A Changing Electricity Industry, A Changing Workforce

A Discussion Paper on the Future Skilling Implications of the Smart Grid

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Energy Skills Queensland (ESQ) is the Industry Skills Body leading energy industry and government engagement on education and training, skills development and labour market issues. Energy Skills Queensland is at the forefront of developing solutions to help industry plan and develop their workforce, and providing opportunities for organisations and individuals to improve workforce skills by brokering training funding.

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Abbreviations and Acronyms

AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
AMI	Advanced Metering Infrastructure
AERI	Australian Energy Research Institute
AVVC unit	Active Volt-Var Control unit
COAG	Council of Australian Governments
DSP	Demand Side Participation
EMS	Energy Management System
EPIA	European Photovoltaic Industry Association
FDIR unit	Fault Detection, Isolation and Restoration unit
GW	Gigawatt
ICT	Information and Communication Technology
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
STEM	Science, Technology, Engineering and Mathematics
ToU tariff	Time of Use tariff

Executive Summary

A convergence of trends, from deep regulatory reform to disruptive "smart" and renewable technologies, are beginning to reshape the national electricity supply industry. These changes are unprecedented and imply a fundamental shift in how electricity is produced, distributed and consumed in Australia. Other countries throughout the world are also experiencing similar changes.

This discussion paper explores the potential workforce and skilling impacts of a changing electricity industry in Australia, and outlines the industry trends and developments that underpin these changes. Importantly, this is a preliminary review or "first look" at the available research and literature published in this area, and aims to be a platform for feedback, deeper industry involvement and more detailed workforce planning. To date, there has been limited research detailing the workforce changes and skilling implications of a changing electricity industry in Australia, and in-depth engagement with industry professionals operating across the electricity sector is now required to substantiate and expand upon the themes discussed in this paper

This "first look" reviews industry, academic, regulatory, media, consultancy and government sources, and both Australian and international research was used to develop the workforce and skilling analysis.

The major workforce impacts of a changing electricity industry identified through this review process include:

1. **Moving to a "smarter grid",** and the technology, services, markets and products this enables, **is currently seen as the major driver of workforce and skill impacts** over the coming years
2. **Three workforce groups were commonly proposed as being most directly impacted by the uptake of smarter grids**, namely
   a. Distribution network operators
   b. Supply chain organisations operating in areas such as telecommunications overlays or software integration
   c. Electrical contractors providing new 'smart' services to domestic, commercial and industrial markets
3. Skill clusters and example occupations impacted or likely to be required for **distribution network operators** were identified as
   a. **Electrical**: Electrical Distribution Trades Workers, Electricians, Electrotechnology and Telecommunications Trades Workers, Technicians
   b. **Engineering**: Power Systems Engineer, Electrical Engineers, Telecommunications Engineers, Technicians.
   c. **Information and Communication Technology (ICT)**: ICT Security Specialists, Software and Applications Programmers, ICT Managers
   d. **Data Analytics:** Database Administrator, Data Scientist, Database Developer/Architect, 'Big' Data Analyst
   e. **Customer Services:** Call or Contact Centre Workers, Customer Services Managers, Advertising, Public Relations and Sales Managers, 'Smart' Electricity Services Broker

4. **Many of these skill clusters may require new roles not previously part of the distribution network operator workforce**, particularly in the areas of Engineering, ICT and Data Analytics
5. **Skills deepening** across existing job roles in Electrical and Customer Service areas is expected.
6. Workforce impacts for **supply chain organisations** are likely to be associated with the delivery of Information Technology (IT) and Operational Technology (OT) systems integration, hardware provision, telecommunications upgrades, data hosting and software development
7. Smart grid skill sets in demand for the **electrical contracting** workforce were identified as the
   a. Design, installation and maintenance of solar photovoltaic (PV) systems (with battery storage capabilities in future)
   b. Advanced Metering Infrastructure (AMI) and smart meters installation and maintenance
   c. Customer services, energy auditing, advice/training and smart electricity services brokering
   d. Systems integration
   e. Instrumentation and control
8. **Skills shortages** may occur in future across key Science, Technology, Engineering, and Mathematics (STEM) roles in Engineering, ICT and Data Analytics, many of which are in shortage across other industry sectors

Five converging themes are driving the above need for new skills and workforce capabilities:

1. **Decreasing electricity use but increasing peak demand** is the 'new normal'. Electricity use declined annually by 1.7 percent from 2009/2010, yet peak demand stabilised and is forecast to grow yearly by 1 percent. Past peaks required heavy capital investment ($30.6 billion) to meet small periods of high demand (90 hours per year).
2. **Increasing electricity prices** have been necessary to cover this investment. From 2009 to 2014 average household electricity prices increased by 50 to 70 percent. Political pressure for industry reform has resulted with 17 reviews into price rises.
3. **Changing industry regulations for demand side participation (DSP)** has emerged as the regulatory framework to offset peak investment and stabilise price over the long-term. DSP empowers consumers to better manage their electricity use.
4. **Solar PV and a distributed market** have also emerged to avoid price rises. One million homes now have solar and may double by 2020. Solar disrupts centralised industry structures with a distributed market, where consumers produce and export power.
5. **The need for a smarter electricity grid** is arising as a way to enable both DSP and a much wider distributed market in future. A smart grid integrates new technologies (like smart meters) and telecommunications capability with the current electricity grid. However, making an electricity system "smarter" is an ongoing process, not a one-time event.

1. Overview

A reliable supply of electricity drives the entire Australian economy. The nation has prospered from a highly skilled electricity industry which provides this service, via a network spanning power generation, transmission, distribution and retail. However, a convergence of trends have emerged which are fundamentally changing how this industry and the wider electricity market operates. These trends are widely understood by industry and are discussed in the latter half of this paper.

What is less well known is how these trends could reshape core elements of the electricity industry workforce over the coming 10 to 15 years. It also remains unclear how other professions working closely with the industry, like electrical contractors, may also be impacted as new technologies and energy services are introduced.

This discussion paper begins to outline these potential workforce and skilling impacts, by drawing together available research into a preliminary overview or “first look” into this area. The workforce changes outlined therefore remain as a high level benchmark of current knowledge. More extensive engagement with the full range of industry professionals and stakeholders operating across the electricity sector can now be pursued to substantiate and expand upon the areas proposed. This paper therefore sits as the first important step in understanding these workforce implications, and aims to be a platform for informed feedback, commentary and deeper industry involvement in more detailed skilling assessments.

This “first look” is also important because it starts to address a critical gap in current thinking about changes in the Australian electricity industry. Most preceding work in this area has focused on emerging market trends and new technologies, without consideration for the expected skills needs. This may be a crucial oversight. 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. This brief paper, the first in a series by Energy Skills Queensland for 2015, begins to fill this critical gap whilst providing a general framework for more detailed workforce analysis.

The paper is presented in two sections. The first section reviews available research regarding the workforce and skilling implications of a changing electricity industry. It focuses specifically on the skills impact of smarter grids, as this was identified across the available sources as a crucial enabler of new regulations, electricity services and products driving change in the industry.
Key areas include:

- Introduction to the workforce and skills review
- The major workforce impact of a changing electricity industry
- Key workforce impacts of a smarter grid for distribution network operators, supply chain organisations and electrical contractors
- Australian skills shortages and their relation to smart grids

The second section outlines the five broader industry trends commonly seen as collectively driving the changes in skill demand. These include

- Decreasing electricity use but increasing peak demand
- Increasing electricity prices
- Changing industry regulations for demand side participation
- Solar PV and the distributed market
- The need for a smarter electricity grid

2. Introduction to the workforce and skills review

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. It is toward a fuller understanding of these shifting skills needs that this review contributes.

2.1. Comments on research availability and approach

The detailed scoping of industry-wide future skill needs normally undertaken in times of intense industry change is at a relatively early stage for the electricity industry. In many countries it is only beginning or has not yet been conducted in a systematic way. As a result, the high amount of specific information sought for this review was unfortunately lacking. Furthermore, the majority of future workforce analysis obtained was either at a very high-level or delivered as a broad and unspecified commentary. In Australia, no industry wide workforce plan has yet been developed and this highlights a priority area for future research.

This does not, however, imply that no significant work has been undertaken to discern the likely workforce implications and skill sets of a changing electricity industry. Indeed, the scope of work obtained for this review still covers a variety of industry, academic, regulatory, media, consultancy and government sources in this area. Secondary research and data both from Australian and international sources was collected. Reviewing this literature involved identifying key drivers of skills demand, identifying workforce groups and occupations most impacted by these changes and synthesising this information together in a single place.

In particular, strategic workforce planning for the future electricity industry has been undertaken by multiple stakeholders in the US, and to a lesser extent in the UK. More targeted work was also located in European and Australian contexts, with research typically focusing on single skilling areas or workforce groups (e.g., engineering or electrical contracting). Understanding the changing dimensions of power systems engineering, for instance, is a highly active area of research.

It is from these key sources that this paper generates a more systematic “first look” into the likely skilling impacts occurring across and within various workforce groups in the Australian electricity industry. Due to the small amount of information available though, primary research with industry is needed to validate and expand upon these findings.

3. The major workforce impact of a changing electricity industry

The first major finding of this review process is that transitioning to a “smart grid” was frequently considered the overarching driver of workforce and skilling impacts of electricity industry change. A smarter grid was consistently described as the main driver of both the demand for new skills across the industry, skills deepening within traditional roles and more diverse skills requirements for those working alongside the industry (e.g., electrical contractors). This was common to research and commentary produced both within Australia and internationally.

The skills related either directly or indirectly to smarter grids (and the flow-on effects of their implementation) featured so heavily across all the information reviewed that it essentially overshadowed any other major skilling areas related to electricity industry change. This does not, however, mean that all skills and workforce impacts of the changing electricity industry are related to smart grids but rather that this is currently a high priority area for skilling and workforce development. Due to this focus in the literature, smart grids have also been adopted as this review’s overarching theme and are used throughout as a lens to further review workforce changes expected across and within the relevant sectors.

A smart grid is generally defined as the overlay of advanced telecommunications, automation, sensing and intelligent metering infrastructure (including smart meters) onto the existing electricity grid (Ausgrid, 2014). Moving to a smarter grid is an ongoing and complex process which also enables a diverse range of intelligent technologies, renewable systems, services, markets and new products to enter the traditional electricity market (a fuller understanding of smart grids is provided toward the end of this paper). It is due to this enabling role and the level of technological integration required that smart grids are expected to have such a wide impact on skill requirements.

Assessing the impact of smarter grids on the skills and workforce requirements is particularly well resourced in the US where smart grid implementation is more advanced and has also received substantial national funding and government commitment (KEMA, 2009). A number of smart grid workforce forecasts, strategic workforce plans and targeted skilling and training plans have been conducted to date. These form the primary basis for the skilling analyses that follow, although Australian research is given a higher priority in areas it was available.

3.1. Skills shortage concerns

Alongside this identification of smart grids as a priority skilling area were consistent claims that smart grid skills shortages were either already occurring or seen as a threat to successful industry change in future. For example, a quarter of utility executives from around the world identified a lack of skills as a barrier to a more intelligent electricity market (Accenture, 2014). Others in the US have postponed deployment of smart technologies and infrastructure for the same reason (Pike Research, 2010). According to sources operating in the UK, an approaching smart grid skills scarcity is predicted to cause a “capability crunch” in the region, which if not proactively managed may delay the positive transformation of the sector (EY, 2013).

Similar concerns were identified in Australia. An early contributing factor to CSIRO’s (2009) ‘Big Failure’ scenario for a national smart grid was identified as a lack of the necessary workforce and skills. Smart grid engineering skills shortages have also been identified by Australian Energy Research Institute (AERI) who have developed professional courses with industry to begin addressing these concerns (AERI, 2014; Agelidis, 2010). From a workforce rollout perspective, poor planning of the skills required for the deployment of smart meters across Victoria 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)). According to some sources, skilled workers are now considered vital to the social acceptance of smarter technologies and a smarter grid overall as consumers need assurance that new services are provided by qualified professionals (E-Oz, 2014b). Further commentary on these types of skills shortages and workforce issues in an Australian context are discussed further in Section 8.

Overall then, the opening findings of this review indicate the primacy of smarter grids to the future workforce and skilling requirements of the electricity industry. Furthermore, both internationally and in an Australian context, smart grid skills appear underdeveloped and poorly understood despite their imperative for successful industry transformation.

4. Key workforce impacts of a smarter grid

This review process then explored the specific skilling and workforce implications of smarter grids, targeting workforces operating both within and alongside the electricity industry. This revealed that three core workforce groups are likely to be most directly impacted by the uptake of smarter grids. The groups identified included:

- Distribution network operators
- Smart grid supply chain vendors; and
- Electrical contractors

Again, this does not imply that other workforce groups and sectors will not be substantially reshaped by smart grids, rather that the three groups listed are currently seen as priority skilling areas. Arguably, this is due to the high degree of skills reconfiguration and occupational change expected in these areas as a result of smarter electricity networks.

Firstly, across the subsectors of the electricity supply industry (generation, transmission, distribution, retail), the available research suggests transitioning to a smarter grid will have the largest impact on the distribution network operator workforce. The overall size of this workforce may decrease or only grow marginally in future as a result of smarter grids, yet critical new roles, new technical and non-technical skills and retraining of staff are expected. For example, traditional roles like power systems and electrical engineering were seen to become more integrated with telecommunications – leading to a substantially more complex skills profile. Existing technical trade roles were seen as requiring additional training and skills deepening. New expertise and critical skills in IT, telecommunications, data analytics and customer services were also proposed.

Secondly, major network projects required to upgrade the current grid, for instance in telecommunications overlays or software integration, are likely to bring short-term “smart grid solution” vendor workforces into the electricity industry. Top-tier technology companies like IBM, Cisco and Schneider Electric are examples of new market entrants in the US already providing these integrative services. This is a rapidly expanding market and if a similar smart grid process occurs in Australia, new competitors and workforces are expected to operate in conjunction with the electricity industry. High level technical skills, across job clusters noted for distribution network operators (IT, telecommunications, and data analytics) will also be required along this supply chain.

Thirdly, movement toward a smart grid typically begins with the installation of smart meters and home energy management systems and this will require new skills and workforce capacity. In the Australian NEM, because this rollout is expected to be customer led and contestable (outside Victoria), electrical contractors with the ability to provide these services may experience high demand in future. The increased market penetration of solar PV enabled by a smarter grid is another key area likely to define the skills needs of these contractors. ‘Smart’ service delivery is predicted to diversify both the technical and customer service skills needed by electrical contractors in future.

5. Key workforce impacts of a smarter grid: Distribution network operators

Smart grid workforce literature suggests modernising the grid will have the most direct impact on the distribution workforce (BLS, 2013; CEWD, 2013; CEWD, 2013b; KEMA, 2009). This literature is diverse and often lacks detail regarding exactly where and how these impacts will occur. Unifying themes, however, are common and can be drawn together to provide an early look at the general implications. These themes include the possible impact of smart grids on the size of the distribution workforce, and the skill clusters and occupational groups most affected.

In terms of size, current thinking suggests the transition and operation of a smarter grid will have a minimal impact on the overall size of the distribution workforce. Specifically, research undertaken by EUSP (2014) and McKinsey (2010) indicate that a smart grid may actually reduce the overall number of staff required by distribution network operators. EUSP (2014), for example, forecast a decrease of around 8.5 percent through to 2025. A major reason for this decline is the succession of many physical jobs and workloads with automated systems. For instance, manual meter reader positions are likely to be superseded by automated smart metering infrastructure.

Others, like KEMA (2009), suggest a slight increase in the workforce as a result of smart grids. This is primarily due to the growth of new highly skilled jobs required by smarter networks. These occupational areas include power and electrical engineering, IT, telecommunications, data analytics and customer services (discussed further below). KEMA (2009) also sees scope to retrain workers succeeded by smart grids (e.g., meter readers) into other roles in smart meter installation or customer services/'smart' electricity services brokering.

In summary, the size impacts of the smart grid on the distribution workforce are expected to be minor. This small impact is further likely given the long-term and complex process of upgrading the entire grid and the financial risks inherent in over investing in smart grid technologies. A slow and piecemeal change to workforce size, rather than a boom in aggregate hiring, is therefore considered to be more likely over the mid to long-term.

Unlike size, the impact of smart grids on major occupational roles and the key skills required by the distribution workforce is likely to be a much larger and more complex issue. Unfortunately, a high amount of detailed research in this area was lacking. The available work, however, can be used to benchmark the predicted implications of a smarter grid on the major occupations and skills mix of the distribution operator workforce.

Five major skill areas unify this preceding work reveal a certain degree of consensus around what broad types of impact the smart grid may have on the next generation of distribution workers. These skill areas stretch from technical trades and customer services, which are considered to experience a low level of impact from smart grids, through to high impact technical skill areas across engineering, ICT and data analytics. Many of these are high impact areas because they require new skillsets and abilities not heavily associated with the current distribution workforce.

Table 1 draws together these five broad skill areas believed to be impacted by smart grids. For each skill category either a low or high level of workforce impact, and the reason for this decision, is provided. Example distribution occupations in each area are also provided alongside an explanation of types of skills required.

Table 1: Skill areas, example occupation and smart grid impacts on the distribution operator workforce (Source: Energy Skills Queensland analysis, 2015)

Skill area and example occupations	Impact of Smart Grid on Workforce
Technical trades	Low impact – core competencies unlikely to change
• Electrical Distribution Trades Workers • Electricians • Electrotechnology and Telecommunications Trades Workers • Technicians	A mixture of on the job equipment training, up-skilling and post-trade qualifications in automation are likely to be required to manage smart grid technology and new procedures or protocols
Engineering	High impact – core competencies may change and new technical skills are likely
• Power Systems Engineer • Electrical Engineers • Telecommunications Engineers • Technicians	New types of integrative engineering skills required with a robust understanding of power engineering, electrical engineering, IT, bi-directional networks, intelligent networks, solar PV integration, data and telecommunications. Team work increasingly important in highly overlapping and technical work teams. High level/senior level technologist problem solving skills may be in high demand.
Information and Communication Technology	High impact – not heavily associated with distribution sector at present and new technical skills likely
• ICT Security Specialists • Software and Applications Programmers • ICT Managers • ICT business and systems analysts	A smarter grid may eventually require a highly-skilled ICT workforce. To plan, organise, direct, control and coordinate ICT smart grid strategies and manage and growing amount of day-to-day ICT platforms and tasks. Cyber security, consumer data privacy and cloud computing are likely to be a key driver of skills needs
Data Analytics	High impact – not associated with distribution sector at present and new technical skills likely
• Database and Systems Administrator • Data Scientist • Database Developer/Architect • 'Big' Data Analyst	Skills and expertise required to plan, integrate, operate, maintain and leverage business insights from "big data" management systems. An exponential amount of digital information may define the future operating environment, and will require skills and personnel not yet present in the sector. Heavy overlap with ICT skills.
Customer Services	Low impact – non-technical skills and upskilling required for a more complex consumer environment
• Call or Contact Centre Workers • Customer Services Managers • Advertising, Public Relations and Sales Managers • 'Smart' Electricity Services Broker	Demand for "smart" customer services teams with deep understanding of new technologies and tailored energy solutions, and the skill to explain these to tech-savvy customers. Skills in electricity services brokering may grow. Public relations to inform and shape consumer perceptions of the economic and social benefits of smart grid services will be important to avoid smart meter backlash similar to Victoria.

6. Key workforce impacts of a smarter grid: Supply chain operators

Outside the distribution sector, available research also indicates grid modernisation may have major workforce and skilling impacts for top-tier technology and telecommunications companies. These companies are likely to form a diverse supply chain offering commercially scaled smart grid “project solutions” to distribution businesses.

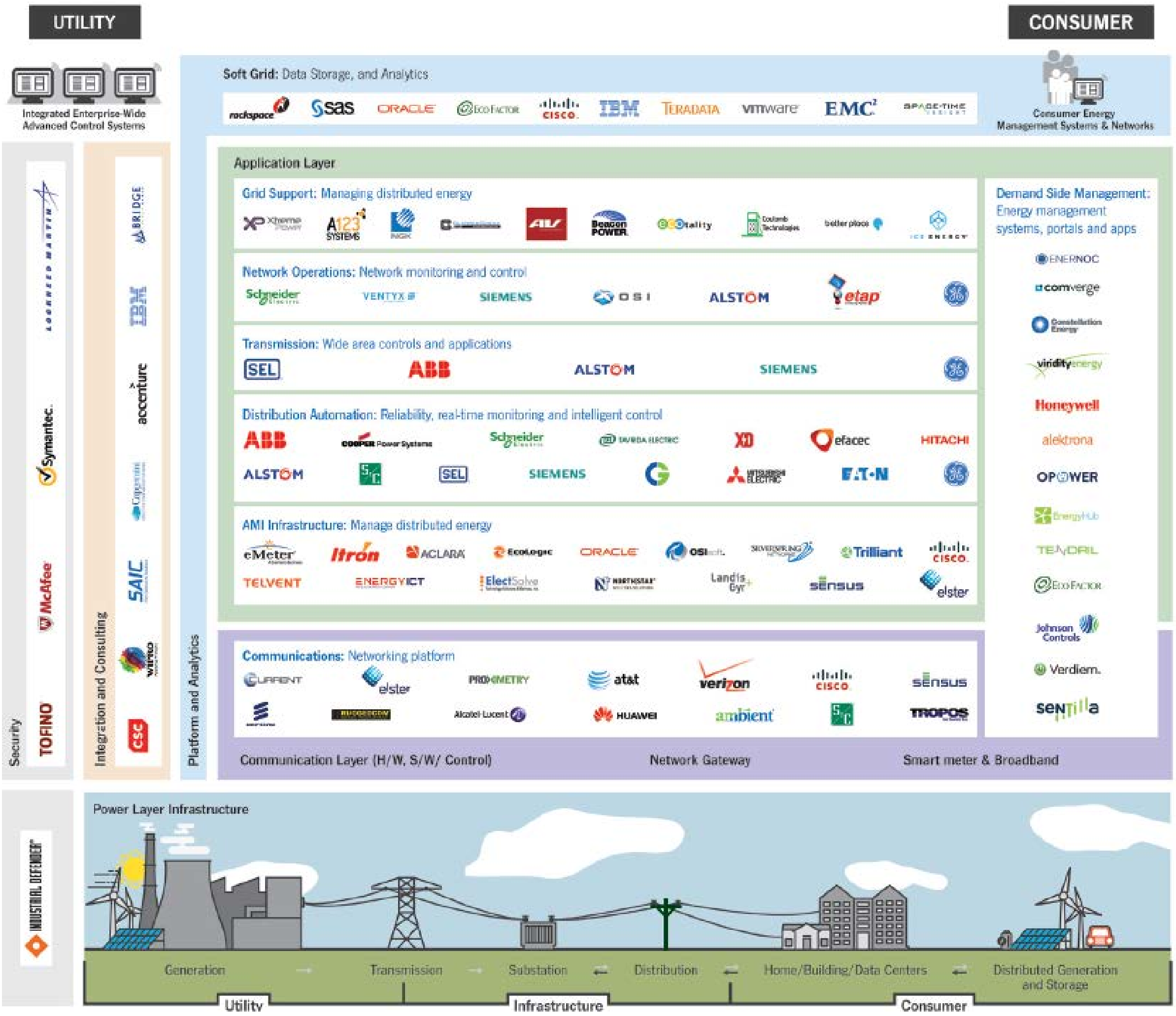
Outside the general consensus that this will also drive demand for new skills in ICT and software development, literature exploring the precise skills and workforce needed in this area is also lacking. Only a high level introduction to this vendor landscape, with a focus on the first mover US market, is therefore provided below. It summarises current thinking regarding the primary function of the smart grid supply chain, potential workforce size and duration, and the key services provided and generic skill needs.

Large-scale smart grid deployment projects are likely to require a whole new network of cross-industry partnerships between technology companies and the electricity industry. This level of “end-to-end ecosystem” independence has not traditionally been associated with either industry, but will be increasingly required on a project to project basis to integrate different smart grid capabilities and technologies. IT/OT systems integrators, hardware providers, telecommunications upgraders, data hosting companies and software development firms are all likely to operate in this ecosystem and may be impacted by smart grid opportunities.

Workforce size and duration for supply chain vendors is likely to be dependent on the project and smart grid integration service provided. Despite these differences though, project work of this nature overall is likely to be temporary and undertaken only to deploy and integrate certain technologies with the grid.

In terms of the workforce size and trajectory of this vendor supply chain, forecasts conducted in the US electricity market suggest that the skills and services provided by these companies will be in extremely high demand over the coming years. KEMA’s (2009) widely influential *US Smart Grid Revolution: Perspectives for Job Creation* has predicted that job creation for direct utility suppliers and software integrating firms would be the highest of all the sectors involved in creating a smarter grid (including the electricity industry and electrical contractor workforce). As an early indication of this emerging market in the US, a complex network of 155 vendor companies are already active in the smart grid solution space, including multinational companies like IBM, Cisco, and Schneider Electric (GTM Research, 2013). Figure 1 on the following page represents this level of supply chain involvement in smart grid solution provision in the US.

Figure 1: US smart grid supply chain companies aligned with smart grid products and service (Source: GTM Research, 2014)



The range of smart grid solutions and upgrade projects offered by these companies is diverse and typically at the macro or systems wide scale. Services stretch from transmission automation through to demand side management systems integration. The range of skills needed for these services is highly technical, but most generally rotates around many of the skill areas required of the future distribution workforce, including integrative engineering, ICT, cloud computing, automation and data analytics.

7. Key workforce impacts of a smarter grid: Electrical contractors

Across the skills review process, the final group substantially impacted by smart grids was identified as the electrical contractor workforce (ELECTRI, 2014; E-Oz, 2014; E-Oz, 2014b; E-Oz, 2014c; IEC, 2013; Ofei-Amoh, 2011). New market opportunities for contractors are predicted over the coming years in the provision of smarter electricity products to a more empowered and active consumer base. As a result, the diversification of both technical and customer service skills may be required for electrical contractors looking to capitalise on these new opportunities.

Unlike supply chain vendors working at the macro scale of grid-side systems integration, many electrical contractors are likely to procure work at the micro scale of customer-side services (ELECTRI, 2014). Specifically, the demand side management capability enabled by a smarter grid opens a new market to competition by skilled electrical workers. Scopes of work are expected to include the installation, configuration, commissioning and maintenance of smarter and more sustainable/renewable electricity systems in residential, commercial and industrial facilities (both new and existing). Contractors may also become key advisors and consultants to large and small consumers in the early identification of strategies and smart technologies that best suit their energy needs, and the auditing of already existing systems.

This range of customer-side products and services enabled by smarter grids is substantial. It is also likely to grow and become more integrated as the grid evolves and the cost of new technology decreases. For example, energy storage and electric vehicles are not likely to be in the mainstream market until 2020 to 2030, at which point skills in the connection, integration and communication of these technologies will be in higher demand (CSIRO, 2013). Other products like smart meters and solar PV units are already on the market, and the skills required to install and maintain these are expected to grow over the coming years. A non-exhaustive list of these smart grid enabling technologies and services at the customer-side of the market are provided below

- Smart meters
- Solar PV systems
- Energy Management Systems
- Energy storage
- Electric vehicles
- Electricity services brokering; and
- Energy auditing

The role of the contractor in future is therefore likely to expand dramatically as residential, commercial and industrial customers explore these technologies and energy services. Additionally, the automation and synchronisation of these technologies into an overall home or industrial electricity system, that maximises efficiency and best fits the client's needs, will further enlarge the role requirements of contractors over the coming years (IEC, 2013). Indeed, to meet the expected proliferation of customer-side smart systems, some electrical contractors are already looking to expand their service offerings by creating multi-skilled and multifaceted roles within their businesses (E-Oz, 2014).

This widening of this occupational role will drive a diversification of the skill sets required by electrical contractors. Sources suggest that a mixture of both technical and customer service skills will be required in future, and are a necessary precursor to the successful deployment of these new technologies.

Precise and systematic identification of these expected skills impacts in an Australian context has yet to be conducted, and no smart grid specific workforce plan for electrical contractors has yet been undertaken. However, drawing together the various pieces of information available at present (and the technologies considered to be a part of most future scenarios) can provide a first "look" at how a smarter grid may impact the electrical contractor workforce and drive demand for certain skillsets.

The available intelligence at present generally outlined six priority skill impacts of smart grids on the electrical contractor workforce. According to the research reviewed, these skillsets are likely to be in high demand in future and have been brought together in Table 2 below. Specific drivers and scenarios underpinning these skill demands are also provided.

Table 2: Smart grid skill sets in demand and their associated drivers for the electrical contractor workforce (Source: Energy Skills Queensland analysis, 2015)

Smart grid skills sets in demand	Drivers of demand
Design, installation and maintenance of PV systems (with battery storage capabilities in future)	• Smart grid enables higher penetration of solar • Large opportunities in commercial and industrial facilities emerge • Further movement of solar and batteries down cost curve compared to grid electricity • Moves from a specific skill for some contractors to a generalist skill of all contractors
AMI and smart meters installation and maintenance	• Contestability in metering services opens market to contractor competition • Promoted by electricity retailers through flexible tariff options • Around 8 million accumulation meters across Australia need upgrading
Customer services, energy auditing and advice/training – smart electricity services brokering	• Smart grid enables active consumers to search for home and business energy solutions • Complex smart electricity market confronts consumer • Contractors become trusted brokers of smart strategies and in-home training for consumers
Systems integration	• Smart grid enables complete home/facility smart energy management systems • Multiple devices need connection with data communications • Further movement of complete energy systems down cost curve • Smarter systems mandated in new construction and rebuild/retrofits
Instrumentation and control	• Building automation in industrial and commercial facilities increases • Smart home automation increases (already 1.2 million households in Australia are considering this service, 115 000 in the next 24 months) • Smart electricity systems and performance auditing all depend on automation, control and instrumentation • Moves from a specific skill for some contractors to a generalist skill of all contractors

8. Australian skills shortages and their relation to smart grids

Supplying the skills outlined above will be critical to ensure the full benefits of a smarter grid are achieved for industry, consumers and the wider Australian economy. Avoiding a scarcity of smart grid skills in future is therefore crucial. However, more systematic and primary empirical research into the future skills demand profile of the industry and the associated supply of workers is needed to accurately determine the 'if, when, where and why' elements of potential smart grid skills shortages.

Even before conducting a more in-depth analysis, though, several preliminary factors suggest a skills scarcity in future cannot be ruled out, especially for the distribution workforce. The skills profile of distribution businesses is predicted to become more specialised, more technical and more diversified in future. This is particularly likely as the demand for new expertise and roles in engineering, ICT and data analytics increases. Problematically, these skill areas and many associated occupations are either already in shortage in the wider Australian economy or have historically been faced with recruitment/hiring difficulties.

Both engineering and ICT professionals are often considered to be in shortage in Australia. For example, electrical engineers (including power systems engineers) have been in shortage for eight of the ten years from 2003 to 2013 (Department of Employment, 2014). For ICT, software engineers are also considered to be difficult to recruit across the entire economy in 2014 (Department of Employment, 2014b). Adding to this, a lack of technical expertise in data analytics has also recently been identified across Australian organisations (Telsyte Research in Kidman, 2014).

These emerging skill sets also exist in a context of decreasing participation in Science, Technology, Engineering and Mathematics (STEM) subjects in Australian high schools, universities and vocational education institutions. STEM skills are considered essential to the growing use and impact of information and communication technologies (like the smart grid) on Australian industries (AIG, 2013). A declining enrolment in STEM based disciplines and training could lead to skills shortages in future for a more technologically integrated electricity supply industry. Specifically, these STEM skills are considered essential to many of the distribution operator workforce occupations/skills likely to be impacted by a smarter grid (listed previously in Table 1) including

- Electrical Engineers (including Power Engineers)
- ICT Business and Systems Analysts
- Software and Applications Programmers
- Database and Systems Administrators
- Electricians; and
- Electrotechnology and Telecommunications Trades Workers

9. Introduction to the changes confronting the Australian electricity industry

The demand for the new skills outlined above has emerged from a complex pattern of trends and changes facing the wider electricity industry in Australia. These trends, from regulatory reform to disruptive technologies, are beginning to reshape the foundations of the industry. These changes are also unprecedented and imply a fundamental shift in how electricity is produced, distributed and consumed in Australia.

Although many forces brought about this reconfiguration, electricity use patterns and electricity prices played a decisive role. For the first time in Australia's history a decline in overall electricity use was recorded in 2009/10. It has continued to decrease each year since. Yet, over the same period, electricity prices have risen faster than ever before, often by 50 to 70 percent. This system is problematic because it distorts the true cost of providing electricity.

This price rise has occurred because, while overall use has declined, peak electricity demand has increased. Peak demand is the highest level of electricity required by the population at a single time point. It is also the key driver of this problematic system because peak demand is the true cost of providing electricity. A forecast of growing peak loads requires heavy capital investment in the network. This investment is used only to meet intermittent periods of high demand (sometimes only a few days per year), yet it constitutes the growing proportion of a power bill (up to 50 percent). The outcome is a distorted electricity market where consumers and businesses use less electricity overall but are required to pay increasing network costs to cover small periods of intense use.

As a result, political pressure for a better overall system is reconfiguring how the industry operates. An umbrella of regulatory reforms has been proposed via the *Power of Choice* and *Better Regulation* programs co-ordinated by the Australian Energy Market Commission (AEMC) and the Australian Energy Regulator (AER). These reforms aim for an electricity industry where non-network alternatives to peak demand are encouraged and electricity price better reflects the cost of providing the network. Tariff reform, smart meters, renewable energy systems and enabling the customer to participate in the electricity market (called 'demand side participation'), are central features of this reform package.

At the same time, consumer behaviour in response to rising electricity prices is also disrupting the conventional structure of the industry. More than one million customers now have rooftop solar PV systems and this is expected to increase in future. Solar PV is often considered a 'disruptive technology' which may partially restructure the industry. Centralised power supplied via one-way electricity distribution networks to a passive consumer base may be replaced by active 'prosumers' who generate their own electricity via solar PV systems and export this bi-directionally back to the grid. When combined with electricity battery storage and electric vehicles over the long-term, this shift from centralised to distributed generation is another key industry change.

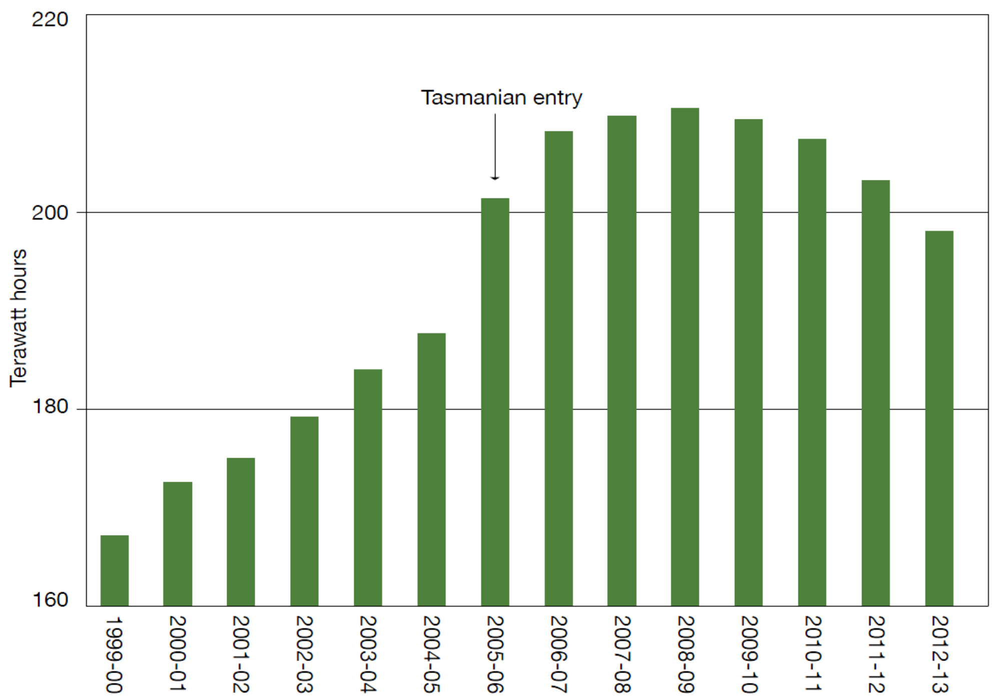
Finally, these changes are in themselves driving a wider need to develop a 'smarter' electricity grid. The current grid is over 100 years old and many of the above trends, like a high penetration of bi-directional PV systems and more customer involvement in the market, require additional grid capabilities. A smart grid then, defined as the progressive integration of new technologies and telecommunication capability on both the network-side and customer-side of the grid, may act as the overarching enabler of the patchwork of other changes confronting the industry.

10. Decreasing electricity use but increasing peak demand

A key assumption used to plan the electricity supply network for a modern nation like Australia is that electricity use will increase with economic growth (E-Oz, 2014). This assumption has been central to the delivery of Australia's electricity network since the 1990s.

However, an unprecedented decline in electricity use has occurred in Australia since 2009/10 (see Figure 2). Annual reductions across the National Electricity Market (NEM) of 1.7 percent have since been recorded (AER, 2013). Electricity demand forecasts over the short-run (to 2016/17) and long-run (to 2023/24) indicate a further decline or flattening of demand across most regions of the NEM (AEMO, 2014). This outlook suggests a structural rather than cyclical change to electricity use, with a low consumption profile considered the 'new normal' for the sector. Contributing factors include increased energy efficiency, changing consumer behaviour, increased solar PV penetration and structural economic shifts from manufacturing to services (E-Oz, 2014).

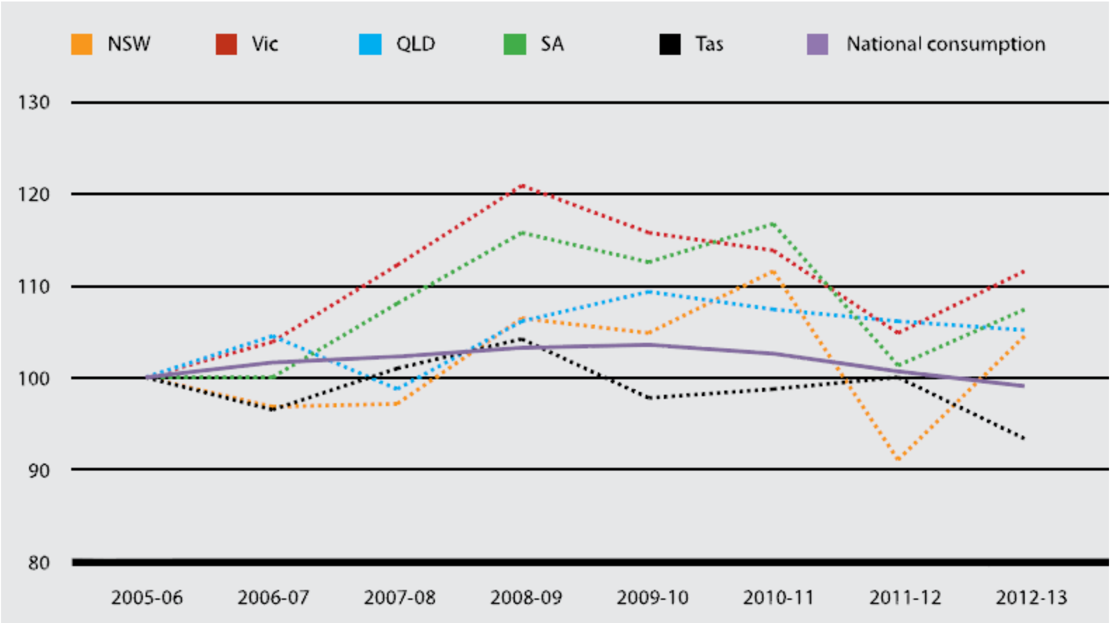
Figure 2: Decline in overall electricity consumption in the NEM (Source: E-Oz, 2014)



A second key assumption regarding electricity supply, that the amount of electricity required at peak times will increase as the economy grows, has not changed as rapidly. While electricity use has been declining, peak demand patterns have continued to grow on average since the 1990s (AER, 2013). As a result, peak demand started to outpace the rate of overall electricity use. For example, between 2005 and 2011, peak demand increased at a rate of approximately 1.8 percent a year, while total energy grew at 0.5 percent a year (AEMC, 2012).

With the exception of 2011/12, peak demand has continued to grow across the mainland regions of the NEM (see Figure 3). For example over the five years to 2013, average peak demand grew from five and 12 percent while consumption fell by 1 percent annually (ENA, 2014). Looking forward through to 2016/17 and 2023/24, although cycles in peak demand are predicted to slightly soften in future and annual growth equate to only 1 percent, a complete reversal of trends like those in electricity consumption is not predicted for peak demand (AEMO, 2014).

Figure 3: Growth in peak demand by NEM region 2005/06 to 2012/13 (Source: ENA, 2014)



As mentioned previously, peak demand is the highest instantaneous level of electricity required in a given period by the population (CSIRO, 2014). Extreme peaks typically occur on the hottest days of the year (especially heatwaves) when air conditioning and other energy-intensive technology use is at its maximum. These peaks then increase year on year as the penetration of air conditioning units and plug-in devices in homes and businesses increase.

This co-occurrence of decreasing electricity use but increasing peak demand is important in understanding why and how the electricity industry is changing. It is a requirement for Australia's electricity assets to be built and maintained to withstand this growing peak of expected instantaneous use. This industry-wide mandate ensures a secure and reliable electricity supply is available and blackouts avoided even in instances of uncharacteristically high usage (IBIS World, 2014).

Under this mandate, rising peak demand (rather than overall electricity use) has become the primary driver of capital investment in network capacity (AER, 2013). Although this is beneficial for electricity reliability, this requirement creates significant economic inefficiencies. Capital expenditure of $30.6 billion over the past five years has been required by distribution businesses to manage forecasted increases in peak demand (IBIS World, 2014). As a result, around one third of Australia's entire electricity network is only needed to meet peak events lasting less than 90 hours per year (IBIS World, 2014). One distribution business estimated that $11 billion in current infrastructure spending will only be required for five days per year (ENA, 2014).

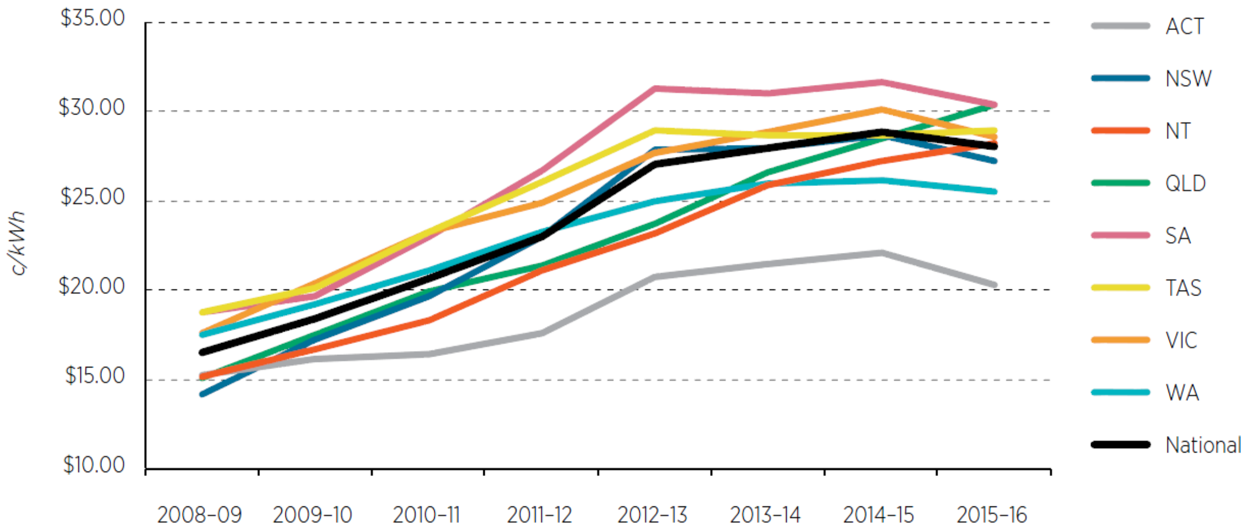
It is this inefficient arrangement that is steering the need for change and reform to the Australian electricity supply industry.

11. Increasing electricity prices

Further driving this need for industry reform is a system where the major costs of providing this network is passed onto consumers. Rapidly increasing electricity prices have occurred in recent years to meet forecasted growth in peak demand, even as aggregate electricity use declined.

As outlined in Figure 4, from 2009 to 2014 average household electricity prices across Australia increased by 50 to 70 percent, or from $970 to $1660 (Grattan Institute, 2014). This was higher than price rises in both Europe and North America over similar periods (APVA, 2013). This is puzzling and frustrating for consumers as electricity costs increase even though they "have done all they can to reduce their usage and save on their bill" (Ergon Energy, 2014a pp. 6).

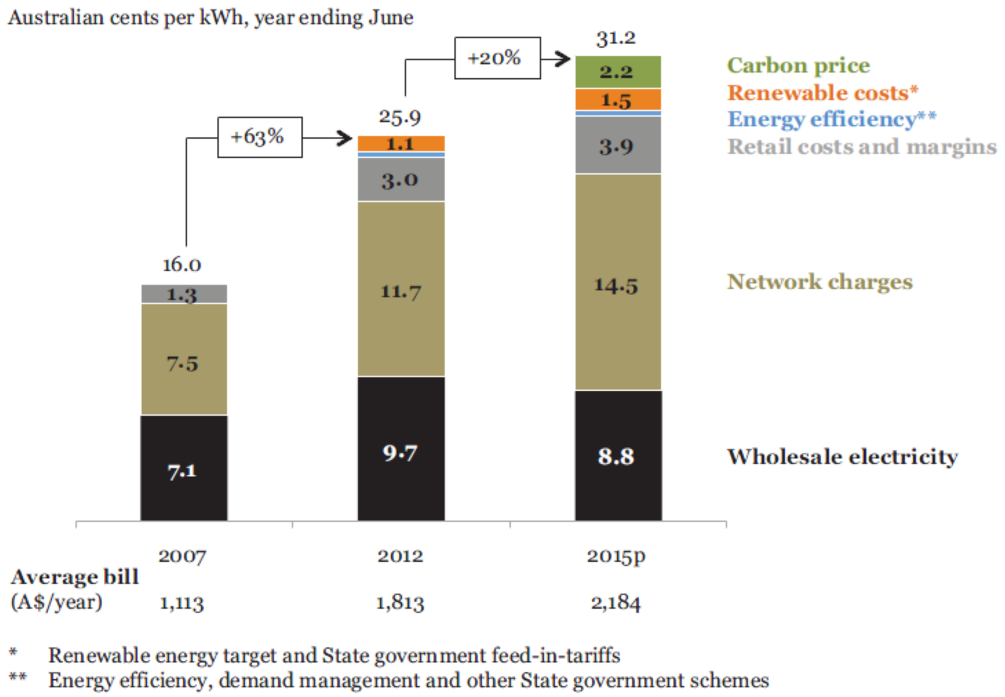
Figure 4: Trends in retail electricity prices by state and territory, 2008/09 to 2015/16 (Source: Department of Industry, 2014)



Briefly explaining the cause of this price increase can help further outline how and why the electricity industry is changing. Generally, the major components of an electricity bill are divided between the four electricity service sectors, including power generation (wholesale electricity), transmission, distribution and retail.

The largest share of an electricity bill comes from network tariff charges associated with the transmission and distribution of electricity (around 46 percent in Queensland, Ergon Energy 2014a). Distribution network tariffs are typically higher than transmission (ENA, 2014). The growth in the cost to provide this network has been the major cause of electricity price increases in Australia (AER, 2013). As detailed in Figure 5 below, the proportion of network tariff charges (represented as cents per kWh) has essentially doubled since 2007.

Figure 5: Australian retail electricity price increase by component (Source: CPD, 2013)



These network charges have increased because transmission and distribution businesses are the entities directly responsible for ensuring the network can withstand forecasted peaks in demand. This requires billions in capital expenditure to meet reliability standards and provide major network expansions for peak capacity (AER, 2013).

As these network businesses are regulated monopolies, the revenue returned via electricity prices must cover the costs of investment in this mandated network capacity. The heavy cost of managing peak demand is then passed through to consumers via higher electricity prices and tariff charge adjustments. In this context, even though consumers are using less electricity, the price of providing a network driven by peak demand growth means that electricity prices increase.

It is this outcome, and the need to stabilise electricity prices over the long-term, that is further driving change within the Australian electricity supply industry.

12. Changing industry regulations for demand side participation

In response, the past five years has seen a number of reviews and regulatory changes proposed for the industry. A total of 17 government reviews into rising electricity prices in Australia have been initiated since 2010 (Edis, 2014).

Across these reviews, the regulatory framework of managing peak demand via network-only investment has been identified as the key issue. Perverse regulatory incentives have also been identified, like passing costs onto consumers to match investment, being rewarded for undertaking costly expansions and having no direct requirement to explore non-network alternatives to peak demand management. According to these reviews this environment encourages 'gold plating' of the electricity network and drives unsustainable electricity price rises (AVPA, 2013).

As a result of these reviews an updated regulatory framework for the industry has been proposed and is being implemented. Specifically, this provides a framework that better incentivises alternative strategies to manage peak demand and encourages non-network alternatives to costly investment. These reforms aim to better enable the industry to manage a future of decreasing electricity use but increasing peak demand, without rapid price increases for consumers.

Although an analysis of all 17 government reviews of the electricity industry is beyond the scope of this paper, the following summarises the two most significant and wide ranging in terms of fundamental industry change. These are the *Power of Choice (PoC)* review and the *Better Regulations* reform program.

12.1. The Power of Choice review

The rationale of AEMC's (2012) PoC review was to identify an overarching regulatory framework that could help avoid costly investment in peak driven network upgrades.

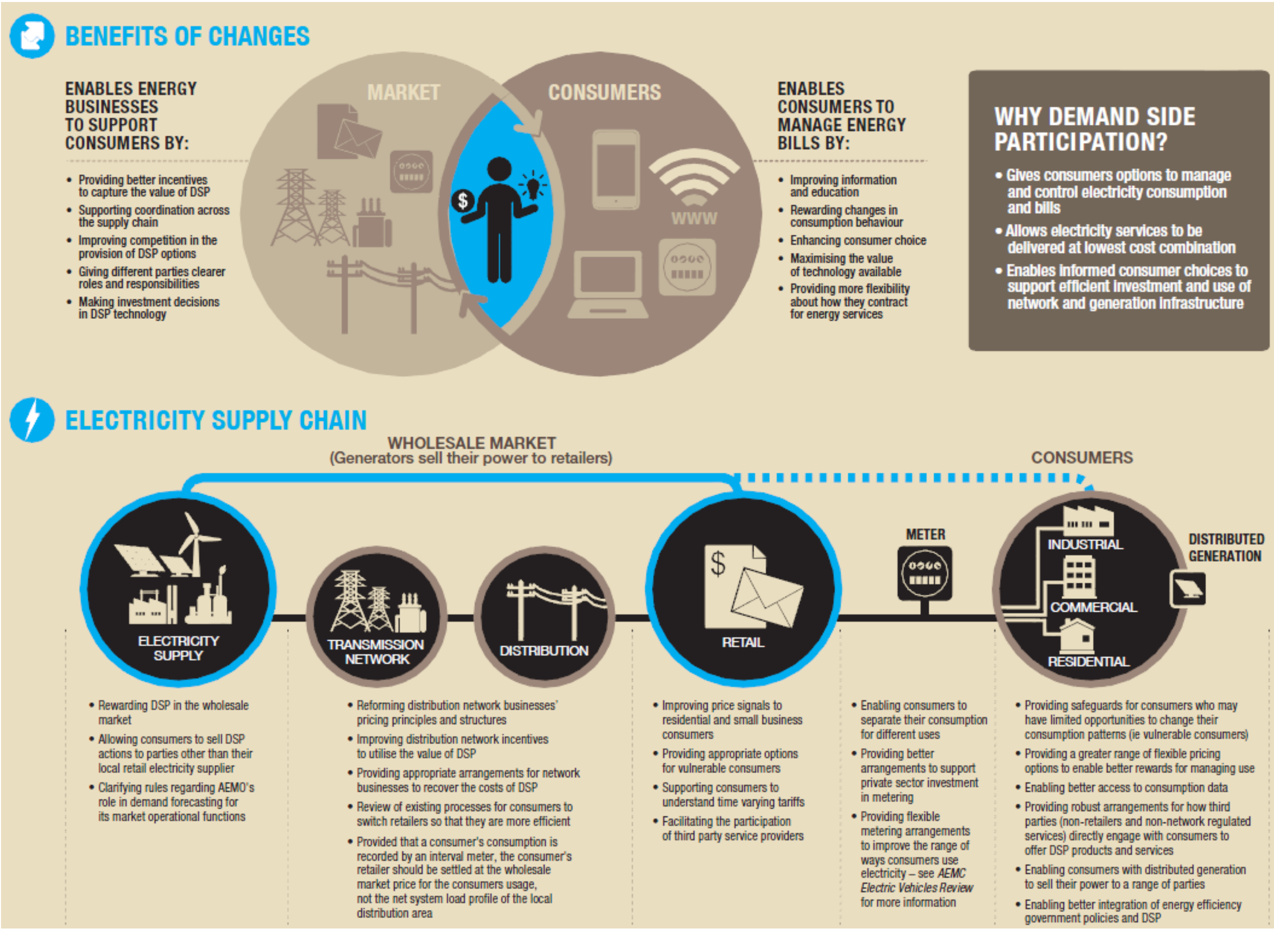
To achieve this, the fundamental problem identified within the existing electricity market was only supply-side strategies had been used to deal with growing peak electricity use. Supply-side strategies mean that only the providers of electricity, like transmission and distribution network operators, had been able to manage peak demand. Heavy investment in network expansions became the prioritised approach. The demand-side of the market (that is, the residential, commercial and industrial consumers that actually use electricity) had been overlooked as a strategic asset that may be collectively encouraged to reduce peaks.

The PoC review therefore identified demand-side strategies and direct consumer participation in the electricity market as the primary change required for a better industry. Labelled demand side participation (DSP) or demand management, this call for more customer involvement is likely to be the defining feature of Australia's future electricity sector. For example, the CSIRO (2014) *Future Grid Forum* suggests that introducing consumer choice and DSP (and the required changes to how the supply-side of the electricity market operates) will be the greatest transformation of the NEM over the coming years.

DSP is an integrative approach to electricity use and peak demand management. It connects the consumer with the electricity market and combines various strategies and market-based mechanisms to manage peak loads. For example, a DSP strategy may include new tariffs which reward customers for using less power at peak times combined with new technologies like smart metres needed to respond to these tariffs. A smarter grid that allows this meter data to be communicated in real-time between distribution business and customers would also be required. DSP strategies like these smooth out peaks in consumption thus avoiding the need for further infrastructure investment, and help to stabilise electricity prices over the long-term (Energetics, 2012).

Eight major DSP recommendations emerged from this review. These include allowing large consumers to directly participate in the wholesale market (called demand response), the phasing in of cost-reflective tariffs, creating a contestable market for advanced electricity meters, enabling access to consumption data, and providing incentives to distribution businesses to provide demand management solutions and connect embedded generation systems (e.g., solar PV). Figure 6 below further explains the overarching rational, objectives and recommendations of the PoC review.

Figure 6: Power of Choice recommendations and overview of proposed market changes (Source: AEMC, 2012)



Industry-wide uptake of each recommendation requires separate regulatory level rule changes to the entire NEM. Each recommendation necessitates a detailed procedure of rule change request, draft rule determination, public consultation and a final rule determination. Following final determination, the actual phase in period of rule changes to the NEM can take a number of years.

Consequently, a long-term and rolling DSP reform process is likely and may take five or more to be completely operational. Changing the electricity industry is therefore a long-term and ongoing progression. Table 3 outlines the eight recommendations and their rule change status as at February 2015.

Table 3: Power of Choice rule changes currently being considered by AEMC and their determination status (Source: AEMC, 2015)

Rule change request	Status
Customer access to information about their electricity consumption	Final determination published 6 November 2014
Distribution network pricing arrangements (tariff reform)	Final determination published 27 November 2014
Improving demand side participation information provided to the Australian Energy Market Operator (AEMO) by registered participants	Draft determination published 18 December 2014
Expanding competition in metering and related services (advanced metering)	Preparation of draft determination
Reform of the demand management and embedded generation connection incentive scheme	Rule change request received by AEMC. Expected to commence consultation in early 2015.
Demand response mechanism – option for demand side resources to participate in the wholesale electricity market	Council of Australian Governments (COAG) Energy Council officials developing rule change request.
Multiple trading relationships	Rule change request received by AEMC
Embedded Networks	Rule change request received by AEMC

Two of these recommendations, identified as driving fundamental change in the current electricity supply industry, are discussed further below.

12.2.Distribution Network Pricing Arrangements (Tariff Reform)

Reforming distribution network tariff pricing to better reflect the cost of electricity use was a key recommendation of the review. As previously mentioned, tariff charges have become the largest component of an electricity bill.

These charges are currently recovered via a flat tariff arrangement and a basic electricity meter (Energeia, 2014). Problematically however, this charge is determined by the volume of electricity consumed, rather than the time of consumption (IBIS World, 2014). Volume-based tariffs provide no incentive or price signals for consumers to avoid peak times. Peak demand therefore increases, triggering more network investment with costs passed onto consumers. Current tariffs therefore hide the true cost of providing electricity which is actually peak use and the investment required by distribution operators to withstand these peaks.

Cost-reflective tariffs have been proposed as the solution. These generally operate via the principle of Time-of-Use (ToU) which allows electricity prices to vary with the time of consumption (IBIS World, 2014). This enables higher charges for electricity during peak times and penalises users who place the most strain (and costs) on the network.

Consumers can therefore save money by moderating their peak usage and shifting consumption patterns toward off-peak periods. User pays principles, where price accurately reflects cost, is gradually integrated into the market via these distribution ToU tariffs. As peak use is penalised, demand in this period decreases, and the need for network investment is reduced. Electricity prices can then stabilise, with some forecasts suggesting 23 percent lower prices over the next two decades under cost-reflective type tariffs compared to current flat tariffs (ENA, 2014b; Energeia, 2014).

In November 2014, AEMC finalised a rule change to the electricity industry mandating phased introduction of cost-reflective ToU tariffs. Flat tariffs will be replaced by these ToU tariffs and phased in from 2017 (AEMC, 2014).

12.3. Expanding Competition in Metering and Related Services (Advanced Metering)

Reforming electricity meters and metering services is another key recommendation of the review. This is required because ToU type tariffs cannot be implemented across the market without the installation of advanced metering infrastructure.

Most meters in Australia do not currently have ToU capacity. A large proportion of consumers, from 70 to 88 percent, have simple accumulation meters (ENA, 2014b; SCER 2013). Basic accumulation meters record the total consumption of electricity at the connection point but not the time of use (IBIS World, 2014). Only advanced metering technology like interval and smart meters can measure usage times. Tariff reform therefore depends on an almost Australia-wide deployment of advanced electricity meters.

However, existing regulation may prohibit the contestability necessary for the development of the advanced metering market which could in-turn offer affordable smart metering products and services to this consumer base (ENA, 2014b; SCER, 2013). Enabling this market is important because government mandated roll-outs of smart meters, like the process in Victoria from 2010 to 2014, are unlikely in the remaining states in the NEM.

To remove this barrier the AMEC (2014b) is currently considering a rule change request to metering services across the NEM. This rule change would expand the competition in metering services and allow customers to engage directly with metering service providers and third-party electrical business that are qualified to provide these products. Final determination of this rule is expected on July 2 2015.

12.4. Better Regulations Program

The *Better Regulations* program was initiated via major amendments to the National Electricity Rules (NER) in November 2012 (AER, 2013). Although it applies more specifically to the rules governing monopoly transmission and distribution network operators, it further attempts to minimise network-only investment for peak demand and help stabilise electricity prices. This program also includes a work stream dedicated to ensuring all network operators exploring DSP strategies.

Previous rules were criticised by the regulator (the AER) due to an inability to sufficiently interrogate the five-year investment plans of these network businesses. According to the AER, minimal scope was available to amend forecasts, include consumer advocacy groups, question investment decisions and explore demand side alternatives (AEMC, 2012b).

The new rules aim to realign the governance arrangements between the AER and transmission and distribution network operators. Broadly, it transfers power back to the AER and provides new tools to scrutinise and amend various aspects of the five-year regulatory proposals.

For network operators the changes alter certain business practices. These include, increased transparency of investment plans, requirements around customer engagement and demand-side management are required. Regulatory investment tests for both transmission and distribution are also required to demonstrate all options, like DSP, have been considered prior to network-only expansion (AER, 2013). All distribution operators are obliged to undertake a *Demand Side Engagement Strategy* exploring non-network alternatives and DSP options to electricity management in the planning and investment process (AEMC, 2012c).

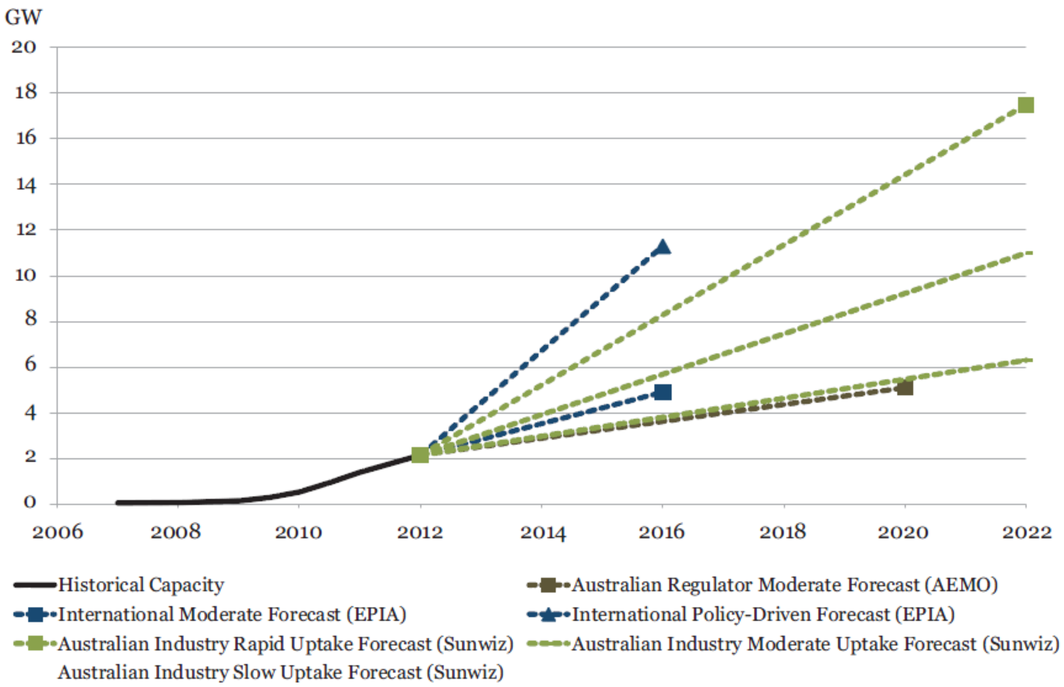
These new guidelines will apply first to five-year regulatory proposals for network businesses beginning in 2015. This includes both the distribution network operators of Ergon and Energex in Queensland who have recently submitted their 2015-2020 regulatory proposals to the AER.

13. Solar PV and the distributed market

The rapid uptake of rooftop solar PV systems over the past five years is another unprecedented change reshaping the electricity supply industry in Australia. This has occurred alongside increasing electricity prices, peak driven investment and the regulatory reforms described above.

Recent figures from the ABS (2014) indicate that 14 percent of Australian households now use small scale PV (less than 100kWs) to generate electricity. In total, this means more than one million solar PV systems have been installed in Australia. Remarkably, this has grown from a base of only 8,000 in 2007. Forward estimates suggest penetration rates may double by 2020 with significant scope for installation in commercial and industrial facilities (CPD, 2013). Figure 7 below provides a further series of forecasts and scenarios detailing the future market uptake of solar PV in Australia.

Figure 7: Total installed capacity of rooftop solar in Australia, history and forecasts (Source: CPD, 2013)



Queensland and South Australia report the strongest growth in PV systems. Queensland has the highest total installations with 322,497 (APVA, 2013b). Around 16 percent of Queensland households, or one in six, now have solar energy systems (Ergon Energy, 2014b). Looking forward, an estimated 15 percent are planning to buy or install more solar PV in the following two years (Ergon Energy, 2014b). South Australia has also experienced rapid growth having the highest market penetration of solar panels in Australia at 17.4 percent (APVA, 2013b).

A convergence of factors underpins this growth. Rising electricity prices and subsidies have encouraged customers to reduce their reliance on grid-only power (AER, 2013). The cost-effectiveness of PV products when compared to the grid, called 'grid parity', has also improved. Rising concerns about climate change and interest in renewable energy solutions has also increased (CSIRO, 2014).

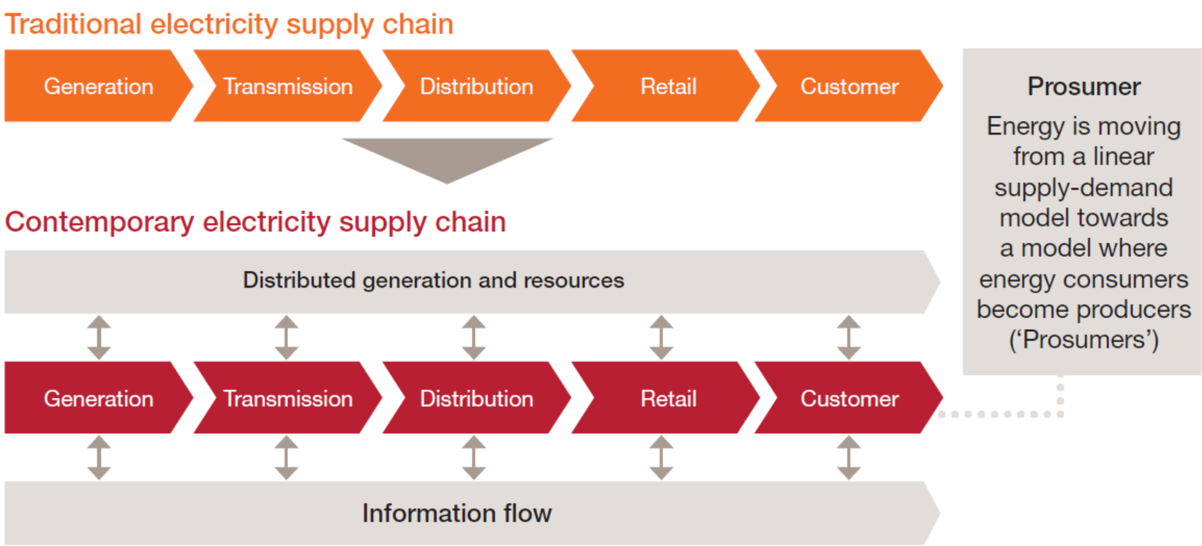
This continued boom in solar PV systems is set to reshape the electricity industry, particularly as it co-occurs with the larger regulatory shift towards the demand-side of the market. The electricity supply industry has traditionally operated along a predictable and linear value chain. Electricity is generated at centralised power stations and transported one-way along transmission and distribution networks. Predictable increases in consumption and a relatively passive consumer base mean competition and threats to this market structure were generally low.

PV systems disrupt these industry norms by creating a distributed generation structure as opposed to centralised generation (see Figure 8). PV achieves this by transforming the role of passive consumers into more active producers/consumers of electricity (the so-called 'prosumer') (PwC, 2014).

Prosumers can both consume electricity and export surplus power bi-directionally back to the grid. This allows the prosumer market to operate alongside (and even compete) with network service providers and centralised power generators. A more integrated, yet complex, electricity supply chain and industry structure emerges.

Under these conditions, distribution network operators may no longer be able to control or predict the electricity requirements of the value chain, and may take on new service roles and organisational strategies within a changing industry. For example, new commercial opportunities may emerge which focus on providing prosumers and other customers with tailored energy solutions which bundle together the sale and management of electricity in new and diverse ways. The role of distribution network operators in the industry may therefore expand to become 'energy enablers' as well as 'electricity providers' (PwC, 2014).

Figure 8: Comparing the traditional and emerging electricity industry supply chain (Source: PwC, 2014)

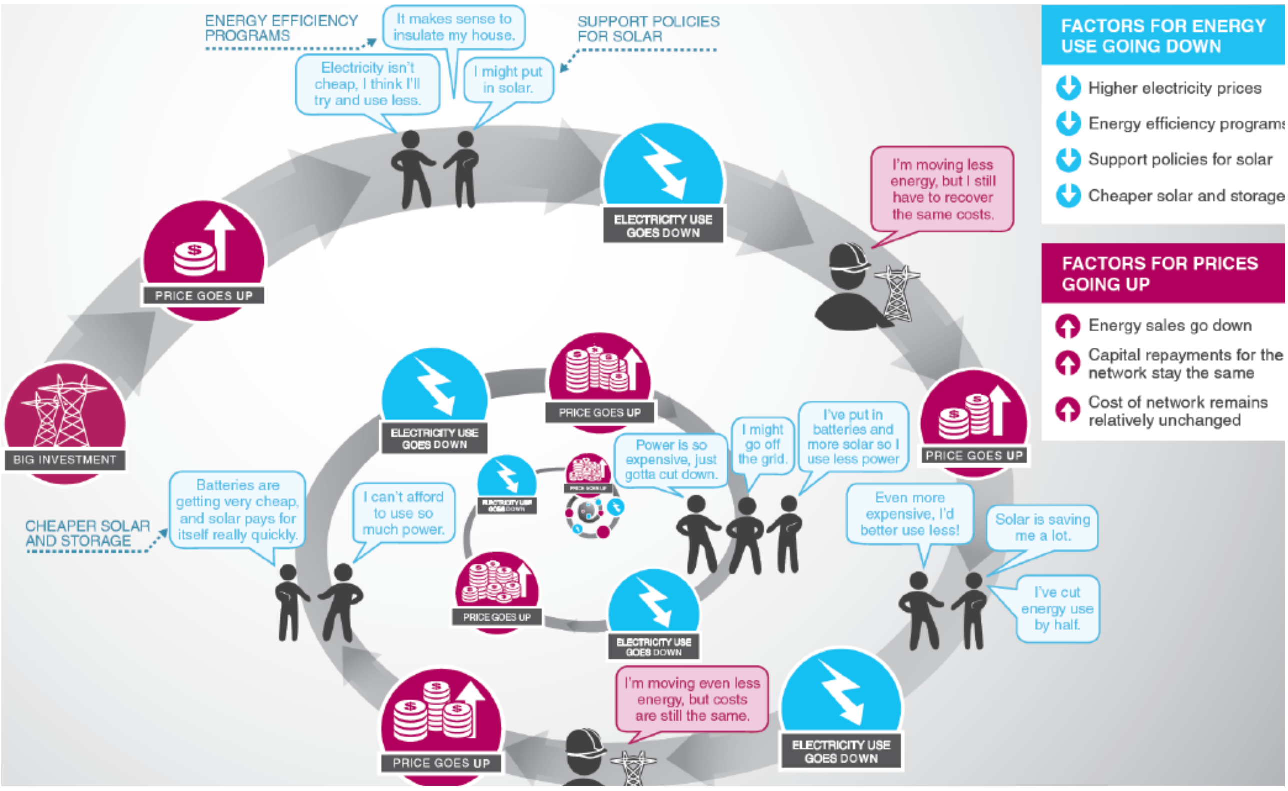


As well as disrupting industry structures, distributed generation and increased PV system penetration also requires significant engineering upgrades and re-design of the grid. The current grid was designed for one-way electricity transportation, from generation plants to consumer premises. Increased PV systems on this network can have adverse technical impacts including voltage spikes, involuntary switching and interference with consumer appliances (Ergon Energy, 2014b). Higher levels of distributed generation therefore require the development of bi-directional networks and the two-way supply of electricity (Ergon Energy, 2014b). Creating a smarter network (discussed in the next section) may be required to enable these functions, including automated voltage management, telecommunication sensors along the grid to gather network performance data, and better remote operations capabilities in control centres to manage and act upon this data.

13.1. The electricity network death spiral

An extreme, yet common, impact that the rapidly growing trend in PV penetration could have on the electricity industry has been labelled the 'electricity network death spiral' (APVA, 2013). Figure 9 describes this scenario. Firstly, substantial network investment and price rises occur. In response, market side PV and (eventually) electricity storage batteries become economically feasible alternatives to the grid. These allow some consumers to disconnect from the network. Those remaining then have to pay more for electricity, thus leading them to invest in PV and battery solutions and also exit the grid. PV and batteries eventually supersedes the role of network operators as the primary providers of electricity. These operates cannot compete with prosumers equipped with PV and storage options, and eventually network businesses become obsolete.

Figure 9: The electricity network death spiral of rising prices and falling use (Source: ISF, 2014)



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There is a growing consensus that the 'death spiral' is a real, yet distant, issue for the industry in Australia (Winestock, 2014). Complete PV and battery storage packages, which are required to leave the grid completely, are not expected to be cost-competitive until 2025 to 2030 (CSIRO, 2014). Moreover, the current PoC reforms being implemented to lower future electricity prices, mainly via tariff reform and advanced meters, are seen as essential to avoid this spiral.

In summary, even though current reforms can offset a complete 'death spiral', the forecast growth of PV and eventually storage is still likely to fundamentally transform traditional industry structures from a centralised to a more distributed model and also require the development of a smarter grid that can better manage bi-directional network usage.

14. The need for a smarter electricity grid

This paper has so far demonstrated that the Australian electricity supply industry is changing in multiple ways. New technologies, like smart meters and PV systems, are emerging. More customer involvement in the industry, via DSP, prosumer markets and ToU tariffs, is likely in future. For distribution network operators, the need for a bi-directional grid, energy enabling services and a focus on non-network alternatives to asset expansion is also evolving.

A contestable market for advanced metering services and smart products is also likely in the near future. Looking further forward, advanced technologies like smart appliances, automated home/business energy systems, energy storage and electric vehicles are predicted.

The progressive development of a 'smarter' and more modernised electricity grid may therefore be needed to enable and integrate this patchwork of changes. Australia's current power grid is now over 100 years old (Origin Energy, 2014). Both transmission and distribution networks were built to service a centralised and predictable electricity demand profile with limited consumer involvement. Growing peaks but lower overall use, two-way PV systems and advanced metering infrastructure were unforeseen parameters of conventional grid design.

These new trends may be better addressed via the development of an integrated smart grid or intelligent network. Indeed, all Australian electricity operators are now involved in the implementation of smart grids and smarter technologies to some degree (Budde, 2014). Defining a smart grid, however, can be difficult, and there is no standard approach or framework for deployment.

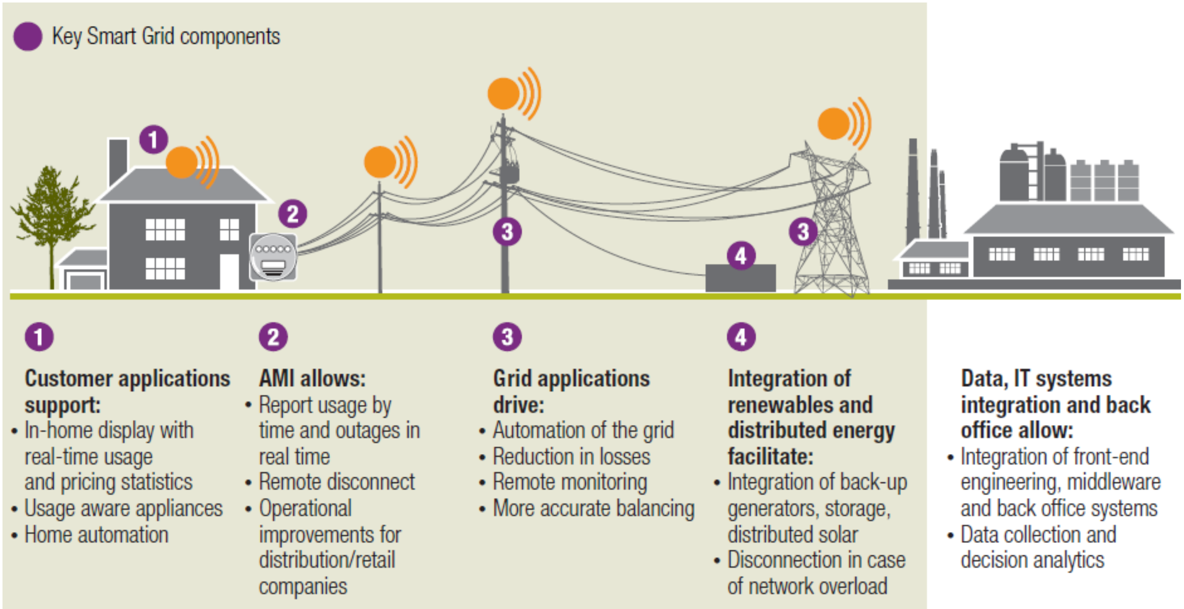
Most simply, a smart grid is the overlay of advanced telecommunications, automation, sensing and intelligent metering infrastructure (including smart meters) onto the existing electricity grid (Ausgrid, 2014). It is an entire, yet gradual, upgrade of the current system with modifications on both the supply-side and demand-side of the network. Table 4 below compares conventional grid capabilities to those of a smart grid.

Table 4: Fundamental characteristics of conventional electricity grids and smart electricity grids (Source: Agelidis, 2011)

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

This upgrade slowly creates a completely computerised grid. Specifically, an electricity network connected and communication-enabled via wireless telecommunications technology, driven by the optimisation of extremely high amounts of real-time data collected at multiple points, heavy with system automation and IT capabilities, and characterised by the integration of individual 'smart' home/business Energy Management Systems (EMS) and Advanced Metering Infrastructure (AMI) along the customer side of the market (COE, 2012). The Figure 10 schematic below further outlines these key smart grid segments and capabilities for transmission, distribution and customer sections of the industry.

Figure 10: Major smart grid segments and functions across transmission, distribution and customer environments (Source: McKinsey, 2010)



A smarter grid therefore better suits the range of products, services and market trends appearing in the industry. For example, smart meters are typically considered the first customer-side step towards developing a smarter grid. Smart meters allow two way communication between customers and distribution network operators, facilitating the uptake of DSP strategies. Customers can then manage their electricity consumption via real-time data and respond to cost-reflective tariffs signals.

Eventually the use of other smart appliances and home/building EMS can be integrated and automated with these meters. Smart grids therefore empower consumers to actively participate in the electricity market and undertake non-network peak demand management. New commercial opportunities to provide these 'smarter' electricity products and automation services are also opened.

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

These technologies, like Active Volt-Var Control (AVVC) and Fault Detection, Isolation and Restoration units (FDIR), may include sensors and monitors to detect faults and automatically re-route supply, manage voltage spike of PV systems and identify infrastructure requiring maintenance (ANAO, 2014; Ausgrid, 2014). In recent modelling trials, grid-side smart technology enabled up to 100 percent penetration of PV systems, compared to a 40 percent maximum of the current grid (Ausgrid, 2014).

The overlay of telecommunications and back-end IT systems capacity can also help monitor and maintain grid stability and facilitate an exponentially higher volume of data to transmission and distribution control centres regarding customer use patterns and overall grid performance. PwC (2014), for instance, estimate that 160 billion data points could be produced annually via a smart grid.

Substantial progress and commitment has already been made within the industry in relation to the deployment of smart technologies that, over time, will create a smart national grid (Budde, 2014). Ergon Energy (2014a), for example, is investing in real-time data capabilities, telecommunications infrastructure and a fully integrated network operations centre to deal with the amount of data generated by these smarter network initiatives. Similarly, South Australian Power Networks (2014) plans to rollout smart ready meters as the standard for customers and develop systems to manage the exponential increase in real-time network and customer data. Strategies like these suggest a smarter grid will slowly emerge in Australia.

In addition, the *Smart Grid, Smart City* trials (which piloted a range of both grid-side and customer-side smart grid technologies) provides a strong business case for transitioning to a national smart grid. A cost benefit assessment of the overall program revealed that smart grid technologies could offset $28 billion of investment planned for Australia's electricity system over the next two decades (Ausgrid, 2014; Department of Industry, 2014) and reduce network charges by 13 percent (Ausgrid, 2014; Department of Industry, 2014).

And despite some consumer resistance to mandated smart meter deployment in Victoria and the lack of national strategy for grid modernisation, all Australian distribution operators are now involved in the implementation of smart grids (Budde, 2014). However, developing and optimising a smarter grid, like the rule changes of the PoC reforms, may take a decade or more to complete (Budde, 2014). Figure 11 (see following page) brings together a range of forecasts and research conducted within the Australian electricity supply industry to display potential timeframes for the deployment of common smart grid technologies.

Figure 11: Road map of smart grid technology deployment across Australia (Source: Energy Skills Queensland analysis, 2015)

Customer applications	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Time of Use Tariffs						Phased in										
Smart Meters*					6 million					8 million					9 million	
Solar PV Systems						30% residential								60% residential		
Energy Management Systems†														60% residential (fast adoption)		
Energy Storage α														20% consumers (steady adoption)		
Electric Vehicles α														5% new cars (slow adoption)		
Grid applications‡																
Real-time Volt Var Control				Early adopters/trials							Wider deployment as business case improves					Steady adoption
Distributed automation				Early adopters/trials							Wider deployment as business case improves					Steady adoption
Fault Detection (FDIR) units				Early adopters/trials							Wider deployment as business case improves					Steady adoption

*Under a customer led rollout scenario which includes meters already installed in Victoria (Ausgrid, 2014)

† Growth expected primarily in new buildings (South Australia Power Networks, 2013)

α Significant technology advancement may increase uptake above forecast

‡ According the Ausgrid (2014), network wide uptake of grid applications is not likely until the 2019/20 to 2024/25 five year regulatory period

15. Conclusion and next steps

The way electricity is produced, distributed and consumed in Australia is clearly transforming. With this transformation comes the demand for new skills, new workforce capabilities and the search for new talent. A smarter grid appears to be a major component of the industry's future, and also a key driver of the types of skills and workforce capacity required. However, the more precise workforce impacts at a whole-of-industry level remain relatively unknown.

This discussion paper has therefore begun the process of determining the type of skills and workforce capacity likely to be needed by the electricity industry over the coming years. As mentioned throughout, however, this is only a first "look" at the small amount of research already available in this area. Findings reveal that fundamental shifts in skillsets and workforce changes are indeed likely to occur and many of these are in highly technical areas that may be in shortage.

Perhaps the most significant finding though is the need for more workforce planning and skilling research to be undertaken in this area both across industry and within different workforce groups and stakeholder organisations. Given the fundamental and disruptive changes to the industry – now is the time for this primary research to begin. This paper therefore sits as the first step in this process and aims to become a starter platform for feedback, deeper industry involvement and more detailed workforce planning. Deeper engagement would brings more refined analysis to these questions and more accurately determine the 'if, when, where, who and why' elements of potential skills shortages and strategies for their avoidance.

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Glossary

Accumulation meter	Track only the total accumulated volume of electricity usage. Charges are based on the amount of electricity used, regardless of the time. Requires a manual meter reader to access property. Also known as Flat Rate Meters or basic electricity meters
Active Volt-Var Control (AVVC) unit	Automated voltage regulating and reactive power controls to measure and maintain acceptable voltages and high power factor at all points in the distribution network under varying load conditions. Part of the *Smart Grid, Smart City* Program
Advanced Metering Infrastructure (AMI)	AMI is an integrated system of smart meters, communications networks, and data management systems that enables two-way communication between utilities and customers
Australian Energy Market Operator (AEMO)	The AEMO delivers an array of gas and electricity market, operational, development and planning functions. It manages the National Electricity Market (NEM) and the Victorian gas transmission network. AEMO also facilitates electricity and gas full retail contestability, overseeing these retail markets in eastern and southern Australia
Australian Energy Regulator (AER)	The AER is the economic regulator for transmission and distribution services in Australia's national electricity market (NEM). AER is an independent statutory authority, funded by the Australian Government. AER's powers and functions are set out in the National Electricity Law and National Electricity Rules
Australian Energy Market Commission (AEMC)	The rule maker for Australian electricity and gas markets. The AEMC make and amend the National Electricity Rules, National Gas Rules and National Energy Retail Rules. Also provides market development advice to governments
Big data	High-volume, high-speed and diverse modes of information that require advanced analytical techniques to organise, interpret and process
Cloud computing	Enables on-demand and convenient access to computing resources including but not limited to data storage and application services. These services are usually sourced by enterprises from external service providers and are located off premises. Cloud computing can result in savings for enterprises as it enables outsourcing of specialised expertise across a diversity of ICT needs
Cyber security	Cybersecurity is the body of technologies, processes and practices designed to protect networks, computers, programs and data from attack, damage or unauthorized access. In a computing context, the term security implies cybersecurity
Data Analytics	Analysis of internally generated and publicly available data and information to predict outcomes and identify trends
Demand response	Demand response is a voluntary electricity program that compensates consumers for reducing their electricity use, when requested by an electricity retailer during periods of peak demand, high power prices or when the reliability of the grid is threatened. Demand response is a type of demand side participation (DSP)
Demand side participation (DSP)	The ability of consumers to make decisions regarding the quantity and timing of their energy consumption which reflects their value of the supply and delivery of electricity
Distribution network operators	Australia’s electricity supply industry involves four sectors— generation, transmission, distribution and retail. A distribution network operator provides the infrastructure (the ‘poles and wires’) to deliver low-voltage electricity to consumers. The *Smart Grid, Smart City* Program was delivered by a distribution network operator. In Queensland, Energex and Ergon Energy are the distribution network operators
Energy Management System (EMS)	An EMS is a computer system which is designed specifically for the automated control and monitoring of those electromechanical facilities in a building which yield significant energy consumption such as heating, ventilation and lighting installations. The scope may span from a single residential dwelling/building to a group of buildings such as university campuses, office buildings, retail stores networks or factories. Most EMS provide facilities for the reading of electricity, gas and water meters

Fault Detection, Isolation Restoration (FDIR) unit	Automation technologies used to quickly and precisely detect fault conditions, isolate faulty equipment and restore power to customers by operating remotely controlled switches. Part of the *Smart Grid, Smart City* Program
Information and Communication Technology (ICT)	ICT is an umbrella term that includes any communication device or application, encompassing: radio, television, cellular phones, computer and network hardware and software, satellite systems and so on, as well as the various services and applications associated with them, such as videoconferencing and distance learning
Information Technology (IT)	IT is the application of computers and telecommunications equipment to store, retrieve, transmit and manipulate data, often in the context of a business or other enterprise
Interval meter	An interval meter records energy use over short intervals, typically every 30 minutes. Like accumulation meters, a manual meter reader must is required for billing. The advantage of interval meters over accumulation meters is that, by measuring when as well as how much energy is used, they allow retailers to offer prices and deals based ToU tariff pricing
National Electricity Market (NEM)	The NEM is the wholesale electricity market for the electrically connected states and territories of eastern and southern Australia – Queensland, New South Wales, the Australian Capital Territory, Victoria, South Australia and Tasmania. The NEM generates around 200 terawatt hours of electricity annually, supplying around 80% of Australia's electricity consumption
National Electricity Rules	The National Electricity Rules govern the operation of the National Electricity Market. The Rules have the force of law, and are made under the National Electricity Law. These rules are made and amended by the AEMC
Operational Technology (OT)	OT represents a broad category of components that utilities depend on for safe and reliable generation and delivery of energy. OT encompasses operating gear, from oil circuit breakers and sectionalises to solid-state relays, and many devices in between. OT also often includes control room applications, such as supervisory control and data acquisition (SCADA) systems that monitor the network, reaching out to devices as complex as substation gateways, or as simple as sensors (Schneider Electric, 2013)
Prosumer	Customers with the ability to generate/produce and store their own electricity
Smart Grid	A smart grid combines advanced communication, sensing and metering infrastructure (including smart meters) with the existing electricity network. A smart grid can improve the reliability of electricity services for distribution network operators and consumers by identifying and resolving faults on the electricity grid, better managing voltage and identifying infrastructure that requires maintenance. Smart grids also have the potential to assist consumers in managing their individual electricity consumption by providing real-time information on electricity use, and enabling the use of 'smart appliances' that can be programmed to operate on off-peak power
Smart Meter	A smart meter is an electronic electricity meter that measures electricity use continuously and records consumption on a half hourly basis. Smart meters also have communication capabilities and can provide close to real-time information on electricity consumption, both to the consumer (through feedback technologies such as an internet portal or smartphone application), and to the electricity provider. A traditional electricity meter measures total electricity use, with regular manual readings by the distribution company to calculate consumption (usually over a three-month period)
Time of use (ToU) tariff pricing	ToU tariff pricing is a method of pricing electricity depending on the time of day it used. This reflects the different costs of generating and distributing electricity throughout the day. To access TOU pricing, consumers must have a smart meter or an interval meter (which records use in half-hour intervals, but does not have the communications capacity of smart meters) installed at home

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