



Strategic Assessment of Network Regulation

Scenarios

February 2015

The Electricity Sector in 2035

INTRODUCTION

Electricity markets across Australia are undergoing a period of substantial change in relation to the way electricity is produced and consumed. Declining consumption and increasing uptake of distributed generation are likely to have significant implications for the future. In response to these trends, the Council of Australian Governments Energy Council (the Energy Council) has tasked officials with stress testing the economic regulatory framework using plausible scenarios that may emerge in twenty years. Officials will then provide advice to Ministers on whether further work on the network regulatory policies is required. This advice will include identifying and assessing:

- potential challenges to, and risks facing, Australian electricity networks over the next two decades; and
- any implications for the economic regulatory framework governing electricity network infrastructure.

The Network Strategy Working Group (NSWG) was established to identify and develop credible scenarios for stress testing the economic regulatory framework that governs network infrastructure. The NSWG held a two-day workshop in October 2014 which included presentations from members of an external reference group, including the Commonwealth Scientific and Industrial Research Organisation (CSIRO), the Australian Energy Market Commission (AEMC) and network business organisations.

In developing these scenarios, the NSWG has drawn on a range of relevant work, particularly the CSIRO-led Future Grid Forum (FGF) scenarios. With a twenty year rather than fifty year focus, various assumptions from the FGF modelling were modified to better reflect the required end point and provide broad guidance to the NSWG in framing its scenarios. A list of the references that have informed these scenarios can be found in Appendix One.

Engaging and incorporating input from a reference group of industry participants and stakeholders with substantial knowledge of energy market issues was critical to the finalisation of these scenarios. Appendix Two provides a list of the reference group members. A second workshop was held in late November 2014 to seek the reference group's input on the scenarios. The outcomes of the workshop were summarised and circulated to the reference group for further comment and, where appropriate, this input has been reflected in the final versions of the scenarios.

This document details the four scenarios, including the most relevant attributes and assumptions for each. The scenarios present possible versions of the future rather than likely versions. They have been deliberately crafted to push the boundaries and ensure the key drivers in each are sufficiently different to provide the broadest context for the follow-on task of stress testing the regulatory framework.

The focal question below will be used for the stress testing exercise.

Is the economic regulatory framework for setting electricity network revenues¹ sufficiently flexible and adaptable to adjust to, and keep pace with, a range of plausible changes in the electricity market over the next 20 years and deliver outcomes that promote efficient investment in, and use of, electricity network services for the long term interests of consumers in relation to price, quality, safety, reliability and security of supply?

¹ *The economic regulatory framework for networks* means the sections of the National Electricity Law that relate to the economic regulation of electricity transmission and distribution networks (including the revenue and pricing principles); chapters 6 and 6A of the National Electricity Rules (as amended by rule changes that have been recently completed or are currently under consideration by the AEMC, including those related to distribution network pricing, competition in metering and the demand management incentive scheme); and networks ring-fencing arrangements (either under jurisdictional instruments or the AER's power to develop national ring-fencing guidelines). The RiT-T and RiT-D requirements in chapter 5 of the Rules have been left outside the scope for stress-testing, however stakeholders are able to raise any potential RIT barriers with the NSWG to investigate separately.

THE FOUR SCENARIOS

Scenarios at a glance

For the purposes of this analysis, the economic regulatory framework has remained relatively static and reflects the rules and requirements that are assumed to be in place in late 2015, incorporating current reforms to distribution network pricing, competition in metering and demand management. Retail price monitoring has largely replaced retail price regulation.

	SCENARIO 1	SCENARIO 2	SCENARIO 3	SCENARIO 4
	Networks business models evolve	New consumer choices drive an evolution	Centralised to localised	Government policy drives outcomes
Consumer services	High level of smart meters, low level customer engagement Dominance of network led services based around 'smart' technologies and demand management	Empowered consumers look to a range of managed options for co-optimising electricity services and prices, including grid-connected on-site generation and storage	Large shift by consumers to distributed sources of energy, both on and off-grid, particularly at community level	Renewables based grid supply dominates but rising prices bring about a range of energy efficient options
Commercial and Industrial	Some industrial businesses move offshore or scale back operations as a result of high gas prices	Consumers remain connected and largely grid reliant Some consumers look to energy service providers for options to lower prices Some fuel substitution due to rising gas prices	Large industrial users remain connected, but look to more energy efficiency options	Industrial users suffer higher prices Some industry participants respond to incentives to implement renewables

	SCENARIO 1	SCENARIO 2	SCENARIO 3	SCENARIO 4
Alternative services	Network providers dominate the provision of alternative services	Prevalence of energy service providers and alternative business models	Micro-grids, as well as individual generation and storage deployment	Incentives for local scale uptake of renewables to grow precinct-scale generation projects
Gas prices	High	Medium and rising	Medium and rising	High
Wholesale market	Some centralised gas-fired generation replaced by large-scale renewable generation	Provides significantly lower proportion of household load as a result of off-grid options Commercial and industrial sectors, as well as hybrid and electric vehicle (EV) load sustain the wholesale market	Substantially less demand being met through the wholesale market	Smaller number of generators competing for dispatch While some base load plants remain, almost all intermediate generators are decommissioned
Transmission networks	Affected by increased distributed generation and loss of industrial load Primarily serve large generators	Maintained to meet reliability standards	Required to transport electricity across the range of options being offered	Investment required due to the introduction of further renewable sources. Greater intermittent generation capacity to be managed.=
Distribution networks	Actively manage peak demand and invest in new technologies to support new product offerings	Consumers remain connected to the grid. Products and tariffs reflect value of connection Distributors focus on managing network reliability and security and maximising the revenue that they can earn from the existing network.	Used as back up for localised generation and for transferring electricity between customers and producers still connected to the grid Costs per unit of energy consumed are high due to inefficient use of capital and loss of economies of scale	Impacted by the need to manage less predictable energy flows due to intermittency of renewables

Scenario 1 – Network business models evolve

2035 in context

Australian governments, through their reforms, have worked to address rising electricity prices and achieve greater pricing stability. Increases in gas prices have reduced its use in centralised generation and for industrial processes. Some large industrial users have been prompted to move their operations overseas. Some domestic users have also responded to the relatively higher gas price increases by switching appliances back to electricity and gas network expansion has halted.

Network distribution businesses have diversified their investments to maintain market share given the emergence of new entrants offering alternative services based on new technologies.

Networks manage demand

Network businesses embrace opportunities resulting from the finalisation of current reforms and respond quickly to the opportunities presented by emerging technologies. The incentive framework is operating effectively, with network businesses implementing efficient demand management options.

The introduction of contestable metering results in the uptake of advanced metering, and distribution businesses are able to make significant adjustments to network tariffs to reflect the cost of providing services.

Network businesses are strongly incentivised to participate on the demand side and have attempted to mobilise their business to capture value. Consumers have embraced options from distribution businesses, rather than retailers, to manage their demand to minimise energy costs.

The initiatives implemented by network businesses have resulted in aggregate network utilisation stabilising as initiatives to reduce peak demand take effect.

Consumer services

Cost reflective electricity prices, particularly in peak periods, and declining costs of new technologies incentivise an uptake of electricity products and services.

There is a high level deployment of smart technologies, including smart meters and batteries. However, the majority of consumers still do not engage with the information they provide. Small consumers

Key attributes

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Connection to the distribution network remains common but throughput is lower.

30 per cent of household load and 15 per cent of business load is met through distributed generation due to a continued trend for consumers to install rooftop solar photovoltaics (PV).

Distribution network businesses are investing in distributed generation and storage to achieve system optimisation.

They also offer customers demand side management solutions based on these and other technologies but compete with other demand management providers.

15 per cent of households have plug-in hybrid or electric vehicles (EVs).

continue to embrace and install localised generation options at moderate to high levels.

Around 15 per cent of Australian households have a plug in hybrid or EV and networks must actively manage the new load added by charging these vehicles.

The value that networks can offer through cost savings derived from demand management make compelling products to consumers. The services offered aid in the uptake of both localised generation and storage, and manage EV charging. Most consumers do not choose to spend time optimising the interaction of their products and services. Accordingly, the majority of customers are inclined to take actions that do not require them to invest significant time to manage their demand.

The dominance of network-led services around 'smart' technology reduces the scope for retailers to play a role in this area. Many retailers continue to concentrate on offering basic retail products through the National Electricity Market (NEM). Coordination between distributors and independent retailers is more difficult than in the past as their incentives are increasingly disparate.

Commercial and industrial Sector

Commercial and industrial consumers remain reliant on the grid supply. Whilst electricity prices have stabilised, some of these consumers are impacted by high gas prices. Many businesses start to look for alternatives; however the relatively high cost of retrofitting equipment to allow fuel substitution leads to the scaling back of operations with some large industries moving offshore.

Gas market influences

High prices have reduced the use of gas for centralised generation and industrial processes. Some large industrial users are prompted to move their operations overseas. The relatively higher increase in the price of gas compared to electricity, and failure of the gas industry to innovate, has also led to gas defection amongst many commercial and residential consumers, particularly in new homes.

Alternative services

Grid connections remain pervasive. There are high levels of deployment of grid-side and customer-side smart technologies, including storage. However, these are dominated by demand management providers, primarily distributors, but in some cases third party providers.

Network businesses and affiliates dominate the market for provision of 'alternative' (now mainstream) services due to their ability to:

- offer value from network optimisation and better overall access to information (e.g. access to data from smart meters);
- use regulated returns to subsidise more innovative/risky ventures; and
- restrict third party access to network infrastructure (such as through imposing stringent safety or technical requirements).

Wholesale market

Demand in the NEM reflects economic growth and structural change in the economy. Carbon policies exert little effect on the generation mix until 2025 when fleet renewal becomes imperative.

Both peak and overall demand growth is flat because of improved price signals, alternatives to the grid supply, greater management of electricity demand, and a decline in industrial load.

Centralised gas generation impacted by high gas prices has generally been replaced by large-scale renewable generation.

Transmission networks

Throughput on transmission networks is affected by increasing levels of distributed generation and a decline in industrial load, but some of this is offset by new load for EVs. Transmission networks continue to primarily serve the large generators in the wholesale market.

Transmission networks are required to manage a greater capacity of intermittent generation which has replaced centralised gas generation.

Distribution networks

Distribution businesses invest in a range of technologies that help manage each customer's impact on the network and support new product offerings for network users. Peak demand is actively managed by distribution businesses to optimise network utilisation. Direct control of large residential loads and grid storage solutions are common.

Distribution businesses also optimise the output of distributed generation (for example of solar PV via smart inverters), as well as the charging and discharging of behind-the-meter batteries as part of demand management services. Distribution businesses invest in a range of smart grid technologies that allow them to actively monitor and manage their networks, including improving reliability in problem areas of the grid.

Because customer impacts on networks are being actively managed, network utilisation is improved. Network prices reflect the more efficient use of the network and do not rise as quickly as under other scenarios. Network prices combined with new services offered by the distributor do not create a strong incentive to disconnect, and a network connection remains common.

Scenario 2 – New consumer choices drive an evolution

2035 in context

Third party service providers are leading an evolution in alternative electricity products and services that are challenging the traditional supply chain model. This evolution occurs in response to the opportunity to capitalise on consumers' continued frustration with high electricity prices, and to leverage the benefits of 'off-grid' and smart technologies.

These new business models grow outside the legacy monopoly network infrastructure and entrepreneurial market entrants take substantial market share. Only innovative distribution sector incumbents evolve to compete in the new non-traditional markets now outside their regulated monopoly assets.

Because consumers generally do not disconnect from the grid, distribution businesses continue to be an important part of the energy landscape, providing back-up supply and a platform for trading of embedded generation. With greater disparity in the way customers use electricity, distributors mostly focus on maximising the revenue that can be earned from the existing network and managing network reliability and security.

Consumer services

A high proportion of small consumers have responded to the emergence of new innovative products and services offered by a range of energy service providers. The energy service providers manage consumers' on-site generation, consumption and storage to minimise overall energy costs.

The most successful offerings require low ongoing engagement by the consumer, through use of agent arrangements or app-based tools. New products and services include energy management systems, energy storage, distributed generation, peer-to-peer energy supply and energy efficient appliances.

Declines in the cost of new technologies, uptake of smart meters and greater cost reflectivity and innovation in electricity tariffs have facilitated growth of these products. Retail price monitoring has largely replaced retail price regulation.

Key attributes



80 per cent of household load is met through distributed generation, led by consumers trying to minimise their own costs.

40 per cent of small consumers have storage and there is significant uptake of demand management products.

Smart meters are now more common than accumulation meters for households, particularly in new homes.

Up to 20 per cent of households have plug-in hybrid or EVs.

5 per cent of consumers are completely off-grid. Of the remaining grid connected consumers, 38 per cent only use the grid for back-up and as a means of exporting to optimise the benefits of embedded generation.

Gas prices are medium but rising due to the influence of international markets.

Up to 20 per cent of households now have a plug-in hybrid or EV, which is commonly charged at the household.

The majority of consumers retain a connection to the grid. Some customers retain grid connection only for the purposes of back-up supply and exporting energy, whilst others retain grid connection as their primary electricity supply.

A proportion of small consumers living in existing high density, multi-level housing are unable to access these new products and services. This subset of small consumers is, therefore, reliant on the grid supply and provides some offset for the general decline in network utilisation.

Commercial and industrial sector

The reliability and security requirements of commercial and industrial consumers mean these groups continue to be largely reliant on the grid. There has been a downward step change in industrial energy load due to rising gas prices. These customers take up cost-effective alternate technology which can be retrofitted into their operations to allow fuel substitution. This has led to a slight rise in commercial electricity load. Some in this sector begin to engage with energy service providers to help maintain lower prices.

Gas market influences

Rising prices have reduced the use of gas for centralised generation and for industrial processes. The price of gas and failure of the gas industry to innovate has also influenced the rise of energy service providers, who embrace a range of options, with a focus on more economic electrical appliance options.

Alternative services

A high number of alternative services have emerged, offered from a variety of players including third parties and traditional energy providers. Products and services are being offered to both residential and business customers, with increasing customer demand for such products leading to reductions in technology costs. Some network businesses have evolved to offer non-traditional products and services in the market, however do not hold significant market share. Governments are not directly incentivising one product or service over another, rather innovation is being driven by consumer choice.

Wholesale market

Demand through the wholesale market provides a significantly lower proportion of the household load as a result of consumer uptake of 'off-grid' options. While the NEM load continues to grow, its profile has flattened and peak demand is tempering because of increased uptake of battery storage that is supplementing household peak load requirements.

The needs of the commercial and industrial sectors, as well as hybrid and EV load, together with a decline in the generation surplus, sustains the wholesale market. This means the generation sector can still provide opportunities for profit. Intermittent generation backed up by storage systems and peaking plant maintains system security and reliability.

Transmission networks

Transmission networks have been maintained to meet stipulated reliability outcomes. Due to consumers taking up demand management, existing networks provide sufficient capacity to meet forecast demand. Network augmentation has been required in some areas of the network to connect and serve major new load.

Distribution networks

Consumers remain connected to the distribution networks. However, a significant proportion of small consumers are no longer fully reliant on the grid, and use it for back-up supply and as a means of exporting electricity to optimise the benefits of on-site generation and storage.

Distribution network flows are generally lower. Distributors are incentivised to focus on managing network reliability and security and maximising the revenue that can be earned from the existing network. They do this by adjusting their products and tariffs to reflect the value of being connected to the network; rewarding efficient use; and where possible, removing unfair cross-subsidies. Uptake of hybrid and EVs has also offset some of the decline in throughput, as has the high-density housing load.

In some remote edge of grid areas, distribution businesses have not maintained grid connection for customers and instead meet their reliability requirements by providing distributed generation and storage. However, as the alternative energy sector becomes more established distributors struggle to compete with specialist providers of off-grid solutions, who can offer lower prices.

The distribution network in other areas has been maintained, with the existing network providing sufficient capacity to meet forecast demand and some investment required to address stability issues caused by interconnected technologies. Some network augmentation has been required to connect and serve new developments, including high-density housing developments, but the decline in peak load means distribution businesses are predominantly concerned with maintaining and extracting maximum value from the existing network. Accordingly, there has been no real growth in the regulated portion of the network business.

Scenario 3 – Centralised to localised

2035 in context

Customers have moved away from the predominant centralised generation model of 2015, particularly households and community users. This has resulted from frustration with continual rises in electricity prices and the emergence of cheaper reliable storage and micro-generation options.

Some consumers are prepared to risk reduced security of supply and disconnect from the grid altogether. To maximise the benefits of their onsite generation systems, some have invested in EVs. Cost-reflective pricing is standard.

Alternative to the 'grid'

The electricity sector is significantly different, with reductions in technology costs for distributed generation and storage combined with high prices for grid electricity resulting in a large number of consumers adopting alternatives to the traditional grid-supported electricity services.

Going off-grid is financially attractive to households and other low energy users. It is less attractive to industrial users, particularly existing industrial facilities. The low voltage grids experience more two-way energy flow.

Consumer services

There has been a large shift by consumers to use distributed sources of energy, both on and off-grid. This is seen particularly at the community level, either through geographic or local council options, where individuals, groups or communities work together to capitalise on economic opportunities.

This provides opportunities for fringe of grid users to have their electricity supplied through micro-grids, which is an efficient outcome at the community level. However, without the system response measures afforded by an interconnected network, voltage and frequency issues are prevalent.

Energy efficiency gains mean that overall usage is lower than in 2015. Medium and small users remain connected in cases where:

Key attributes

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80 per cent of consumers have distributed generation (mainly smaller consumers).

65 per cent of consumers have storage.

30 per cent of consumers are 'off-grid'.

Of the remaining grid-connected consumers, 55 per cent use the grid for all their electricity and 45 per cent use the grid just for back-up.

Costs per unit of energy consumed are higher than current levels due to inefficient use of capital and loss of scale economies.

Gas prices are at medium levels.

- decentralised generation is not technically feasible or competitive with on-grid generation; or
- end users value the special features of grid supply.

Commercial and industrial sector

Large industrial consumers still use centralised generation provided through high voltage lines to ensure reliability. There is some investment in energy efficiency options to counteract rises in both electricity and gas prices.

Gas market influences

With many customers going off-grid, the medium level gas price means gas peaking plants are important for maintaining system security and reliability.

Alternative services

Alternative services include the provision, operation and maintenance of micro-grids, as well as individual generation and storage deployment. In addition, consumers connected to the grid have access to a wider range of demand management services.

There is a high level of competition for these alternative services and much of the trend to move off-grid is driven by the effective marketing of non-network alternative services by third party providers.

Wholesale market

There is substantially less demand being met through the wholesale market, resulting in a smaller number of generators competing for dispatch. While some base load remains, almost all intermediate generators have been decommissioned.

Demand from the wholesale market is underpinned by large industrial load. The remainder of required generation is provided by renewable generation and high cost peaking plant to maintain system security and reliability, resulting in highly variable spot prices. A number of large, medium and small scale storage systems (for electricity and heat) even-out intermittent supplies.

Transmission networks

Transmission networks are still required to facilitate the transfer of electricity from large-scale plant, including renewables, to the point of consumption. In addition, transmission networks continue to transfer electricity between regions to support competition between the remaining generators and provide system support for those regions with high penetration of intermittent generation.

Distribution networks

Urbanised areas, particularly central business districts, remain connected to the grid. This ensures high quality electricity in areas where these services are the only

practical and safe alternative, or where the value of a reliable supply reflects the end-users' needs.

Distribution networks are used as backup to localised generation where these are undergoing maintenance, during periods of extreme weather and to manage voltage variations. Where consumers with distributed generation remain grid-connected, distribution businesses need to increase expenditure in network assets or alternatives, where feasible, to maintain voltage and frequency levels.

Network prices increase because the costs per unit of energy consumed are higher due to inefficient use of capital and loss of economies of scale. Peak load issues also persist, keeping network costs high.

Scenario 4 – Government policy drives outcomes

2035 in context

Following several extreme weather events across the world, there has been an international commitment to reduce greenhouse gas emissions. The Australian Government has joined this commitment, focusing its attention on the electricity generation sector.

At the same time, storage reliability has improved and a range of centralised renewable energy options are being deployed. The public support the investment in a range of renewable energy generation options and as a result predominantly utilise grid supply. There are also an increasing number of hybrid and EVs in the mix.

Networks face major challenges to deliver government policies

An ambitious and technically challenging energy policy is implemented targeting 80 per cent renewable energy supply for climate change mitigation. As a centrally-driven policy, centralised energy generation remains prominent.

The technical challenges in adapting to a large amount of highly variable energy puts networks in a position where capital investment is needed to maintain reliability and security of the system. Investment is also required to ensure capacity to meet a growing EV load.

Consumer services

Renewable generation rapidly increases as a proportion of the generation mix driven by government targets. The policy does not directly incentivise energy efficiency; however, increases in electricity prices resulting from the renewable energy policy lead to consumers implementing energy efficient options. Cost reflective tariffs ensure energy efficiency options implemented by consumers are more oriented towards peak demand reduction than overall energy demand.

Consumer demand plays a lesser role than the imperatives of the renewable generation target. However, eliciting a strong consumer response at times of constrained networks or generation supply, and incentivising usage at other times becomes important to grid stability at the distribution level. Over 30 per cent of households own an EV.

Key attributes



50 per cent of all generation in the NEM is renewable by 2035. This is split between large (80 per cent) and small scale (20 per cent) generation.

The investment in and operation of networks is oriented around delivery of a renewables based generation sector.

Large investments in grid stabilising technology required: storage, smart meters, network control and direct load control.

Other investment predominantly relates to supporting a growing EV load.

30 per cent of households have plug-in hybrid or EVs.

Consumer preferences are less of a determinant of outcomes.

Direct load control becomes mandatory technology for applications like residential air conditioning and electric hot water systems. Accordingly, smart meters are quickly rolled out under the competitive framework.

Commercial and industrial sector

Some in the commercial sector respond to government incentives to implement local scale generation. The industrial sector finds this more difficult and is subject to higher gas prices and high energy costs from being connected to high priced grid supply.

Gas market influences

Gas prices are high, but with policy drivers focussing on renewable energy and the overall rise in electricity prices, there has been little switching by consumers at household, as well as the commercial and industrial levels.

Alternative services

While much of the renewable target is met through transmission-scale renewable generation, there are generous incentives for local scale uptake. Many councils, commercial entities and property developers take up these incentives to grow precinct-scale generation projects.

Consistent with current trends, additional residential customers install small-scale renewable generation. The accelerated roll out of smart meters provides a technical infrastructure for third party services, albeit one whose capabilities are largely oriented towards network management.

Wholesale market

The NEM remains the main playing field for generation of energy, but growth in demand is moderate. The NEM itself is challenged by increasing amounts of intermittent generation bidding in at very low prices and market outcomes are strongly affected by transmission congestion, particularly in areas with high amounts of wind generation. A large proportion of the coal and gas generation fleet is retired. Peaking generators are essential for maintaining system security.

Transmission networks

Additional transmission investment is required, with a variety of new connections being constructed to deal with new energy flows. There are corresponding new requirements to ensure system stability. Management of congestion becomes a key concern given the large amount of redundant network capacity required to cater for intermittent generation.

Distribution networks

Distribution networks continue to provide a similar service to the present day, but passing on price signals from the transmission sector becomes a greater concern in regulatory settings. Distributed energy grows, with intermittent solar and wind dominating. Distribution businesses face pressure to become 'smarter' in order to manage less predictable energy flows both at the local level due to distributed energy and also at the transmission interface due to intermittency.

To do so, distributors require support to roll out smart meters, invest in storage, and pursue direct load control technologies. This new investment, however, is not supported by significant growth in sales.

Reference List

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Victoria’s Future Energy Networks – Sapere Research Group (Victoria)
(Commercial in Confidence)

Reference Group Participants

Australian Energy Market Commission (AEMC)

Australian Energy Market Operator (AEMO)

Australian Energy Regulator (AER)

Alternative Technology Association (ATA)

Australian Council of Social Services (ACOSS)

Clean Energy Council (CEC)

Commonwealth Scientific and Industrial Research Organisation (CSIRO)

Energy Efficiency Council (EEC)

Energy Networks Association (ENA)

Energy Retailers Association of Australia (ERAA)

Energy Supply Association of Australia (ESAA)

Energy Users Association of Australia (EUAA)

Grid Australia (GA)