data set available of education by sector level.

Table 1 : Total Workforce by level educational attainment

	Total Employees by Sector					
	TNSP		**DNSP**		**Network**	
	No.	**%**	**No.**	**%**	**No.**	**%**
Postgraduate Degree Level	289	10.5%	1,510	5.1%	1,799	5.5%
Graduate Diploma and Graduate Certificate Level	86	3.1%	525	1.8%	611	1.9%
Bachelor Degree Level	824	30.0%	4,476	15.0%	5,300	16.3%
Higher Education	**1,199**	**43.6%**	**6,511**	**21.8%**	**7,710**	**23.7%**
Advanced Diploma and Diploma Level	442	16.1%	4,137	13.9%	4,579	14.1%
Certificate Level	701	25.5%	12,524	42.0%	13,225	40.6%
VET	**1,143**	**41.5%**	**16,661**	**55.9%**	**17,804**	**54.7%**
Level of education inadequately described	22	0.8%	226	0.8%	248	0.8%
Level of education not stated	32	1.2%	403	1.4%	435	1.3%
Not applicable	355	12.9%	5,998	20.1%	6,353	19.5%
Total	**2,751**	**100%**	**29,799**	**100%**	**32,550**	**100%**

(Australian Bureau of Statistics, 2011)

Noticeably, the TNSP and DNSP sectors rely heavily on both the VET and higher education sectors to educate their respective workforces. The TNSP sector had almost an even split of their workforce recruited from both higher and vocational education pathways, with 43.6% (1,199 workers) and 41.5% (1,143 workers) respectively. The 2011 census data highlights that there were 567 electrical engineers within the transmission sector at that point in time, which account for approximately 47% of the 1,199 employees educated through a higher education pathway.

Whilst the DNSP workforce has a significantly higher proportion of workers educated through the VET system 55.9% (16,661 workers) in comparison to 21.8% (6,511 workers) recruited from higher education pathways.

Apprenticeships and traineeships are a significant VET pathway for the technical and trade workers workforce cluster, and account for 39.6% (1,088 employees) and 41.4% (12,341 workers) of the TNSP and DNSP overall workforces respectively.

Enrolments and completions of apprenticeships and traineeships within the VET sector have experienced a declining trend in recent years. It is important to understand whether this trend remains true for the training packages that are an important pathway for the TNSP and DNSP organisations.

The following outlines the traditional network workforce occupations/skill sets that are critical and will experience the most change.

Electrical Engineers

"An electrical engineer designs, develops and supervises the manufacture, installation, operation and maintenance of equipment, machines and systems for the generation, distribution, utilisation and control of electric power." (Australian Bureau of Statistics – ANZSCO, 2013).

The skill sets and responsibilities of electrical engineers are currently essential within the generation, transmission and distribution sectors of the electricity supply chain, and form significant proportions of both the DNSP and TNSP workforces, 6.2% (1,846 employees) and 20.6% (567 employees) respectively as at the 2011 census.

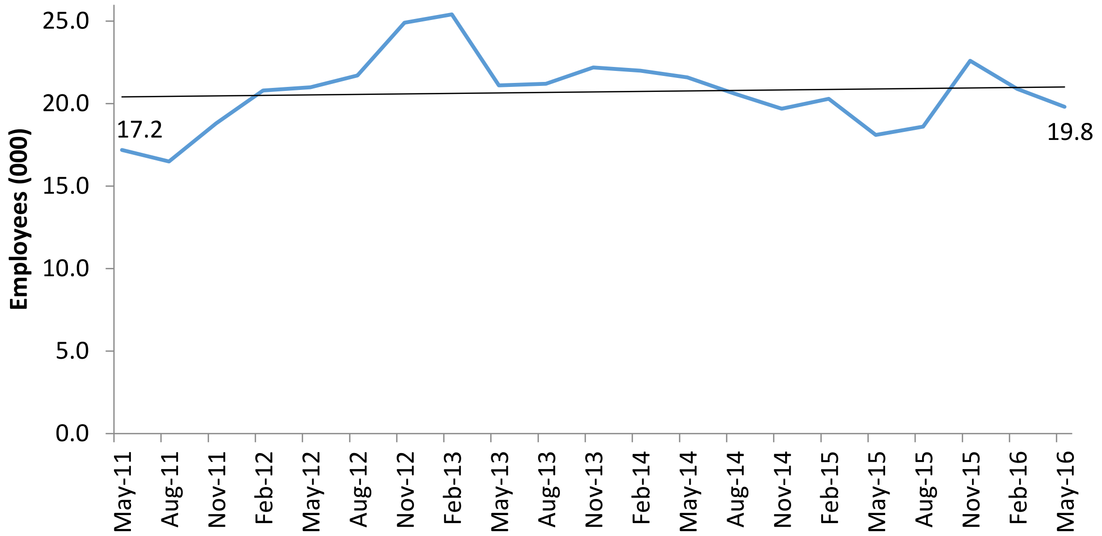
Key drivers causing skill gaps for electrical engineers are as follows:

- Technologies such as battery storage and electric vehicles which will enable the two-way flow of energy into a grid that was designed for a one-way flow
- Networks will be required to enable large flows and the integration of renewable energy
- Systems will need to be established to monitor and manage microgrids
- System configuration and integration
- Integration of industrial battery storage devices
- The ability to work with, manipulate and understand big data and supporting software
- Increasing focus on risk management, enabled through big data and analytics
- The discipline of asset management will become increasingly important as assets, whilst more advanced in functionality, will have a shorter life cycle. The ability to manage risk driven by systems integration complexities, whilst maximising value and performance, will become critical
- Dynamic interaction of fast response devices requiring sophisticated modelling and planning tools
- Emergence of very different risk profiles for electricity supply management.

A higher level of economic analysis skills will be required by electrical engineers in the future, particularly with regard to investments on the power system. The skill impacts listed above are expected to be experienced 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 e.g. R/Python, it is expected that big data analysis will be an extension of the mathematical component of their current role.

Figure 7 highlights an increase of 2,600 (13.1%) electrical engineers in the national labour force in the reporting period of May 2011 to May 2016. Industry has reported that a number of factors have impacted on the demand for electrical engineers in recent years, including the automation and offshore outsourcing of some tasks and business processes.

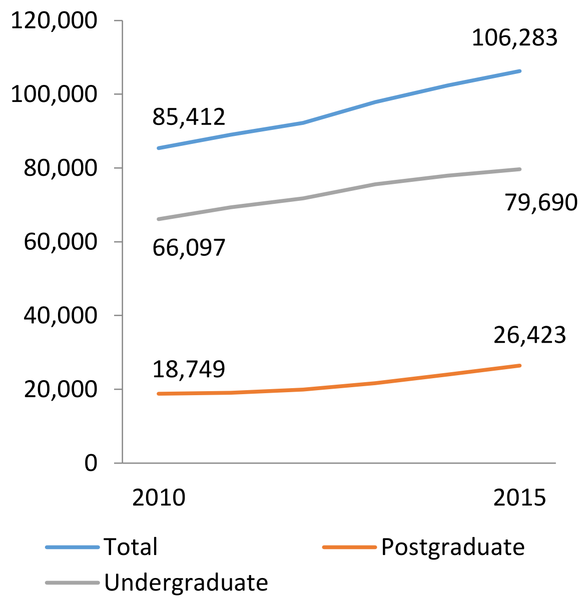
Figure 7 - National employment trend analysis - Electrical Engineers



(Australian Bureau of Statistics, 2016)

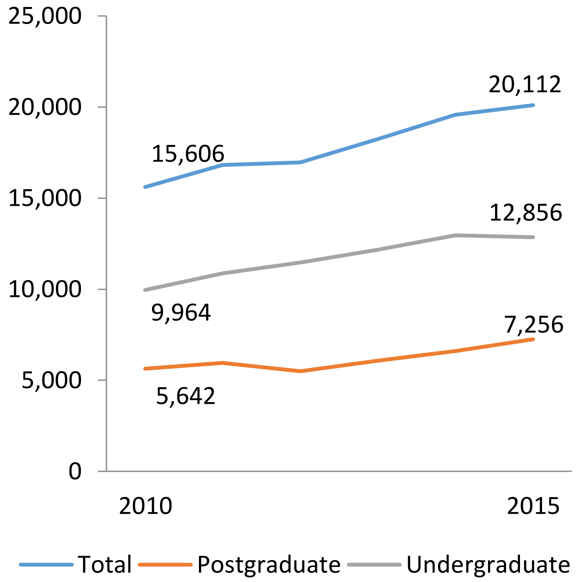
Enrolments and completions of national higher education engineering and related technologies courses have been increasing over the past five years.

Figure 8 - Higher Education - Engineering and related technologies course enrolments



(Department of Education and Training - Australian Government, 2016)

Figure 9 - Higher Education - Engineering and related technologies course completions



(Department of Education and Training - Australian Government, 2016)

Whilst the above data relates to the broader discipline of engineering, the electricity industry has advised each vacancy receives a large pool of applicants with supply outweighing demand.

A strong link has been established between Industry and the Australian Universities that deliver electrical engineering courses, and this link is ensuring that the skill requirements of tomorrow's engineers are reflected in the curriculum being taught within universities.

The effectiveness of this link can be measured through the most recent API Biannual Skills and Demand Survey. A total of 14 companies within the distribution, transmission and generation sectors contributed to the survey, which documented that graduates who rated with 'average to strong skills' increased from 53% in 2013, to 83% in 2015 (The Australian Power Institute, 2015).

It is of utmost importance that industry and education continue to work together on researching the future needs of electrical engineers and develop future curriculum content around this information. A good example of new 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.

Also identified in the 2015 skills and demand survey by API, are the following five technical streams of skills (both engineering and non-engineering) that companies will require from their future engineering workforce:

Systems engineering

- Power systems analyses
- Asset management
- Real time digital systems
- Renewable and new technology integration
- Storage systems

Systems planning, design and analysis

- Operational technology/IT linkages
- Leveraging software/data skills
- Data collection and security
- Thermodynamics and performance
- Analytics/modelling

Business and commercial management

- Project management
- Financial management
- Risk based asset management
- Life cycle asset management and costing
- Regulatory management
- Contract management
- Stakeholder management

Intelligent network and protection

- Digital networking and telecoms for intelligent networks
- Power source isolation
- IT/Engineering mix – integration
- SCADA/Telecom
- Protection engineering
- Smart Grid IEC61850 Systems integration
- Handling big data using database applications

Renewable and alternate technologies

- Renewable energy
- Batteries and storage
- New energy storage technologies
- Managing new technology
- Renewable generation technologies and integration
- Environmental and chemical engineering
- Embedded generation and power storage
- Battery technology

(The Australian Power Institute, 2015)

In addition to the above technical skills, improved communication skills are essential for the electrical engineering workforce; furthermore APIs survey concluded 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."*
  (The Australian Power Institute, 2015)

Electrical Engineering Technicians

"Electrical engineering technician's conducts tests of electrical systems, prepares charts and tabulations, and assists in estimating costs in support of electrical engineers and engineering technologists. Registration or licensing may be required." (Australian Bureau of Statistics, 2013)

Data sets for electrical engineering technicians are included in the Australian and New Zealand Standard Classification of Occupations (ANZSCO) unit level classification for electrical engineering draftspersons and technicians. The skill sets of this ANZSCO unit level classification are prominent within both the distribution (1,390 employees or 11.6% as at the 2011 census) and transmission (128 employees or 4.7% as at the 2011 census) industries.

Electrical engineering technicians will be impacted by digitisation, automation and the introduction of advanced electronic protection relays and telecommunication protocols. Whilst protection relays are established within the industry, proliferation of intelligent electronic devices (IEDs) and the requirement to create an intelligent network whilst managing the lifecycle of these assets is problematic. 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.

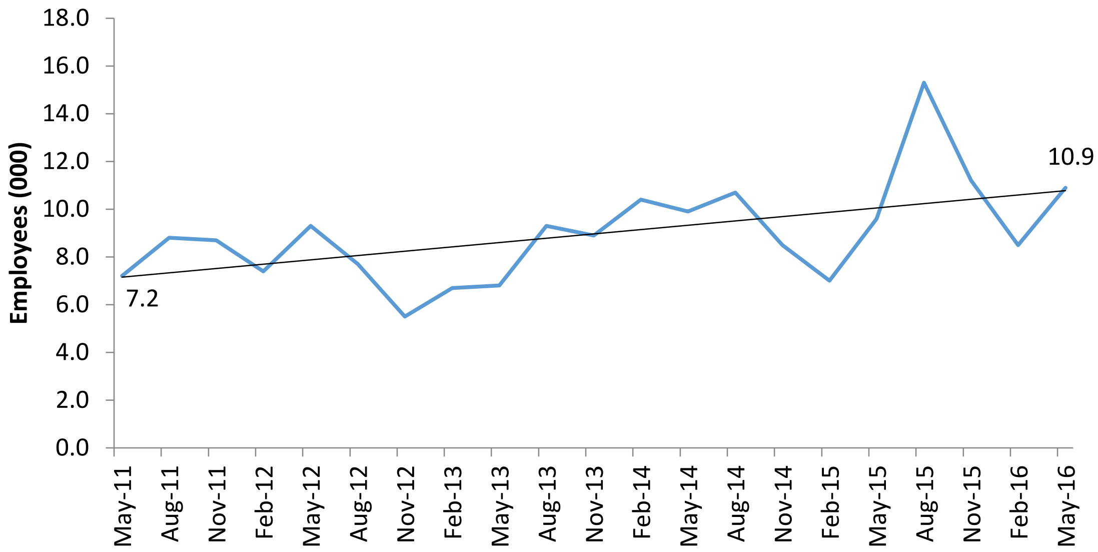
Enterprise (as outlined in section 2) and ICT skills are key skill changes for the future electrical engineering technician. The future worker will need to do the following:

- Take a systems approach to working. This is increasingly important as old and new technologies are integrated and require different approaches to repair and maintenance. Testing and maintenance of systems will progressively be performed digitally with less reliance on physical tools

- 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 the engineering professional will absorb these into their role through ongoing professional development activities.

The following graph highlights that, whilst growth of 33.9% (3,700 employees) has been recorded in the five-year period ending May 2016, significant spikes and declines being recorded.

Figure 10 - National employment trend analysis – Electrical Engineering Draftspersons and Technicians



(Australian Bureau of Statistics, 2016)

Electrical Tradespersons

"The Electrical tradesperson (electrician) designs, assembles, installs, tests, commissions, diagnoses, maintains and repairs electrical networks, systems, circuits, equipment, components, appliances and facilities for industrial, commercial and domestic purposes, and service and repair lifts, escalators and related equipment." (Australian Bureau of Statistics, 2013).

As at 2011, electrical tradespersons accounted for 11.6% (3,455 employees) of the DNSP workforce and 5.0% (199 employees) of TNSP equivalent (ABS Census, 2011).

There will be a number of new skill sets required by electrical tradespersons for a safe and reliable transition to a changing electricity sector, these skill sets will need to be adopted in the short to medium term. They are:

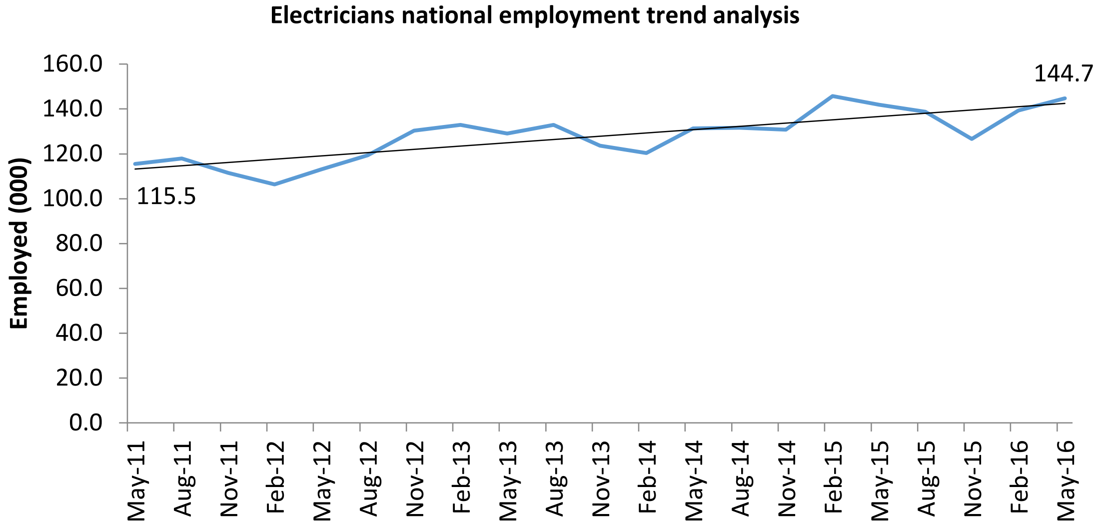
- Given the high penetration of distributed solar generation, and the predicted uptake of energy storage, requirements to work with direct current (DC) systems at reasonable voltages (from 48V to 1,000V DC) will be more prominent for electrical tradespersons. The lack of training in DC presents a higher 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 vocational education and training, as well as ongoing professional development for existing workers. The creation of a specialist license may be required to address skill shortages of the current workforce in the interim

- A significant skill gap will be created with the requirements of the electrical tradespersons 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 and potential become 'plug and play'
- The interconnectivity of smart technology has resulted in the need for the electrical trades persons to have a network focussed mindset, as products are unlikely to be standalone pieces of equipment
- Increased need for systems thinking skills will be required for installation of technology to ensure the equipment is configured correctly and correctly interconnected
- The introduction of technologies with embedded digital capabilities will see the progression and need for the installer/maintainer (technical trade worker) to embrace ongoing professional development. Much the same as a computer programmer will need to learn relevant new coding languages throughout their career, the installer will be required to learn the particulars of emerging technologies that enter the market
- Consumer education skill sets – The maintainer/installer of this equipment will be the primary source of knowledge for the consumer at the point of installation. Due to the complexities and varying nature of how these systems work e.g. customer and network interaction, the maintainer/installer will be the conduit between the manufacturer and the end user. Each consumer will have varying levels of knowledge of this technology and an informed consumer is essential. Poor understanding and/or low confidence in any technologies can lead to inefficient use and low adoption rates. This, combined with the potential safety risks of an incorrectly or insufficiently trained workforce, highlights that education of new technologies by the manufacturer alone is not sufficient
- The supplier will need to understand the consumer law implications of supplying complex and diversified systems with many interactive components from different vendors.

Some of the identified technical skills that will be required for both smart meter and battery storage are located in addendum three.

Figure 11 highlights that demand for electricians (please note this data relates to electricians as is reported on by the ABS) has been significant within Australia. A growth of 29,200 (20.1%) was recorded for the five years ending May 2016, which is anticipated to continue until 2020 with a further 26,000 electrician occupations expected to enter the labour market (Department of Employment - Australian Government, 2016).

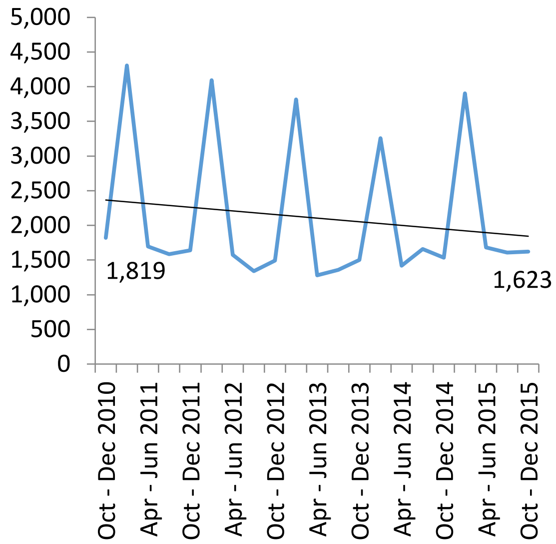
Figure 11 - National employment trend analysis - Electricians



(Australian Bureau of Statistics, 2016)

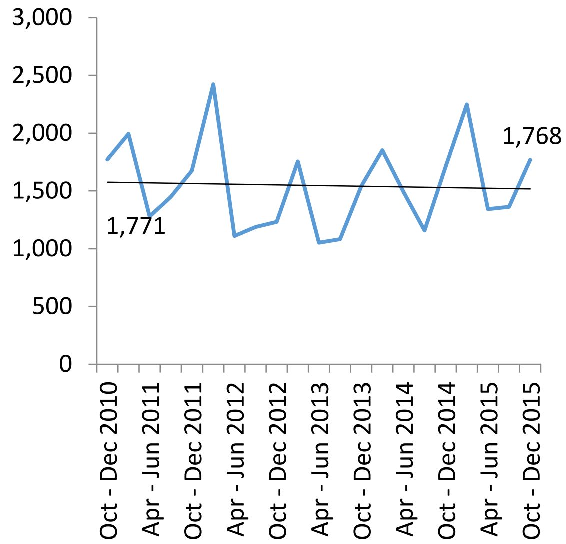
Commencements of electrical apprenticeships have experienced declines in the five-year period ending December 2015. Spikes in commencements are experienced in the January quarter as new contracts are signed in this period aligning with the end of the previous school year. Figures 12 and 13 have been created from data sourced from the occupational (ANZSCO – NTIS) group of the apprenticeship and traineeship collection from VOCSTATS NCVER. The occupational (ANZSCO – NTIS) group measures the intended occupational outcome of a qualification undertaken by an apprentice/trainee as part of a training contract.

Figure 12 – Electrician - Apprenticeship and Traineeship commencements by ANZSCO – NTIS code



(National Centre for Vocational Education Research - Apprenticeship and Traineeships, 2016)

Figure 13 – Electrician - Apprenticeship and Traineeship completions by ANZSCO – NTIS code



(National Centre for Vocational Education Research - Apprenticeship and Traineeships, 2016)

Another complexity for the electrical tradesperson workforce is the inconsistency in licencing requirements across the country. Whilst harmonisation of electrical licensing regulations is not recommended, the opportunity for licencing (and licence renewal) to play a role in supporting the requirements for initial up-skilling and ongoing professional development needs to be explored.

Executive Management

Executive Management is responsible for the formation and the development of strategic pathways that businesses follow 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 and predict and understand future environments is essential. This is not only essential to the businesses future but also the workforce that is employed within them.

Thought leadership and a strong commitment to embracing change were identified as key risk areas for company board members, CEO's and general manager's working in the electricity industry. Specifically, leadership in the network operators and electrical contractors will continue to be 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.

Workers employed within specialised industry streams such as ICT, engineering and construction are likely to require additional qualifications, such as change management and business model creation, to adapt to a constantly changing business environment. Newly created management roles such as 'Chief Data Officer' and 'Chief Customer Experience Officer' will become more prominent to align businesses with the evolving business models.

The education process will be ongoing throughout the transformation and beyond. Board members, CEOs, and executive managers will be required to have a deep understanding of industry trends and emergent technologies.

6. Recommendations

The objective of this report is to identify the key mechanisms which enable sustainable pathways for workforce skills development that are adaptive in a timely way to technical and societal changes. These pathways will deliver a competent workforce, responsible for a successful electricity sector transformation, providing the Australian consumer with a reliable and safe supply of electricity which meets the greater and changing consumer demands.

The initiatives required over 2017-27 to achieve the 2027 objectives are:

- Initiative 1 - A coordinated approach to higher level skills/skills deepening investment and prioritisation needed to educate and train the existing workforce, particularly for technicians, maintainers, and electrical workforce
- Initiative 2 - Education and training package process review to ensure there are ongoing mechanisms to support rapid change and new technologies in curriculum design and delivery
- Initiative 3 - Skills Awareness Campaign for both the consumer and the worker to increase awareness on what the 'new world' worker will look like.

A coordinated effort is needed from all levels of government, industry, and the training sector 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.

The assumptions that underpin the shortlisting and selection of recommendations are:

- The initiatives directly address the barriers to enabling a skilled workforce outlined above
- Each initiative can be developed with a national focus, as well as be tailored to the specific needs of each state and territory
- It is assumed there is bi-partisan support to achieve the outcomes expected for the enabler to successfully support the broader Electricity Network Transformation ENTR program.

Initiative 1 – Higher Level Skills investment and prioritisation for existing workers

The speed of which emerging technologies are entering the market will result in a clear skills gap should the existing workforce not have adequate training. The complexity of embedding new technologies is higher generally in the early stages of adoption and as the product/service evolves the complexities narrow. The speed and complexity will increase the number of workers who will need to be upskilled/reskilled in the short to medium term and without government training initiatives and funding support there are a number of workforce and consumer risks. Incorrect installation of technologies can have a range of impacts including safety, cost and reliability impacts on the Australian consumer.

Funding levers at both Federal and State and Territory levels will need to be reconsidered in order to enable the initial rapid transformation of appropriately skilled workers. By increasing the funding and priority of key higher level skills initiatives, industry will be more effective in transitioning its workforce safely and competently to 'the new world of work'. As such it is pivotal that the existing workforce have access to additional funding for training in the short term to address these complexities.

The required characteristics of such training are as follows:

- The training will be required to have pre-requisites, dependant on the qualifications and skill sets of the worker
- The workforce will need to have access to funding to compensate the costs of training
- If incentives or rebates are offered to the consumer by State or Federal governments e.g. Clean Energy Council Solar accreditation requirement for solar rebate, evidence of accreditation should be mandatory
- The pathways need to be clear and transparent to the worker i.e. why do I need training, what does it give me, how does it benefit my career/business
- Systems thinking[9] needs to be embedded as a core component of a number of existing qualifications.

Whilst it is anticipated and expected that industry and individual worker, depending on the requirement, will hold responsibility for funding ongoing skills development. It is however not feasible for the rapid transformation of a large workforce to happen without significant intervention and a coordinated approach from government. 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 work.

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

Initiative 1 – Higher Level Skills investment and prioritisation for existing workers

#	Action	Start Year	Finish Year[i]	Responsible Entities 1 & 2[10]	Critical Dependencies[11]
1	Creation of a Workforce Skilling Taskforce to be established with contributions from Federal, State and Territory governments. The purpose of this taskforce is to oversee funding for key skill sets and qualifications needed to upskill and reskill the electricity sector and supporting industries. An industry levy could also be included to ensure there is appropriate funding support for existing workers and new entrants. The qualifications and skill sets deemed most critical will be determined through Initiative 2, Action 1 of this section.	2017	2022	• Federal Government • COAG (Skills and Training Committee) • Educational institutions • Customer representative and groupings	• Initiative 2 - Education and Training Package Review, Action Item 1 is a critical development • Technology advances - Will monitor and design to the emergence of new technologies i.e. battery storage • Policy, regulatory and institutional enablers – address skills required to meet RET
2	Update of State and Territory VET investment plans to include recommended skill sets and qualifications, with adjustment to funding parameters that currently rule out existing workers e.g. workers who have already received funding for a VET qualification or higher education degree.	2017	2022	• State and Territory Governments	• Initiative 2 - Education and Training Package Review, Action Item 1 is a critical development • Policy, regulatory and institutional enablers – address skills required to meet RET

[10] **Responsible Entities 1 & 2** are the primary and secondary entities responsible for implementing the *Action* and may include: (a) Energy Networks; (b) Government; (c) Regulatory bodies; (d) Customer representatives and groupings; (e) Energy retailers; and/or, (f) Energy Service Companies.

[11] **Critical Dependencies** include any specific activities or threshold steps that provide the basis for the *Action* to be possible and may include: (a) policy, regulatory and institutional enablers; (b) technological advances; (c) workforce and industry capacities; and/or, (d) specific collaboration with other stakeholders.

Initiative 1 – Higher Level Skills investment and prioritisation for existing workers	
Implementation Risks & Barriers	**Proposed Mitigations**
• Lack of Bi-Partisan support will create uncertainty with the longevity of policy and regulations	• Leverage the broader research identified in the ENTR to articulate the 'burning platform' for which the benefits of bi-support are clearly defined
• Restrictive training funding rules for existing workers and those who already hold qualifications are not removed	• Pilot programs delivered in each state and territory, contextualised to each region's rules and regulations, to ensure that the integrity of the funding is maintained and targeted to core critical skill sets and qualifications. NB the pilot qualifications could vary from state to state dependant on the immediate workforce requirements
• The funding parameters of the Workforce Skilling Taskforce are not rigorous enough to support quality versus quantity of training resulting in inappropriate training delivery and an incorrectly skilled workforce	• Ensure training provider rules are established to adhere to strict guidelines to access funding. These would be set in line with Industry expectation as the majority of workers will be already employed • Ongoing audits of training providers who are accessing the fund to ensure they are complying with the funding guidelines
Performance Indicator	**Success Metric**
• Taskforce is created and funded, and managed centrally to ensure there is appropriate funding support for existing workers and new entrants	• Investment in qualifications and skill sets for critical qualifications and skill sets is increased substantially and managed centrally
• Existing workers are accessing additional skills development funding	• Increased intakes and completions of existing workers in identified qualifications and skill sets

Initiative 1 – Higher Level Skills investment and prioritisation for existing workers		
Quantitative Net Benefits	**Qualitative Net Benefits**	**Key Investments required**
• 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 the correct safety procedures being followed on the installation and maintenance of electrical products. In-turn this will 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 installations and maintenance of electrical technologies such as DERs will lead to the consumer experiencing the full benefits of the said technologies, including full functionality and more affordable electricity which is a major driver of the transformation	• Approximately $2billion[12] over five years to 2021.

[12] *Figures produced are based on basic financial modelling using forecasted employment and training data. It is recommended that a full economic model of cost impacts be undertaken.*

Initiative 2 – Education and Training Package Process and Design Review

There are a number of training packages (VET) and university courses which are focused on core skill areas that will need to be adjusted to enable the delivery of the Network Transformation namely electrical, engineering, and ICT skills. With the recent reform to the VET national system for development and review of training packages still in the initial phases of roll-out, it is unknown if the model will be responsive and flexible enough to keep up with emergent technology.

The university sector will also need to adapt, working with industry experts, to redesign curriculum to address future skills needs i.e. there is no specific ICT degree that specialises in energy. The power systems engineer of the future will also require new skill sets not currently being widely taught in Australia. These are just a few examples of curriculum updates that will be necessary.

A nationally recognised accreditation process for certain work, tied to potential future government rebates[13], will be a key component of the education process for both the worker and the consumer.

A review of current processes, to test how they respond to emergent technology, is needed to develop a framework that will provide long term guidance and support for flexible and responsive curriculum changes.

The alternative to this initiative would be to let the market adjust of its own accord which is likely to result a longer rollout time for new technology, and increased safety risks form an under-skilled workforce. A market led approach could also lead to inconsistency of education and training curriculum development and quality of educational outcomes.

[13] *Similar to the Clean Energy Councils' Solar Photovoltaic accreditation process for installers, any future government rebate would be dependent on the work being carried by an accredited installer.*

Initiative 2 – Education and Training Package Process and Design Review					
#	Action	Start Year	Finish Year	Responsible Entities 1 & 2	Critical Dependencies
1	Overhaul and creation of specific VET and degree courses, in core areas such as electrical, engineering, ICT, data science and cyber security, to ensure they are comprehensive and relevant to the future workforce requirements for the electricity sector and supporting industries. Development of new training and education products will align with the guidelines set out by Standards Australia which address current standards and new technology areas. These will also need to be aligned with each State and Territory regulatory and licensing framework.	2017	2019	• Australian Industry Skills (SSO for Electrotechnology training packages) • Engineers Australia • ENA • TAFE • ACPET • Universities Australia	• Creation of the Workforce Skilling Taskforce (Initiative 1, Action 1) • Standards Australia releasing new guidelines for emergent technology • Support from ASQA, Australian Industry Skills Council, Universities Australia and other relevant industry bodies will need to be undertaken prior to this activity being commenced
2	Agreement on a nationally recognised accreditation process to create a suitable pathway for installers of small scale Distributed Energy Resources (DER) e.g. energy storage devices. This will encourage installers to undertake assessments to ensure completion of relevant training requirements. It will also provide evidence to the customer that the installer meets the minimum skill and knowledge requirements	2017	2018	• Federal Government • State Government • Industry • Associated Industry Bodies e.g. Clean Energy Council	• Creation of the Workforce Skilling Taskforce (Initiative 1, Action 1) • Initiative 2 - Education and Training Package Review, Action Item 1 is a critical development
3	Development of a framework to monitor, review and update	2017	2018	• Australian Industry Skills	• Creation of the Workforce

	current training package development processes to ensure there is capability and capacity to update and design VET qualifications in a timely manner.			Council • Department of Education (Federal)	Skilling Taskforce (Initiative 1, Action 1) • Support from ASQA, Australian Industry Skills Council, Universities Australia and other relevant industry bodies will need to be undertaken prior to this activity being commenced

Initiative 2 – Education and Training Package Process and Design Review	
Implementation Risks & Barriers	**Proposed Mitigations**
• Inconsistent development and delivery of new training products, in particular non-accredited training for licensed products and technologies	• Mandated standards are put in place and supported by industry and government
• Lack of policy appetite for an accredited pathway tied to rebate eligibility criteria	• Bi-partisan support gathered through the launch of the ENTR report is continued throughout the lifecycle of the initiative and activities. Additional business case detailing the impact and success of the solar rebate scheme to supplement the recommended actions
• Change of government resulting in changed policy and processes which support this initiative	• Bi-partisan support gathered through the launch of the ENTR report is continued throughout the lifecycle of the initiative and activities
• Lack of support from the emergent technology manufacturers to collaborate with the education sector to develop appropriate training	• Early adopters from both industry and consumers to provide input and subject matter expertise where there are instances of lack of technology manufacturer collaboration
Performance Indicator	**Success Metric**
• New training products are endorsed and available for delivery within one year of the ENTR report release	• Recognition and delivery of revised qualifications and skill sets for critical roles that are currently difficult to source, and will be prominent in future, is embedded nationally by 2020
• Accreditation pathway way developed and implemented	• Reduction in safety incidences as a result of un-accredited workers operating in the market
• A methodology/framework to enable responsive and flexible training package creation and review is created within one year of the ENTR report being released	• Methodology/framework is embedded in business as usual practice by 2019

Initiative 2 – Education and Training Package Process and Design Review		
Quantitative Net Benefits	**Qualitative Net Benefits**	**Key Investments required**
• Greater alignment between the cost of training and relevant employment outcomes, measured through completion and employment rates • Reduced time to review and redesign training packages that meet industry need	• Australia is seen as a global test bed for renewable energy, a skill ready workforce is imperative to ensure the successful rollout of such technologies. Successful outcomes will see Australia becoming a leading player within this industry that will have numerous economic benefits.	• Approximately $500k over two years to 2018.[14]

[14] *Figures produced are based on estimated financial modelling. It is recommended that a full economic model of cost impacts be undertaken.*

Initiative 3 – Skills and Safety Awareness Campaign

One of the key safety risk areas identified through the research is the area of new technology installation. Development and investment in a national education campaign, tailored to the specific regulations and legislation of each state and territory, to enable consumers to be informed about the type of worker they need. There is a large understanding gap of what worker needs to be involved in each step, and has the potential for unskilled and unlicensed workers to carry out work.

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.

Initiative 3 – Skills and Safety Awareness Campaign					
#	**Action**	**Start Year**	**Finish Year**	**Responsible Entities 1 & 2**	**Critical Dependencies**
1	Develop and implement a Consumer Skills Awareness campaign to educate consumers on who the 'right' worker is for specific work tasks	2017	2018	• COAG (Skills and Training Committee) • Consumer Advocate Groups such as Energy Consumers Australia • State Government Consumer Ombudsman	• Creation of the Workforce Skilling Taskforce (Initiative 1, Action 1) • Initiative 2 - Education and Training Package Review, Action Item 1 is a critical development
2	Develop and implement a Workers Skills Awareness campaign that highlights what skills are needed to deliver quality outcomes for the ENTR. This will be contextualised for each State and Territory to align with the individual regulatory and licensing framework	2017	2018	• Department of Education (Federal) • Department of Education (State and Territory)	• Creation of the Workforce Skilling Taskforce (Initiative 1, Action 1) • Initiative 2 - Education and Training Package Review, Action Item 1 is a critical development

Initiative 3 – Skills and Safety Awareness Campaign	
Implementation Risks & Barriers	**Proposed Mitigations**
• Lack of funding to develop appropriate campaigns	• Additional business case detailing the impact of similar rollouts in other jurisdictions where safety issues where prevalent to supplement the recommended actions
• Campaign not developed in a timely manner to best reach targeted audience	• Campaign to be developed in tandem with the training package reviews outlined in Initiative 2, Action 1.
Performance Indicator	**Success Metric**
• Education campaigns created and rollout nationally	• Consumers reporting high confidence levels in emergent technology • Increased number of emergent technology being installed

Initiative 3 – Skills and Safety Awareness Campaign		
Quantitative Net Benefits	**Qualitative Net Benefits**	**Key Investments required**
• Safe rollout of new technology will reduce the cost of electricity to the consumer	• Increased Electrical Safety – A competent electrical supply workforce leads to the correct safety procedures being followed on the installation and maintenance of electrical products. In-turn this will 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 installations and maintenance of electrical technologies such as DERs will lead to the consumer experiencing the full benefits of the said technologies, including full functionality and more affordable electricity which is a major driver of the transformation • Enabling mass adoption of DERs – Consumer satisfaction will largely be created through the success of the above points. The experience consumers have with initial products will impact on purchase of further technologies.	• Investments to be determined

7. Final Thoughts

There are a number of quantitative and qualitative net benefits from realising the objectives of this research:

- Reduced cost to the consumer – Safe rollout of new technology will reduce the cost of new technology and electricity to the consumer
- Economic contribution through workforce participation – Greater alignment between the cost of training and relevant employment outcomes, measured through completion and employment rates, will create economic benefit through continual workforce participation. This includes indirect benefits associated with upskilling and retraining the current and future workforce
- Workforce productivity – Reduction in the time needed to review and redesign training packages, that meet industry need, will directly impact workforce productivity as workers will be able to upskill and retrain in a responsive manner
- Increased electrical safety – A competent electrical workforce will lead to the correct safety procedures being followed on the installation and maintenance of electrical products. In-turn this will increase the safety of electricity consumers and the workforce from a reduction in electrical fault related injuries and/or deaths
- Increased value add for consumer – The correct installations and maintenance of electricity technologies such as DERs will lead to the consumer experiencing the full benefits of the said technologies, including full functionality and more affordable electricity which is a major driver of the transformation
- Enabling mass adoption of DERs – Consumer satisfaction will largely be created through the success of the above points. The experience consumers have with initial products will impact on purchase of further technologies
- Australia as a world leader – Australia is seen as a global test bed for renewable energy, a skill ready workforce is imperative to ensure the successful implementation of such technologies. Successful outcomes will see Australia becoming a leading player within this industry that will have numerous economic benefits.

There will be significant investment required over the next three to five years to develop a highly skilled workforce who have the knowledge in a timely manner. Investment will be required in the following areas:

- Development of higher level skills in the existing workforce – Approximately $2billion[15] over five years (2017 – 2021)
- Development of educational pathways that may not currently exist for both new entrants and existing workers – Approximately $500k[16] over two years (2017 – 2018)
- Enhanced training and development infrastructure requirements to assist industry with progression to a digitalised workforce NB Costs to be determined
- Development of safety campaign to educate both the workforce and consumers on what skills are required to deliver the work NB Costs to be determined

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[15] Figures produced by ESQ in collaboration with ENA, and are based on basic financial modelling using forecasted employment and training data. It is recommended that a full economic modelling of cost impacts be undertaken.

[16] *Figures produced are based on estimated financial modelling. It is recommended that a full economic model of cost impacts be undertaken.*

This investment will initially need to be led by government, both State and Federal, with the expectation that over time employers and the individual workers will be responsible for skills development. New initiatives or model/framework creation will require upfront investment from all stakeholders, but are expected to become business as usual activities over time.

8. Appendix

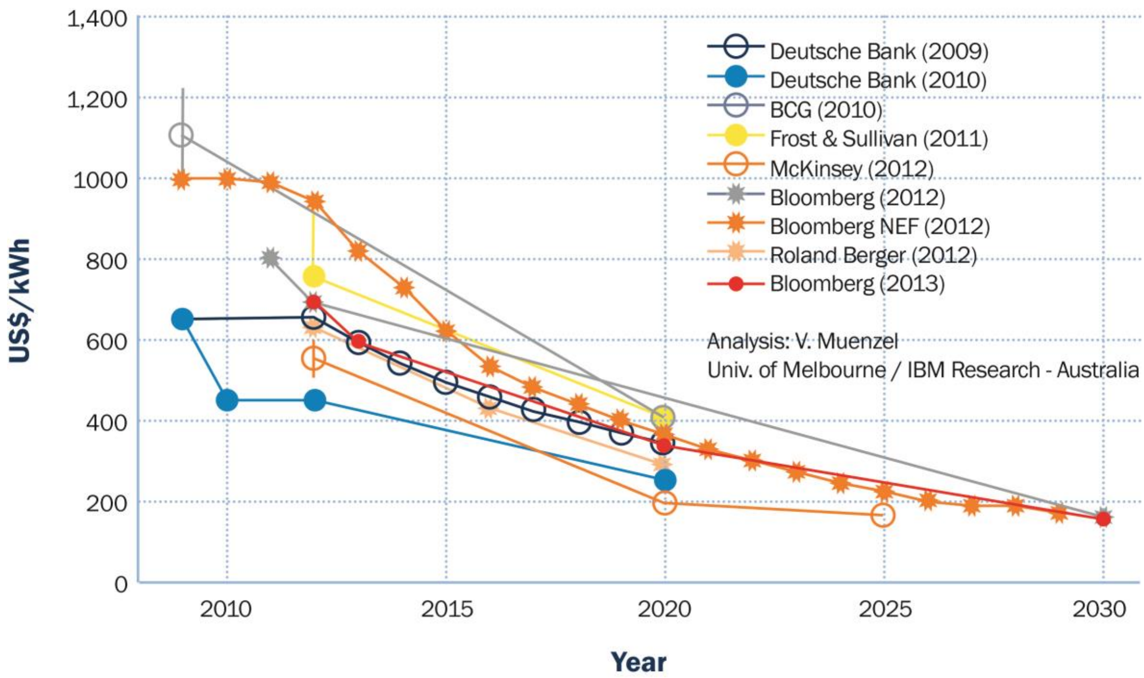
Addendum One: Emergent technologies impacting electricity sector and supporting industries

Battery Storage

The advancements in battery storage technology affordability and availability, to both domestic and commercial consumers, are contributing to workforce skilling and training requirements. Whilst the price point of battery technology currently exceeds price parity for mass adoption, sales are increasing within Australia with technology 'first adopters' and environmentally conscious consumers purchasing units.

Mass adoption of this technology is predicted to occur when the cost of these units are financially viable. Figure 14 outlines that the historical and projected costs of energy storage, based on numerous research findings.

Figure 14 - Battery storage cost projections



(University of Melbourne/IBM research – Australia)

However, the speed of adoption has the potential to significantly increase should a government rebate scheme be put in place. This was demonstrated with solar technology when a rebate was made available to the Australian public. Such a rebate has the potential to make battery storage financially viable and increase the speed of adoption.

A number of DNSPs are currently operating battery storage pilots around Australia.

Whilst not in the scope of this report, there are a number of industry groups that will also be impacted by emergent battery technology. The recycling and transportation industries will need skills to handle and manage increasing dangerous waste. There is also a need to consider battery specialists, who are skilled in working with chemicals, who can understand and develop how batteries are used, maintained and how to enable second life opportunities.

Smart Meters

A smart meter provides consumers and utilities with the ability to record the household consumption of electric energy providing close to real-time data, and may be the primary communication equipment that will help facilitate a shift in the way consumers use, store and implement their electricity needs.

Smart meters provide a range of benefits to both the consumer and utilities:

- *make it possible to have electricity prices that more closely reflect the cost of supply (such as higher prices in peak use times), and a reduction in cross-subsidies between electricity users*
- *provide near real-time information on consumption to the energy retailer and to users — reducing meter reading costs and allowing households to adjust their usage patterns (for example, in response to prices that vary between use periods)*
- *allow connections to smart appliances (such as through 'set and forget' controls on household electrical equipment) that involve 'two-way communication' between electricity consumers and the grid*
- *can increase reliability through improved fault detection, enable quicker restoration of power following an outage, and can receive and carry out remotely issued commands*

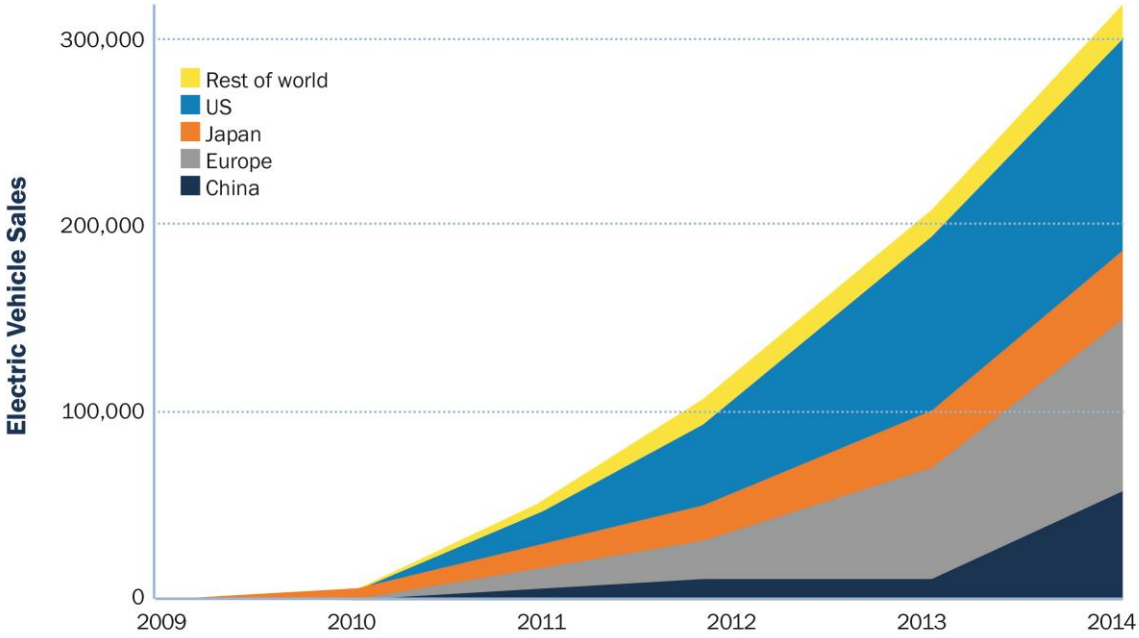
(Australian Government Productivity Commission, 2016)

The mandatory rollout of smart meters in Victoria in 2009 resulted in poor planning of the skills required for the deployment of smart meters and led to increased costs, longer installation times, project delays and substantial customer dissent (Smart Grid Smart City, 2012). Electric shocks were also reported by customers (Hemmingsen, 2011). This further highlights the importance of identifying the key mechanisms which enable sustainable workforce skill development pathways for the Australian electricity sector and supporting industries.

Electric Vehicles

The emergence of Electric Vehicles (EVs) is seen as a key driver in achieving Australia's commitment to net-zero emissions under the Paris agreement. Globally, sales of electric vehicles have increased dramatically in recent years from 45,000 in 2011 to 300,000 in 2014 (International Council on Clean Energy, 2015), as shown in Figure 15

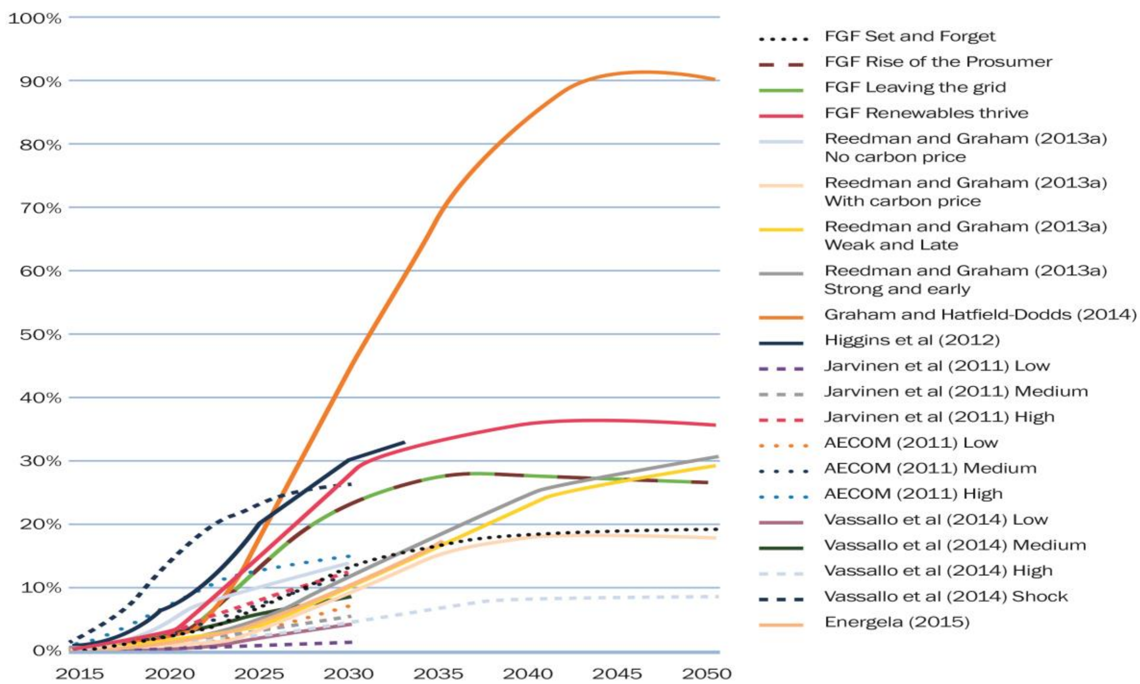
Figure 15 - Electric Vehicles adoption analysis



(International Council on Clean Transportation, 2015)

As technology improves, and key issues associated with electric cars such as distance travelled between charges is resolved, the adoption is expected to increase significantly. As outlined in figure 16, projections of electric vehicle fleet adoption are expected to grow sharply in Australia.

Figure 16 - Electric vehicle adoption projections



(Energy Networks Australia and CSIRO., 2015.)

Owners of EV's may need to have a charging station installed on their premises. These charging stations will need to be networked with other technology such as Battery Storage devices. Due to the scope of this research paper, the necessary skills for electric vehicles have not been included.

Home energy Management systems

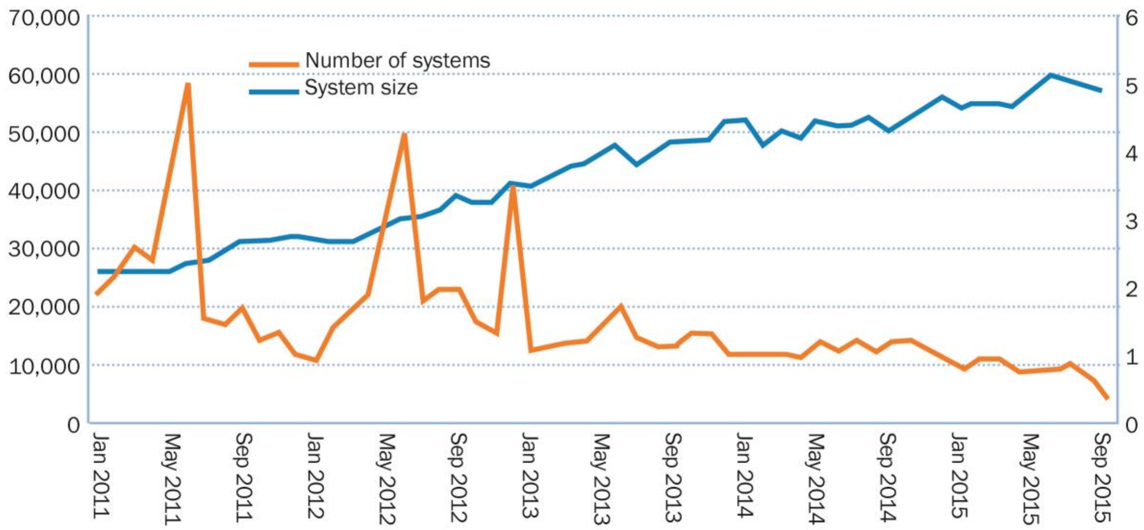
Home energy management systems connect with residential battery storage technologies to provide energy consumers with the most out of their investment at a relatively low cost.

An energy management system adds a layer of smart overlays to battery energy storage systems through embedded software, and has algorithms set to understand consumer consumption trends to reduce the cost of energy.

Advanced Solar PV

Household solar photovoltaic is an established technology within Australia. As is evident in Figure 17, whilst the number of installations is declining across Australia, an increase in the average size of installations is being recorded. The decreasing cost of technology, resulting in consumers getting better value for the technology they are purchasing, is considered a key driver behind this trend.

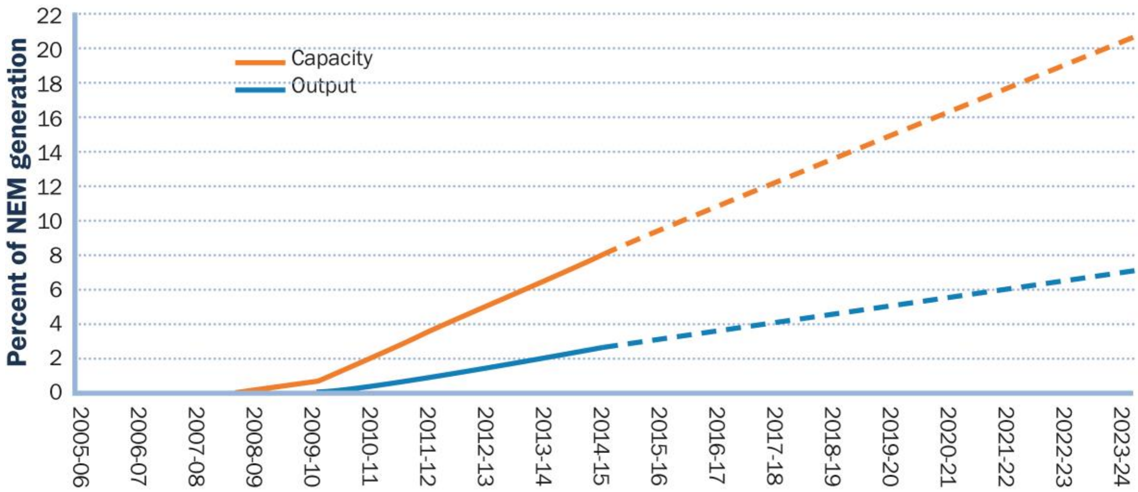
Figure 17 - Australia Solar PV installations analysis



(Australian Energy Regulator, 2015)

Sourced from the same report, Figure 18 predicts the capacity and output percentage of the NEM that Solar PV will contribute to the National Energy Market (NEM) annually until the 2023-24 year. The increased volume of electricity fed back into the grid will create challenges for electrical engineers who will be required to create a system that will accommodate two way flows of electricity.

Figure 18 - Predicted capacity and output percentage of the NEM from Solar PV



(Australian Energy Regulator, 2015)

The Clean Energy Council (CEC) has established a successful accreditation process that provides training and the necessary skills that are required to be developed for the installation and maintenance of this equipment. Clean Energy Councils' Solar Photovoltaic accreditation process for installers was successfully used as a mechanism for consumers to be eligible for government rebates, ensuring workers had the appropriate training to carry out the work. To be qualified for the CEC accreditation program applicants must fulfil certain requirements such as the applicant must hold an electrical license to ensure that they possess the necessary base qualifications.

Microgrids

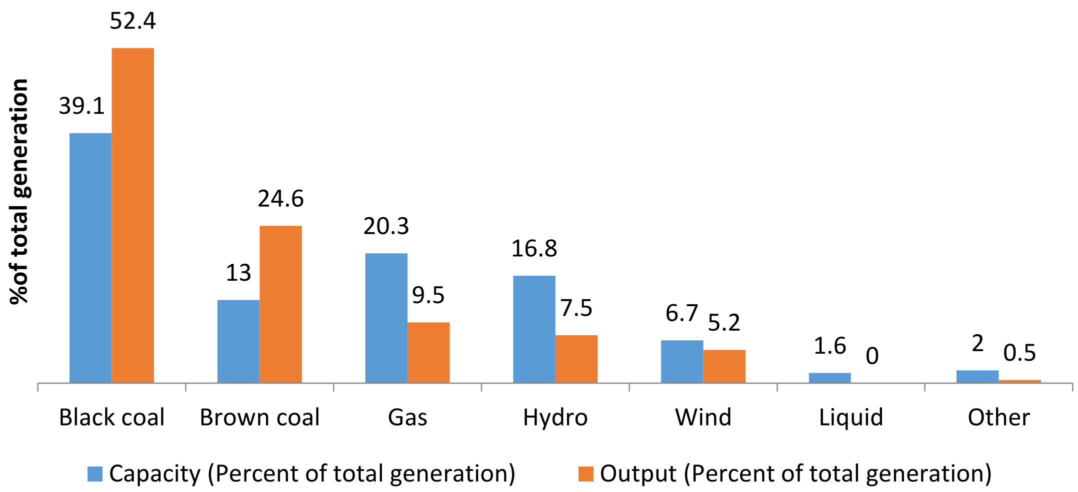
A microgrid is a local energy grid with control capability, which means it can disconnect from the traditional grid and operate autonomously (US Department of Energy, 2014). Locations that have supply reliability issues, or have local access to renewable energy resources, are two examples of situations where microgrids may evolve.

Large-scale Renewable Generation

In 2001, the Australian Government committed to the Renewable Energy Target (RET), which in its current state after the Australian parliament passed the Renewable Energy (Electricity) Amendment Bill 2015, aims for 33,000GWh to be produced from renewable sources by 2020. Post-2020 targets are to be adjusted accordingly.

It is important to comprehend the impact of the transition from a centralised model where all electricity is generated from fossil fuel power stations, to a decentralised model where electricity is generated from multiple sources i.e. large-scale renewable plants, traditional fossil fuel plants and DERs. Traditionally electricity generation has been sourced from power plants through the burning of fossil fuels. Whilst this method of generation remains the primary source of electricity generation (outlined in Figure 19), the emergence of new technology, government reform, increasing customer demand and environmental concerns has seen the traditional centralised generation model (fossil fuel power plants) increasingly evolve to a decentralised model with more intermittent renewable energy resources.

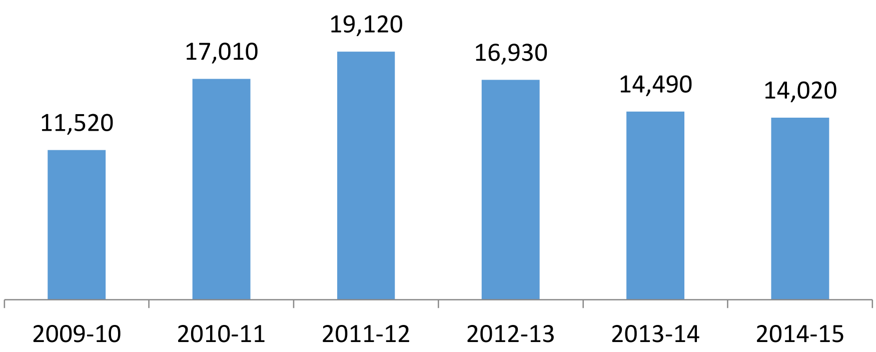
Figure 19 – Generation capacity and output by fuel source in the NEM - 2015/16



(Australian Energy Regulator, 2016)

Figure 20 outlines the employment trend by direct full-time employees within the renewable electricity generation sector. Direct fulltime employment spiked within the sector in 2011-12, with 19,120 employees. Since this spike, a year on year decrease has been recorded with a total of 14,020 in 2014-15 being recorded.

Figure 20 - Direct Full-time employment by renewable energy type - Australia



(Australian Bureau of Statistics, 2015)

With the transition from the conventional fossil fuel generation to large-scale renewables being in its infancy, limited data is available when assessing the impact on whether the overall workforce numbers will increase or decrease as the fossil fuel industry gets smaller and the renewables larger.

Drones technology

Drones, which are capable of providing remote and real time diagnostics, automated failure finding, interoperability, and are centrally controlled by application software, will be increasing used as fault finding and maintenance tools for remote and rural regions across Australia.

Addendum Two: Job Automation

The concept and practise of automation of roles, tasks and duties of workers through computerisation is not new or exclusive to the era of digitalisation. However, due to the exponential speed in which technological breakthroughs are prevailing, the automation of a high proportion of occupations has become a reality. An estimated 40 % of Australian jobs within 10 to 15 years have a medium to high potential for automation (Committee for Economic Development of Australia, 2015).

Jobs and tasks that are routine, which tend to be low to medium skilled occupations, are more susceptible of being automated (Australian Government Productivity Commission, 2016). In contrast, the automation of these jobs creates highly skilled positions requiring employees to work with new technology. The occupation of linesworkers was identified during our research as being a position that may be automated in the long term through the introduction of technologies such as drones and thermal imaging.

PwC identified Australian occupations which are both 'the most at risk' and 'least at risk' of automation within the next 20 years as illustrated in Figure 21. The following highlights the occupations least at risk.

Figure 21 - Australian jobs least at risk from computerisation and technology in next 20 years

Occupation	Probability of being automated	Number of workers affected
Medical practitioners	0.4%	89,754
Education, health and welfare managers	0.7%	75,082
Midwives and nurses	0.9%	301,762
Advertising, public relations and sales managers	1.5%	126,616
Database and systems administrators and ICT Security Specialists	3.0%	34,764
Education professionals	3.3%	56,264
ICT managers	3.5%	57,184
Tertiary-level teachers	3.6%	116,001
School teachers	4.0%	407,693
Engineering professionals	4.2%	132,736
Legal professionals	6.5%	82,552
Social and welfare workers	6.8%	123,933
Accomodation and hospitality managers	7.2%	100,765
Construction, distribution and production managers	8.2%	258,794
Child carers	8.4%	130,794
ICT network and support professionals	9.7%	49,688

(Pricewaterhouse Coopers, 2015)

As is evident, a number of the occupations identified are ICT based and engineering professionals who are important and prevalent within both the TNSPs and DNSPs sectors.

Addendum Three: Technical Skills – Battery Storage and Smart Meters

This list is not exhaustive, but provides a snapshot of the technical complexities that will need to be addressed by electrical workers employed in the electricity supply industry and by electrical contractors.

- Meter template setting for multiple configurations using field tool and/or remote terminal
- Familiarisation with Meter Management System (MMS), including back end setup
- Meter communications modes e.g. Modems, Wi-Fi, ZigBee, Mesh Radio
- Modem hardware application setup
- Communications protocols and security e.g. TCP/UDP
- Communication technology e.g. 3G/4G, Mesh Radio, PLC
- Antenna installation and characteristics
- Meter data/asset management – Database queries, database manipulation, reports generation
- AEMO Metrology requirements
- Meter hardware configuration for tariffs
- Understanding RS485 and RS232 communication wiring
- Requirements for earthing of screens at one end
- Requirements for CAT 5 wiring (internet connections). Marking off and testing RJ45 connectors.
- CT polarity and importance of association of voltages and currents
- Location of metering CT's and VT's in relation to site load summation or solar import/export
- Understanding inverter input screens and setting of limits e.g. zero export, output limits, power quality management etc.
- Types of RDCs applicable to inverter critical load circuits - Type AC, A or B
- Protection systems for large-scale embedded generation - Standard 233
- Environmental conditions and impacts on batteries and inverters
    - Where to position equipment
    - Noise impacts on large systems
- Building code requirements for commercial projects
- Labelling requirements for PV and battery systems
- Correct sizing of storage capacity to meet operational expectations of customers
- Installation contractor/Suppliers understanding of AS/NZ 4755.35 requirements and identification of load boundaries for compliance to standard
- Cost benefits analysis for BESS. At present market electricity tariff rates including associated costs for installation and commissioning of BESS
- Maintenance and warranty requirements for BESS e.g. internet connection may be required to monitor systems, warranty may be reduced if not monitored
- Tariff knowledge - Infeed tariff impact if customers are on 44c infeed contracts, can inverters be changed without losing the infeed tariff (same kW, increased or decreased kW)
- Customer awareness of battery terminology (kW, kWhr, etc.) and the capability and duration of the stored energy to power their site demands.

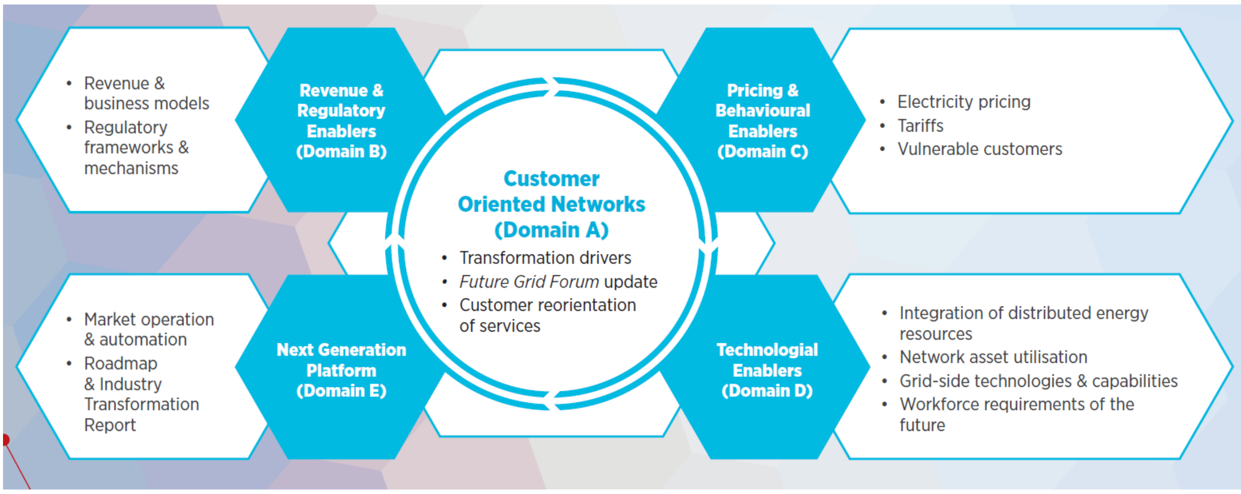
Addendum Four: Methodology

This research paper will form part of the national ENTR. The ENTR, a joint initiative of the ENA and CSIRO has been developed to identify the preferred transition which the electricity network industry must make in the next decade, to be ready to support better customer outcomes under a diverse range of long-term energy scenarios.

By setting out a pathway for the transition of electricity networks by 2027, the ENTR seeks to position network businesses and the whole energy supply chain for the future, to support the evolving needs of customer, innovate and develop new services that customers value and foster the long-term resilience and efficiency of Australia's energy system.

The ENTR is structured into five domains, which each consist of a number of work packages. As outlined in Figure 22, this research paper falls within the technological enablers domain (Domain D).

Figure 22 - Electricity Network Transformation ENTR structure



(Energy Networks Australia & Commonwealth Scientific and Industrial Research Organisation, 2015)

As such the focus of this report concentrates on the workforce skilling, training and professional development requirements that will be required to enable successful implementation of new technologies within the network industry.

The ENTR is designed to rely on significant stakeholder input and collaboration to form inferences that represent views and opinions of key industry stakeholders. To ensure that this research falls within the wider ENTR principles, this report has used both quantitative and qualitative research to form conclusions.

Initially an extensive review of published literature (both domestic and international) and statistical data was undertaken. This review provided a base knowledge that assisted in the development of a workshop that was held with network operator representatives.

Following the workshop an online survey was circulated to a wider audience. Stakeholders from all sectors of the electricity Industry, government agencies and educational facilities were encouraged to participate.

The responses from both the workshop and wider survey provided an insight into where industry felt that skill and training requirements will be evident in the coming decade. Further consultation was then undertaken with subject matter experts to develop a coherent understanding of the workforce impacts. The findings were used to identify the key mechanisms which enable sustainable workforce skill development pathways for the Australian electricity sector and supporting industries.

To identify the impact on occupations, skills, training and professional development, and the requirements to address them within the network industry in the coming decade, the following method was adopted.

Identification of key occupations within the distribution and transmission networks was sourced from 2011 census data (the most current publically available data by the level of occupation required for this analysis) by Australian and New Zealand Standard Classification of Occupations (ANZSCO), 2013 major level, as identified below;

Figure 23 – Distribution and Transmission industries by Employees – ANZSCO Major Classification

	DNSP	%	TNSP	%	Network Industry	%
Technicians and Trades Workers	12,341	41.4%	1,088	39.6%	13,429	45.1%
Clerical and Administrative Workers	6,394	21.5%	702	25.5%	7,096	23.8%
Professionals	5,898	19.8%	458	16.7%	6,356	21.3%
Managers	3,259	10.9%	398	14.5%	3,657	12.3%
Machinery Operators and Drivers	590	2.0%	31	1.1%	621	2.1%
Labourers	485	1.6%	28	1.0%	513	1.7%
Inadequately described	453	1.5%	20	0.7%	473	1.6%
Sales Workers	259	0.9%	19	0.7%	278	0.9%
Community and Personal Service Workers	96	0.3%	4	0.1%	100	0.3%
Not stated	23	0.1%			23	0.1%
Total	**29,798**	**100%**	**2,748**	**100%**	**29,798**	**100%**

(Australian Bureau of Statistics, 2011)

Further analysis was then undertaken of occupations by ANZSCO unit classifications to determine the scope of the research. The following major groupings were discarded from further involvement within the research on the justification that occupations (unit level) will have minimal to no impact from emergent technologies and as such will from the no further part of this research.

- Machinery Operators and Drivers
- Labourers
- Sales Worker
- Community and Personal Service Workers
- Occupations that will not identified as having critical impact were removed from the analysis

Ongoing consultation with and review by ENA on the research paper was carried out throughout the project term. The conclusions found within this paper have been based and developed through all the findings of all the above mediums.

Addendum Five: References

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