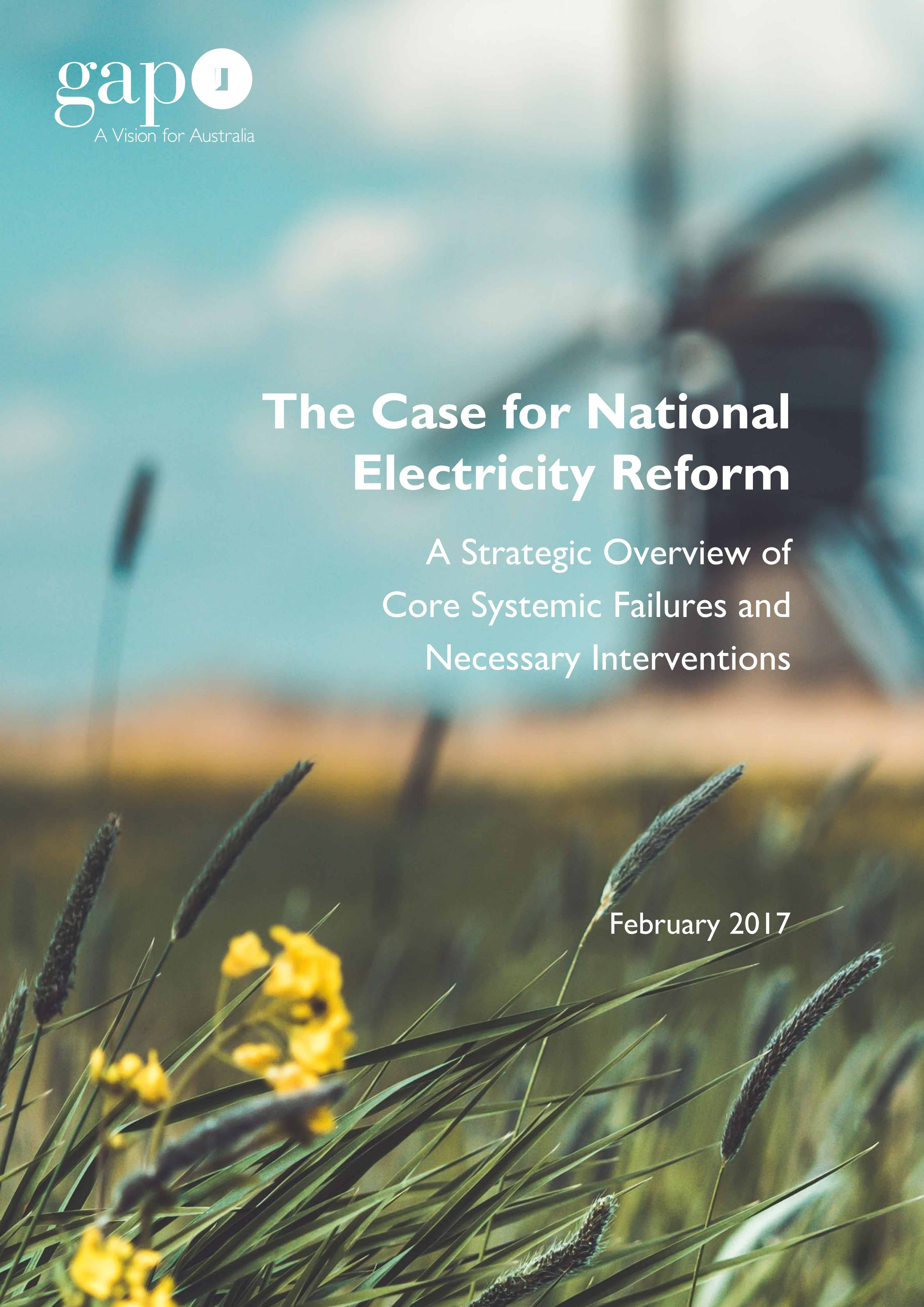


gap
A Vision for Australia

# The Case for National Electricity Reform

## A Strategic Overview of Core Systemic Failures and Necessary Interventions

February 2017

2017 NSCEE & Global Access Partners Pty Ltd

Title:
"The Case for National Electricity Reform: A Strategic Overview
of Core Systemic Failures and Necessary Interventions" — Report

Global Access Partners Pty Ltd

ACN 000 731 420
ABN 74 000 731 420

Postal address PO Box 978 Strawberry Hills NSW 2010 Australia
Telephone +61 2 8303 2420
Facsimile +61 2 9319 5754
Email info@globalaccesspartners.org

Cover photo credit: Shutterstock

The report is released under a Creative Commons Attribution 4.0 International Public License
(CC BY 4.0), *https://creativecommons.org/licenses/by/4.0/*

Copies of this publication can be obtained by contacting (02) 8303 2420.

# Abstract

This paper discusses the case for national electricity reform, given Australia's rapidly evolving mix of electricity generation. It recommends the redesign of the National Electricity Market (NEM) to increase efficiency, reduce prices and secure supplies.

Unofficially titled the 'Heineken Report'[1], the paper addresses the most challenging questions of energy reform and focuses on aspects which other reports may downplay or ignore.

# Disclaimer

This document's development was guided by the deliberations of the National Standing Committee on Energy and the Environment (NSCEE) - a cross-jurisdictional, multidisciplinary group of stakeholders organised by the institute for active policy Global Access Partners (GAP) in 2016.

The report represents the diverse range of views and interests of the individuals and organisations involved. Given the different perspectives of Committee members, it should not be assumed that every member would agree with every argument or recommendation in full.

The report has been prepared in good faith on the basis of information available at the time of writing and sources believed to be reliable. However, it should not be used as a substitute for independent professional advice or further consultation with industry experts. Evaluation of the material presented is the sole responsibility of the reader.

(cc) Global Access Partners Pty Ltd, 2017

# Abbreviations and Acronyms

| | |
|---|---|
| AEC | Australian Energy Council |
| AEMC | Australian Energy Market Commission |
| AEMO | Australian Energy Market Operator |
| AER | Australian Energy Regulator |
| BOO | Build, Own and Operate |
| BOOT | Build, Own, Operate and Transfer |
| COAG | Council of Australian Governments |
| CRC | Cooperative Research Centre |
| CSIRO | Commonwealth Scientific and Industrial Research Organisation |
| ENDPO | The proposed CRC in Energy Network Design, Planning and Operation |
| GAP | Global Access Partners |
| GDP | Gross Domestic Product |
| GJ | gigajoule |
| GW | gigawatt |
| ICT | information and communication technologies |
| IoT | Internet of Things |
| kWh | kilowatt hour |
| L | litre |
| MW | megawatt |
| NEM | National Electricity Market |
| NEMCC | The proposed NEM Coordination Council |
| NEMICC | The proposed NEM Industry Collaboration Council |
| NEMPDA | The proposed NEM Planning and Design Authority |
| NEO | National Electricity Objective |
| NREL | National Renewable Energy Laboratory, USA |
| NSCEE | National Standing Committee on Energy and the Environment |
| PV | photovoltaics |
| PVC | photovoltaic cells |
| R&D | research and development |
| TWh | terawatt hour |
| VRE | variable renewable electricity |

(cc) Global Access Partners Pty Ltd, 2017

# Contents



(cc) Global Access Partners Pty Ltd, 2017

# Executive Summary

The NEM is the wholesale electricity market in Australia's eastern and southern states. It was launched in December 1998 and trades over $11 billion of power every year to meet the needs of 19 million end-user consumers. The disaggregation of state-owned, vertically integrated power corporations was a key structural reform in its time, but a fresh set of technological, social and environmental challenges now requires equally bold reforms to be undertaken.

Responsibility for the NEM is split between the policy maker (the COAG Energy Council), the rule maker (AEMC), the regulator (AER) and the operator AEMO. Whilst this separation of powers was consistent with the principles of micro-economic reform, it now inhibits the ability of government and other stakeholders to take a total-systems overview. This report calls for new arrangements, including the creation of a NEM Design and Planning Authority, to ensure a more holistic approach.

Changes to current management structures are required to embrace innovative technologies and consumer and environmental priorities. The coal-powered NEM of the past will be transformed by a greater diversity of generation, consumer empowerment, micro-grids and battery storage. Far from posing a threat to prices and supplies, this should improve the network's agility and boost its security, reliability and resilience. A successful transition will rely on closer stakeholder partnerships, better planning and a broad commitment to change, but the right administrative arrangements must be in place for it to happen.

Current regulations shaping fossil fuel and renewable power generation do not align with Australia's fast-changing demand profiles and more diverse grid technology. A failure to address these issues contributed to the South Australian blackout of 2016, and without decisive change such events may be repeated.

The demonstrable link between fossil fuels and climate change should be acknowledged by the Australian Government. National energy and environmental policies must be aligned to meet Australia's international emissions obligations and the needs of domestic power customers. Continued reluctance to coordinate government activities will only undermine investor confidence and hamper the modernisation of the NEM.

The National Electricity Objective (NEO) should be updated to reflect the interdependence of modern economic, social and environmental concerns and incorporate notions of duty of care and public value. The original aim of micro-economic reform has been achieved, but competition and downward pressure on prices has been inhibited by a lack of consumer knowledge.

(cc) Global Access Partners Pty Ltd, 2017

Customers want reliable and secure supplies at a fair price, with the ability to make informed choices between suppliers. A lack of billing transparency has left customers vulnerable to exploitation, but new metering services and other technological advances should be adopted across the NEM to allow both consumers and producers to manage their affairs more effectively.

We support the creation of a comprehensive blueprint for change and an explicit timeline for its implementation. We urge Federal and State governments, electricity companies and consumer groups to cooperate in pursuit of agreed and balanced goals to keep the life-blood of the nation flowing.

(cc) Global Access Partners Pty Ltd, 2017

# Recommendations for Reform

**1.** Australian Federal and State Governments should accept the need for NEM reform and produce a blueprint for its transformation. The blueprint should address the system as a whole, set clear targets and milestones, and form the basis of accountable actions by its managers. The blueprint should:

- Encompass the core areas of an expanded and enhanced NEO;
- Identify the key drivers of transformational change, the strategic issues demanding attention, and the actions required to meet the revised NEO;
- Establish priorities and assign responsibilities for those actions;
- Create appropriate regulatory rules and structures which incentivise, facilitate and attract participation across all sectors of the NEM by industry, consumers and all levels of government.

**2.** Governments should broaden the current NEO to reflect emerging economic, social and environmental issues. The existence and interrelation of these issues imposes a greater 'duty of care' on the industry, and policy should be assessed for its public value. The Government should:

- Include environmental considerations within the NEO;
- Ensure that the NEM's structure, rules and regulations facilitate, rather than restrict, participation;
- Redesign industry rules and regulations to reflect changes in generation, storage and related technologies, greater consumer interaction and the importance of climate change policies, while retaining a strong market approach.

**3.** Stakeholders should adopt governance and management structures which address the system as a whole. These structures should be proactive, engaging and include all stakeholders through improved coordination and collaboration. The Government should:

- Recognise that the NEM is a complex management challenge with multiple tiers of participation and accept the need for stronger partnerships between government, industry, and the community;
- Retitle and reimagine the core function of the Senior Council of Officials to the NEM Coordination Council (NEMCC);
- Empower the NEMCC to take a holistic approach and make it accountable for overseeing strategic policy and operational advice to the Council of Australian Governments (COAG) within an expanded and improved NEO. The NEMCC would act as custodian of the NEM blueprint and be responsible for reporting to COAG on its implementation and for recommending changes;

(cc) Global Access Partners Pty Ltd, 2017

- Expand NEMCC membership to include the chairs of the Australian Energy Market Commission (AEMC), the Australian Energy Market Operator (AEMO), the Australian Energy Regulator (AER) and the proposed NEMPDA. These bodies would still retain their accountability to, and reporting structures for, COAG Energy Ministers. A representative from Energy Consumers Australia should also be included;
- Appoint an independent chair of the NEMCC.

**4.** Recognise the critical importance of system design and planning to the NEM. Planning and better system design is required to ensure the security and reliability of supply, given the plethora of technical, management and operational combinations.

**5.** System design and planning should be undertaken by a dedicated and single-minded authority. We therefore urge:

- The establishment of a NEM Planning and Design Authority (NEMPDA) to optimise the design and planning of the network within the revised NEO.
- The NEMPDA would maximise technological and operational opportunities within the constraints of Australia's generation, transmission and network options. It would recommend the most appropriate suite of practical solutions, while emphasising the need for decarbonisation;
- The NEMPDA would design a network which maintains acceptable security and reliability targets, while transitioning from a single interconnected network to one of 'networks within networks';
- The Authority should identify key technical and operational issues that require regulation or rule-making, to ensure it operates within its designated parameters;
- The Authority would manage the staged transition of the network to the new blueprint and initiate and manage the commercial investments required at regional and local levels;
- The NEMPDA would address issues around synchronous and non-synchronous generation, transmission and interconnection. It would consider technical initiatives around the provision of black start and ancillary services. It would also investigate the type and mix of generation and support services required in certain locations to maintain network integrity and resilience.

(cc) Global Access Partners Pty Ltd, 2017

**6.** Government should establish structures that promote industry interaction and participation across the NEM and enhance the understanding and adoption of best-practice technical and operational measures. The Government should therefore:

- Establish a NEM Industry Collaboration Council (NEMICC) to encourage the dissemination of international technical and operational ideas, evaluate best practice, and work with the NEMPDA and COAG;
- Transform stakeholders from regulated participants to collaborative partners, given the need for greater cooperation;
- Appoint an independent chair and ensure the NEMICC encompasses a broad range of industry figures to offer the diverse skillsets and knowledge required. Its membership should include the chair of the Australian Energy Council.

**7.** Government should use existing suites of programmes and grant schemes to encourage appropriate market responses by industry and consumers to meet new NEM priorities: We therefore support:

- The establishment of a Cooperative Research Centre in Energy Network Design, Planning and Operation (ENDPO);
- The ENDPO would offer a focus point for optimising energy solutions by bringing together the best and brightest minds in industry, academia and government to work in partnership;
- The ENPDO would work closely with the NEMPDA to improve technical, operational and management knowledge in this new era in energy supply;
- Existing environmental and business grant schemes could be used to encourage industry and consumers to use energy trading, micro-grid, storage and behind-the-meter software to modernise the NEM.

**8.** Government should accept the obvious link between energy policy and climate policy to ensure each proceeds in a coordinated and positive direction. This will require:

- Determined and good faith efforts by Commonwealth, State and Territory Governments to align their renewable energy targets. These targets should be reflected in the blueprint for the NEM;
- A staged transition from legacy fossil-fuel generation capacity to methods which produce fewer harmful emissions as part of an integrated approach. Thermal generation plants should not be shut on an individual, ad-hoc or state-based basis, as in South Australia and Victoria, but as part of a national plan.

(cc) Global Access Partners Pty Ltd, 2017

**9.** Government and other stakeholders must recognise the consumer-centric nature of a modernised NEM. This will require:

- Greater transparency in data collection and reporting across NEM sectors, notably in customer accounts which currently lack clarity and transparency;
- Pricing which reflects costs as the network and services become more diverse and flexible and consumers and 'prosumers' look to maximise value through a wider range of options;
- Consumer education to help them understand their choices, participate in decision-making and capitalise on their opportunities;
- Growth in behind-the-meter value-added services that support consumer choice, facilitate micro-grids and optimise choice and demand management.

**10.** Stakeholders must acknowledge and address key information and data gaps in the network. These gaps are expanding due to the rapid diversification of generation, including household solar capacity, behind-the-meter storage and other initiatives. To ensure planning is based on comprehensive information, there should be:

- A comprehensive suite of energy infrastructure audits on a regional, sub-regional and sectoral basis;
- Analysis of this data to inform network planning and design, infrastructure investments and pilot micro-grid initiatives to test new rules and regulations;
- Industry and community participation in projects which reflect growing diversification, growth and rationalisation opportunities.

(cc) Global Access Partners Pty Ltd, 2017

# The Finkel Review

The South Australian blackout on 28 September 2016 was the first in the state since the launch of the NEM. It provoked widespread community and political debate with much finger-pointing about the technical, institutional and administrative influences to blame.

An emergency COAG meeting of State and Federal Energy Ministers on 7 October 2016 agreed to a review of the NEM by an independent expert panel chaired by Australia's Chief Scientist Dr Alan Finkel AO. The COAG Communiqué[2] stated:

> "Given the critical importance of energy security, reliability and system resilience, the Council agreed that it is timely for a wider independent review to take stock of the current state of the security and reliability of the national electricity market and provide advice to governments on a coordinated, national reform blueprint."

The Finkel Review was asked to offer:

> "a plan to ensure future energy security, affordability and sustainability as more renewable energy comes into the electricity system and more coal-fired power stations close."

This blueprint will:

> "outline national policy, legislative and rule changes required to maintain the security, reliability and affordability of the NEM in light of the transition taking place."[3]

The Finkel Review will use and build on a range of other work, including:

- Reviews into South Australia's 'black system event' by AEMO, AER and the AEMC;
- Reports by AEMO and the AEMC on the security and market arrangements of potential power frameworks;
- Analysis by AEMO and the AEMC of the impact of Federal and State carbon mitigation policies on energy markets;
- The Vertigan Review of governance arrangements;
- National gas market reforms which affect the NEM's security, reliability and affordability;
- A review of existing regulatory arrangements for interconnector investment.

Dr Finkel explained his approach in the annual Zunz Lecture at the Sydney Powerhouse Museum on 3 November 2016.[4] He noted the 'trilemma' faced by reformers, given the need for reliability, affordability and ecological sustainability. The three points of this triangle should have consumers at its centre as

> "it is the consumer who sets the expectations; and the consumer who ultimately decides if they are met." [5]

**(cc) Global Access Partners Pty Ltd, 2017**

He stressed the primacy of consumer choice and

> "the freedom to put the grid we share to work in the way that each of us wants, for our household, or our business or our town",

but accepted that choice has cost implications and must be handled with care.

All stakeholders accept these three basic objectives, but disagree about the balance between them. Dr Finkel accepted the wealth of data available, but said that no systemic review had assessed the complex interactions of a 'market in the midst of rapid change'.

Dr Finkel, the four Review panel members, expert advisers and members of the Review taskforce met consumer groups, energy market bodies and peak energy organisations as part of their first round of consultations. The Panel engaged with the International Energy Agency to evaluate Australian performance against global best practice. Their Preliminary Report was presented to the COAG meeting of Energy Ministers on 9 December 2016.[6]

The Preliminary Report did not offer conclusive findings or recommendations.

> "instead, it fulfils the role of an issues paper, setting out observations and questions to guide a process of open consultation on the design of a new blueprint for the electricity sector".[7]

The Report accepts the extent of change since the design and implementation of the NEM almost thirty years ago. These factors include technological advance, diverse generation options, changing consumer needs and the growing threat of climate.

The dominance of coal, gas and hydro generation will increasingly be undermined by solar, wind and other renewable energy options, leading to a more hybrid, diverse and disruptive technology mix. A revamped NEM will also have to find its place in a more consumer-centric economy where customers are increasingly knowledgeable and empowered to make decisions for themselves.

These changes are directly challenging the current structures, rules and regulations of the NEM, and reforms are required to unlock the value from this richer and more interactive and responsive environment.

The Preliminary Report acknowledges seven major themes:

1. Technology is transforming the electricity sector
2. Consumers are driving change
3. The economy must reduce its carbon emissions
4. Variable renewable electricity generators, such as wind and solar PV, can be effectively integrated into the system
5. Market design can support security and reliability
6. Prices have risen substantially in the last five years
7. Energy market governance is critical

(cc) Global Access Partners Pty Ltd, 2017

Each theme in the Report offers a range of questions to trigger debate and explore options within the 'energy trilemma' of providing energy security and affordable access while reducing carbon emissions.

After further consultations in the first quarter of 2017, the Finkel Review will offer its blueprint outlining the changes in national policy, legislation and administration it believes are required.

(cc) Global Access Partners Pty Ltd, 2017

# The National Electricity Market

## History of the NEM

The NEM is over a quarter of a century old. The catalyst for its formation was a1991 Industry Commission (now the Productivity Commission) report[8] which argued that Australia's GDP could be increased by restructuring the electricity industry.

The report identified the following key elements for reform:

- The separation of generation and retail from the monopoly components of transmission and distribution;
- The introduction of competition into generation and retail by giving non-discriminatory access to transmission and distribution systems;
- The sale of publicly owned electricity generation, transmission, and distribution assets to the private sector; and
- The enhancement and extension of the interconnectors between NSW, ACT, Victoria and South Australia. This was subsequently extended to include Queensland and Tasmania.

In response to the report, COAG formed a National Grid Management Council, charged with coordinating the planning, operation and development of a competitive electricity market.

The disaggregation of monopolistic state-based energy companies, such as Pacific Power in NSW, followed the Industry Commission's recommendations as part of wider micro-economic reforms in other capital-intensive utilities such as water and transport.

A 2013 KPMG case study on the NEM commissioned by the AEMC chronicles the key milestones in the reform process.[9]

(cc) Global Access Partners Pty Ltd, 2017

# Micro-economic Reform – The Impact of the Hilmer and Harper Reviews

Australia's electricity industry before the NEM had seen the core components of generation, distribution and retail undertaken within large vertically integrated, publicly owned monopolies. The disaggregation of this structure and transfer of assets to the private sector were part of the same competition policy which shaped the rules and regulations of the NEM.

The Commonwealth offered State governments significant incentives to embrace privatisation, and revenues from sales were used to reduce debt or pay for services and infrastructure. Other nations, such as Britain and France, pursued similar reforms at the same time, while Australia's water industry was restructured after the publication of the Hilmer Report on National Competition Policy[10] in 1993.

According to a 2016 report by Synergies Economic Consulting[11],

> "In the electricity sector, separation into generation, transmission, system control and market operations, distribution, and retail supply was largely successful. The limited scope economies across the activity levels, reflected for example in the specialised technologies deployed in each layer, meant that the benefits of separation in terms of enhanced competition significantly exceeded any loss of scope economies."

'Economies of scope' are the proportionate savings generated by producing two or more distinct goods when the cost of doing so is less than producing each separately. These contrast with economies of scale from the reduction of average cost by increasing production.

> "Economies of scale focus on the output level of one product, whereas economies of scope focus on the variety of products offered" (Nickolas 2015)[12]

The 2015 Harper Review[13] was the first comprehensive assessment of Australia's competition policy since the Hilmer Report. It concluded that competition policy should:

- Make markets work in the long-term interests of consumers,
- Foster diversity, choice and responsiveness in government services,
- Encourage innovation, entrepreneurship, and the entry of new players,
- Promote efficient investment in and use of infrastructure and natural resources,
- Establish competition laws and regulations that are clear, predictable and reliable,
- Secure necessary standards of access and equity.

(cc) Global Access Partners Pty Ltd, 2017

Whilst the Harper Review did not specifically address energy regulation, it did reinforce the idea that competition policy, laws and institutions should promote the interests of consumers, and polices should be subject to a public interest test. It also emphasised that a balance should be struck between the disruptive impact of technology and digitisation and consumer safeguards.

Whilst Hilmer and the initial micro-economic reform of the electricity sector did the 'heavy lifting', the Harper Review emphasised the importance of meeting consumer needs, addressing digital disruption and adopting innovation and technology to accelerate competition.

Business, social and technological environments have changed significantly since the publication of these reports. Despite the general acceptance of micro-economic reform overall, its effects on the electricity market have not been without their critics, with some economists arguing the benefits have been overstated. Prof John Quiggin[14] wrote a report for the Electrical Trades Union in 2014 which argued that

> "Privatisation, corporatisation and the creation of competitive electricity markets were supposed to give consumers lower prices and more choice, promote efficiency and reliability and drive better investment decisions. But after 20 years the evidence is that none of these promised improvements have been delivered." [15]

This critique has an element of truth, not because the reforms were wrong in principle, but because they were poorly implemented and the structures created have subsequently failed to react to technological change, increased complexity and the issue of climate change.

(cc) Global Access Partners Pty Ltd, 2017

# NEM Operations, Structure and Governance

### Existing Structures

The NEM is an energy market, rather than a capacity market. Generators are paid for selling electricity, rather than keeping generation capacity available to meet short-term or peak demands. This emergency capacity is maintained through ancillary service contracts with generators which agree to be available during emergency events.

NEM policy is steered by the COAG Energy Council, supported by a Senior Council of Officials from state energy portfolios. Three separate bodies report to COAG's Energy Council; the Australian Energy Market Commission (AEMC), the Australian Energy Market Operator (AEMO) and the Australian Energy Regulator (AER).

The roles of the AEMC as the rule maker and the AER as the regulator are clear and distinct, but AEMO's position as the market and power systems operator can conflict with its other duty as the NEM's national transmission planner. AEMO operates the power systems in Western Australia, the Victorian wholesale gas market and transmission system and other gas markets and hubs.

Finkel's Preliminary Report argues that this division of responsibilities between different institutions means there is no single entity to offer a 'whole of system' perspective and advice to ministers, officials and the general public. The coordination required to handle the NEM's growing complexity and the impact of transformational technological change could be achieved through an improved and integrated oversight structure.

### Recommendations for Change

- Reconstitute the Senior Council of Officials as the NEM Coordination Council (NEMCC)

The Senior Council of Officials could be reformed to include the senior officials and chairs of the AEMC, AEMO and the AER and be charged with taking a whole-of-systems approach in their advice to COAG. The new body, to be called the NEM Coordination Council (NEMCC), would act as custodian of the NEM blueprint and be responsible for tracking and reporting against its targets and milestones. The appointment of an independent Chair would further enhance its credibility. The NEMCC would offer a forum to share and discuss the initiatives of its constituent bodies, without affecting their individual responsibilities. Importantly, the Council would act as a body that could holistically discuss and debate the NEM challenges and their interrelations and offer integrated and coordinated advice to COAG.

(cc) Global Access Partners Pty Ltd, 2017

- NEM Planning and Design Authority (NEMPDA)

Given the challenge of disruptive technological change and the need to redesign the network to cater for renewable generation, micro-grids and battery storage, the creation of a dedicated authority to redesign the network and its components has been suggested. The task is too important to remain a sideline for AEMO, which should be left to operate within the market, rather than plan it.

A robust system engineering approach, will be required to help the NEM adapt to change effectively and optimise the opportunities which innovation will provide. This should allow problems and solutions to be addressed, with a completely different suite of design and planning criteria to those applied to date.

Just as COAG Energy Ministers established Energy Consumers Australia in 2015 to provide national advocacy on matters of strategic importance to energy consumers, a similar forum for industry should collaborate with a newly established NEM Planning and Design Authority (NEMPDA).

- NEM Industry Collaboration Council (NEMICC)

In early 2016, twenty-one major electricity and downstream natural gas businesses in the wholesale and retail energy markets formed the Australian Energy Council (AEC); however, there is still a need for a structure that reaches out to industry from within the NEM. This should not be seen as a lobby group for NEM participants, such as the AEC, but one that can provide 'best industry knowledge' to both COAG and the NEM as a whole.

This industry body would disseminate best practice from across the globe and give market participants, on whom the success of the market depends, a voice. This NEM Industry Collaboration Council (NEMICC) would offer a 'safe house' for sharing ideas and planning strategic approaches and a consultative avenue between industry and COAG. The new Council would be dominated by the domestic industry, with a number of international experts contributing to its role as a think-tank. It should also include the chair of the Australian Energy Council.

The NEMICC should develop strategies that advance the NEM as a whole, rather than representing sectoral interests or the positions of established management, regulatory or administrative structures within the NEM.

The NEM was an exercise in competition policy driven by centralised control, but reform of the NEM must be a partnership between governments, industry and the broader community. The establishment of an NEMICC would signal a new direction of positive engagement and respond to the formation of the AEC.

(cc) Global Access Partners Pty Ltd, 2017

- CRC in Energy Network Design, Planning and Operation (ENDPO)

The government should also tender for proposals for the establishment of a Cooperative Research Council in Energy Network Design, Planning and Operation (ENDPO).

This CRC would bring together the best and brightest minds in industry, academia and government to work in partnership to optimise solutions. It would redress the loss of corporate and technical expertise since the dismantling of integrated energy operators over the last 25 years.

(cc) Global Access Partners Pty Ltd, 2017

# Active Response to Technological Change

Rapid and disruptive technological and environmental developments require equally radical amendments to the NEM to maximise consumer and social outcomes. A blueprint for change is required, outlining clear and precise objectives within a flexible decision-making framework.

The Finkel Review has been asked to deliver such a document, while the 2016 Electricity Network Transformation Roadmap produced by Energy Networks Australia and the CSIRO attempted the same task.[16]

The Electricity Network Transformation Roadmap offers milestones and actions to guide an efficient and timely transformation of the electricity sector and the NEM over the next decade. The roadmap argues that a carbon-neutral electricity sector can be achieved by 2050, when customers could produce up to half the total electricity supply.

This would certainly meet Australia's international environmental responsibilities, but also creates a complex array of technical, economic and regulatory challenges. The report's modelling suggests that $1,000 billion could be spent by all stakeholders before 2050, but the investments and decisions made at the start will determine overall success.

Without a well-planned and properly executed approach, including the timely allocation of key resources and proper policy and market instruments, Australia will not navigate the transition efficiently. Poor planning will see a costly duplication of energy investments, and so steps must be taken to ensure an efficient and secure integration of large-scale renewable energy schemes and customer-owned distributed energy sources.

Legacy generation capacity owned by private sector investors could become 'stranded assets' in the future, while investor uncertainty around the lack of consistent and clear market signals is also inhibiting long-term investment. As the NEM becomes more consumers - rather than producer - oriented and its capacity fragments between off-the-grid initiatives, battery storage, micro-grids and smart networks, investment certainty will be ever harder to find. This further underscores the need to have a planned, but nimble pathway to a principle-led goal.

(cc) Global Access Partners Pty Ltd, 2017

# Overview of the Electricity Network Transformation Roadmap

**FOUNDATION:** 2017 | 2018 | 2019 | 2020 | 2021 | 2022

**IMPLEMENTATION:** 2023 | 2024 | 2025 | 2026 | 2027 | 2027+

**Overall Customer outcomes by:** 2027 | 2050

## CUSTOMER ORIENTED ELECTRICITY

### Foundation: Improve Trust with Customers

» Enhanced customer engagement and collaboration
» Customised choices, better information on services and new connection and advisory services
» Demonstrate investment reflects customer value while improving service performance and response times
» Review of Consumer Protection and concessions

### Implementation: Networks provide a service platform

» Open network platforms embrace diverse customer needs and aspirations
» Collaborate with customers and market actors to create new value with streamlined connections
» Leverage network information and digital services for personalised innovation in a dynamic market

### Outcomes: CUSTOMER CHOICE AND CONTROL

**2027**
» Over 40% customers use onsite resources: 29 GW solar and 34 GWh of batteries.
» Concessions to support those who need it most.

**2050**
» Almost 2/3 customers use onsite resources, including 1/3 customers on a new stand alone system tariff.

## POWER SYSTEM SECURITY

### Foundation: New systems to support diverse generation

» Update Transmission Interconnection test
» Review frameworks for protection systems, efficient capacity and balancing services
» New market frameworks for ancillary services
» Develop new power system forecasting and planning approaches to anticipate system constraints
» Enhanced intelligence and decision making tools
» Close focus on physical & cyber security

### Implementation: Harmonised System Operations at all levels

» Transmission networks support system stability with new services.
» Distribution networks provide visibility of DER and potentially Frequency Control Ancillary Services (FCAS) and delegated balancing services.
» Real-time communication and controls

### Outcomes: LOWER BILLS FOR VALUED SERVICES

**2027**
» Avoid over $1.4 BN in network investment.
» Average network bills 10% lower than 2016.

**2050**
» Total system spend is $101BN lower to 2050.
» Save households $414 pa by 2050.
» Network charges 30% lower than 2016.

## CARBON ABATEMENT

### Foundation: A stable Carbon Policy for higher targets

» Develop nationally integrated carbon policy framework
» Implement emissions Baseline & Credit Scheme
» Set Light Vehicle emissions standard policy to provide incentives for electric vehicle uptake, supporting climate goals
» Review Australia's emissions reduction target
» Agile network connections and integration of large and small scale renewable technologies

### Implementation: Reviewing scope for greater efficiency

» Review technology specific incentive schemes to focus on least cost abatement
» Review scope for more efficient economy wide carbon pricing where consensus
» Review Australia's emissions reduction target (2027)

### Outcomes: FAIRNESS & INCENTIVES

**2027**
» Networks pay over $1.1 BN pa for DER services.
» Over $1.4 BN in cross subsidies avoided, saving $350 pa for med size family without DER.

**2050**
» Networks pay over $2.5 BN pa for DER services.
» Over $18 BN in cross subsidies avoided, saving $600 pa for med size family without DER.

## INCENTIVES & NETWORK REGULATION

### Foundation: Incentivising efficiency and innovation

» Ensure extensive smart meter penetration
» Assign customers to new range of fairer demand-based network tariffs, with a choice to Opt Out
» Enable standalone systems and micro-grids as a substitute for traditional delivery models
» New innovation incentives in Regulation and Competition frameworks

### Implementation: Unlocking value of distributed energy resource orchestration

» Networks pay for distributed energy resource orchestration to provide system support in the 'right place at right time'
» New network tariffs that provide beneficial incentives for standalone systems and micro-grids to stay connected to the grid
» New and more adaptive regulatory approaches that are customer focused

### Outcomes: SAFETY, SECURITY, RELIABILITY

**2027**
» Planned and efficient market response avoids security & stability risks.
» Robust physical & cyber security management.

**2050**
» Real time balancing, reliability and quality of supply at small and large scale, with millions of market participants.

## INTELLIGENT NETWORKS & MARKETS

### Foundation: Essential information for an integrated grid

» Establish open standards and protocols to enable secure system operation, management and exchange of information and interoperability with distributed energy resources
» Networks enhance current system monitoring and models to inform advanced system planning
» Build distributed energy resource maps and feeder hosting analysis to support locational valuation of distributed energy based services

### Implementation: Networks optimised with distributed energy resources

» Active network management for technical stability, enabling distributed energy resource markets and efficient optimisation.
» Networks provide a suite of grid intelligence and control architectures to animate distributed energy resource markets, as well as providing system security.
» Establish a new network optimisation market to procure DER services for network support.
» A flexible and agile workforce to support the new optimised energy system.

### Outcomes: CLEAN ENERGY TRANSITION

**2027**
» Electricity sector carbon abatement to reach 40% by 2030 – greater than current national target of 26-28%.

**2050**
» Electricity sector achieves Zero Net Emissions by 2050.

## Electricity Industry Context

Until the mid-1990s, electricity generation was dominated by large thermal power stations using Australia's plentiful reserves of coal, supplemented by price-competitive gas resources. Gas prices have been affected in recent years by export pricing initiatives. Large power stations were often built next to coal mines in NSW, Victoria and Queensland.

Installed generation capacity increased from approximately 3 GW in 1955 to 30 GW in the mid-1990s. There was also an extensive web of transmission and distribution networks, interspersed with voltage-reducing substations and local distribution networks to deliver electricity to customers. Local and distributed generation was either abandoned or excluded from future network planning.[17] This long-standing trend has now been reversed, as large synchronous thermal power generation is giving way to a diverse array of different generating sources, such as wind and solar PV.

Development of the electricity sector in the late 1970s fed a large manufacturing base in the eastern states and South Australia, and electricity prices fell significantly. However, as demand grew and several energy intensive aluminium smelters came online, it became clear that greater generation capacity was required.

This led to the construction of new thermal capacity by the state-owned electricity commissions, although the long construction times and high cost of such power plants challenged state governments and the energy utilities. This led to price rises over time and an over-supply of capacity as the economy changed.

The high levels of investment required and the dependence on base load generation meant the market had little of the flexibility and agility afforded by the more diverse array of generation sources available today.

Consumers relied on the transport of electricity from power stations near coal mines across vast distances to urban centres. This increased the importance of companies such as TransGrid, a high-voltage NSW transmission firm carved from the vertically integrated, state-owned Pacific Power company.

These factors mean the NEM is the largest geographically connected power system in the world, stretching from northern Queensland down the eastern side of Australia and across to South Australia and down to Tasmania, through the submarine Basslink cable.

At the core of the NEM is the wholesale market where generators with a capacity above 30 MW are required to bid against competitive generators of all types for set five-minute intervals in one of the five regions within the NEM. Prices are settled every 30 minutes as the average of the prices in the six five-minute auctions.[18]

(cc) Global Access Partners Pty Ltd, 2017

Prices reached during off-peak or regular demand periods tend to reflect the short run marginal costs of production, whilst prices during peak periods – such as during a heat wave – can spike up to 25,000% to a cap of around $14,000 per megawatt hour. This volatile market is supposed to allow the heavy fixed capital costs of electricity generation to be recovered over the complete business cycle.[19]

The agility of embedded hydro and gas, together with other nimble generation sources which can fire up in a short term, allows them to profit from times of peak demand, particularly as these can be predicted with some degree of accuracy.

Some argue this disparity between the response times of base load thermal power and more nimble embedded alternate energy sources has not been fully addressed within the NEM, given its huge size and singular pricing mechanisms. The introduction of battery capacity, smart networks and sensors, micro-grids and behind-the-meter initiatives will bring increased pressure for changes in the NEM.

While most economists believe the NEM is an effective market mechanism, they also acknowledge its powerful price incentives for rogue behaviour, given its high prices at times of peak demand.

### Lessons learned from the South Australian blackout

An analysis by Carbon + Capital Markets in August 2016[20] of the South Australian outage points to rogue behaviour by operators of the state's gas and diesel plants. They contend that between 1:30pm and 10pm the output from the state's wind farms was just 9 MV - compared to a capacity of 1,200 MW - and dipped as low as 1.33 MW in one of the settlement periods.

For most of this time, electricity flowed through the Murray Link Direct Current interconnector from Victoria into South Australia, at an average of 126 MW. Due to upgrade works underway, the main Heywood interconnector had average imports of just 9MW and, for some periods, had outflows to Victoria from South Australia, despite much lower prices in Victoria.

Simultaneous peak demand on the South Australian power system averaged 1,863 MW over this period. This is not significantly higher than the average annual demand of1,500 MW and substantially below the highest peak demand of around 3,000 MW seen every year. However, as interconnector flows into South Australia were limited due to Heywood's upgrade works and wind farm generation was negligible, this left a larger than usual amount of generation to be met by the gas turbine and diesel plants.

An analysis of market data[21] shows that AEMO anticipated high prices and signalled this to the market twelve hours before the event. Despite the gas and diesel operators being warned that high prices could be anticipated, the generators failed to make more of their capacity available.

(cc) Global Access Partners Pty Ltd, 2017

Analysis[22] of the available generators, including Snowy Hydro, Engie, Origin, AGL and Energy Australia, shows that all generators except Origin were operating well below capacity. Carbon + Capital Markets concluded that the very high prices and shortage of supply experienced during the crisis was not due to becalmed wind farms, but the lack of competitive rivalry between the operators of the South Australian gas and diesel-generating plants.

The motivation for a generator to produce is a product of the cost of production, its contractual commitments, and the cost of purchasing power on the spot market. The fact that several generators did not dispatch additional supply, despite prices being many times above their production costs, suggests they were holding out for even higher prices, rather than competing actively. They were intentionally restricting supply to inflate prices even further to profit more in time.

While the NEM is widely seen as an effective example of micro-economic reform, this incident underlines that all markets are imperfect to some degree and problems such as these must be addressed by good regulation. There were a range of factors at play in South Australia, but the crisis was exacerbated by diesel and gas suppliers looking to collectively exploit the market rather than compete within it to satisfy customer needs.

The South Australian outage was not due to a single event or circumstance, but rather a range of technical, administrative, operational and increasing complexities within the NEM. South Australia is particularly vulnerable, given its position at the end of the network and reliance on broad pipes with Victoria.

The increasing mix of synchronous and non-synchronous generation and the growing reliance on wind and PVC has reduced the buffering and balancing capacity of the NEM to meet shocks from natural disaster events or major technical difficulties. Such impacts on network security and reliability must be addressed to maintain operational performance and confidence in the NEM in the future.

Investigations and reviews into the South Australian event continue and will doubtless identify an ever more complex interplay of causal factors. The AEMO Preliminary Report "Black System Event in South Australia on 28 September 2016" traces a series of interacting events which together triggered the blackout of over 850,000 customers across the state.[23]

These included the automatic shutdown of nine of the 13 wind farms that were operating at the time due to voltage dips in the network after high winds had damaged high-voltage transmission lines. The reduced input from the windfarm network increased the draw on the Heywood Interconnector and, when it was overloaded, it shut down, triggering a network shutdown when grid frequency and voltage collapsed.

Problems were exacerbated when the ancillary restart generators failed and could not reboot the grid to allow other generators to restart their synchronous operation. Power was only restored when the Heywood interconnector came back online and used to help the Torrens Island power station to restart its power generation.

(cc) Global Access Partners Pty Ltd, 2017

# Objectives and Outcomes of an Effective NEM

## National Electricity Objective

The current National Electricity Objective (NEO) is:

> "... to promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to – price, quality, safety, reliability, and security of supply of electricity; and the reliability, safety and security of the national electricity system." [24]

A similar objective is stated for gas, under the National Gas Law.

Today's NEO comprises several interdependent parts, including:

- the attraction of investment to ensure the development, maintenance, and efficient and effective operation of the NEM,
- ensuring these investments and the management of the NEM remain in the customers' interest,
- the need for clear outcomes regarding price, quality, safety, reliability, and security of supply to meet the long-term interests of the consumer,
- Delivering the desired levels of reliability, safety and security to the customer.

These objectives are as valid today as they were when they were written; however, the exclusion of environmental factors is a glaring omission.

The micro-economic reforms which created the NEM and similar privatised markets have been accused of overlooking the broader social and environmental factors that people within the market should consider.

However, the current omission of environmental considerations is more the fault of a rigid system being unable to evolve in the light of market and social changes. This lack of flexibility has also distorted market mechanisms, clouded investment strategies and left the consumer more of a price-taker than they should be.

The NEO should therefore evolve to reflect and facilitate industry adjustment to changes in technological and environmental factors, including the growth of renewables, storage technologies and different consumer needs.

In debates regarding regulatory changes, the AEMC argues that it is bound by law which prevents it taking environmental benefits, opportunities or consequences into account. However, the law should be a servant of common sense, and not its master, and laws which were made can be change.

(cc) Global Access Partners Pty Ltd, 2017

# Public Value and Duty of Care

Consumers have every right to expect a reliable supply of energy at a competitive price at a time and place of their choosing through a diverse array of climatic conditions.

While the pressing topic of climate change tends to focus attention on heatwaves, storms or other events, the impacts of bushfires or other damage to infrastructure should not be overlooked. Victoria has had several devastating fire events in recent years. One hundred and seventy-three people died in the 'Black Saturday' bushfires of 2009, a tragedy which cost the country $4.4 billion, according to the Royal Commission set up after the event.[25] The Insurance Council of Australia estimated the cost of personal claims on damaged property alone to be $1.2 billion.

Electricity distribution networks can also cause fires, as well as be damaged by them, when vegetation is not cleared from around their poles and wires. This was a cause of recent litigation between residents of the Blue Mountains in NSW and the energy distributor.[26]

This highlights the electricity industry's 'duty of care' and the issue of public value. Neither of these concepts is included within the current NEO, and they should be considered in a future iteration, given the importance of electricity to the community.

Energy, like clean water, is an essential element of individual wellbeing and social cohesion, as well as business and manufacturing. The way these basic services are being delivered is challenged by a range of technological factors and policy imperatives. Market signals are vital in a competitive market to attract investment and ensure the maintenance of assets, as well as attracting new entrants and retaining existing players.

Unfortunately, asset stripping, low levels of maintenance and price gouging have been a problem in many of the privatised capital-intensive utilities. This is not limited to Australia, as the UK's water industry has also seen problems with its reliability and service levels, but Australia's energy generation and distribution sectors have certainly not been immune.

These actions underscore the importance of a strong regulatory framework to protect customers and ensure standards of service, reliability and safety are maintained. A balance must always be struck, however, as the publicly owned system was accused of 'gold plating' the network and over-charging consumers to pay for it.

These problems have prompted calls for cost-reflective pricing and transparency around the elements which make up consumer charges. Consumers under the publicly owned system bore the risk – expressed through higher prices – of the inefficient, centrally planned over-investment in capacity. Similarly, they bear the risk of outages caused by under-investment in the privately run system of today. The precise importance of various factors which contributed to the South Australia incident may remain a matter of conjecture, but the result underlines the importance of appropriate

(cc) Global Access Partners Pty Ltd, 2017

network design and infrastructure, proper maintenance and the observance of operational rules and regulations to ensure a reliable and cost-efficient service.

Core infrastructure elements and market rules and regulations must reflect and respond to changes in the system and the interrelationships of other policies, including Federal and State policies on renewables and climate change.

(cc) Global Access Partners Pty Ltd, 2017

# The Case for Reform

The electricity market and its regulatory framework are not adequately serving the needs of market participants, power consumers or the nation. Current structures and arrangements are not able to meet changing market conditions and broader political and business objectives and must be reformed to allow more flexibility.

Business interests have called for greater certainty to encourage the long-term investment required. The Townsville Bulletin of 28 November 2016[27] noted a call from the chief executive officer of Sun Metals, one of the largest electricity users in Queensland, for reform of the electricity market to reduce costs through more frequent market settlements to improve efficiency, as 5-minute prices are currently averaged over 30-minute periods. Sun Metals electricity costs have jumped from $50 million to $70 million over the last twelve months on the wholesale market. Queensland's power market is still dominated by base load generation from thermals, and consumers are right to question what has caused this sharp price increase.

The South Australian outage left the BHP Olympic dam project without power for four hours and BHP Billiton warned that such incidents put investment and jobs at risk. The company called for policies to reduce emissions and guarantee supply to be jointly pursued.[28]

Consumers can now choose between 30 retailers, yet they lack the information and pricing transparency required to make an informed choice and therefore encourage real competition. The current level of competition has not driven down prices to consumers, although it has helped boost retailers' margins.

Customers pay the full network distribution charge, for example, regardless of their source of power and their distance from the generation point. As generation sources diversify and individual and community off-the-grid initiatives become more common, a shrinking number of network consumers will be left responsible for distribution cost recovery.

The average consumer is not well-informed about the choices available and how they should proceed. This has prompted the emergence of organisations such as The Big Switch, which not only have greater market buying power, but the knowledge and capacity to weigh up the choices available and make better decisions.

Merely creating the market and offering more choice and opportunity to 'shop around' should not be seen as the end in itself. Choice is a tool to improve prices and services to the consumer, while overall policy must take account of Australia's international commitments to reduce emissions to fight climate change.

(cc) Global Access Partners Pty Ltd, 2017

Technological innovation should help reduce prices and improve service quality, and lower barriers to entry for new participants should encourage a wider range of innovative solutions, with embedded generation, storage within networks, off-the-grid initiatives and behind-the-meter applications all having a role to play.

The NEM was always a large and complex undertaking, and this task has been further complicated by a host of new policy, regulatory and operational challenges. The NEM has outgrown its origins in micro-economic reform and must now be reshaped to improve pricing, functionality and environmental performance.

The NEM is now an exercise in complex project management. The International Centre for Complex Project Management says complex projects embody

> "uncertainty, ambiguity, dynamic interfaces and significant political or external influences". [29]

The NEM certainly falls under this definition.

(cc) Global Access Partners Pty Ltd, 2017

# Impacts and Opportunities from the Changing Generation Mix

## Renewables vs Base Load Debate

Arguments about the merits of base load versus renewable generation are not only old, but increasingly outdated. It is no longer useful to pit one against the other. A more nuanced debate should assess the sources of generation we have access to, what their cost structures are, and whether they can deliver the electricity required in a reliable fashion at a competitive price.

Experience in Europe, the USA and the UK shows that reductions in base load thermal power are required to meet carbon reduction targets. The question in Australia is not whether this should occur, but how the transition should be managed to ensure stable and affordable supplies in the NEM. While environmental goals are not the only priority, it should be remembered that traditional power stations have their risks too. A smaller number of larger power stations make the network more vulnerable to terrorist or cyber attack, accidents or natural calamity. The large brown coal fires at the Hazelwood plant affected generation, for example, among the other problems they caused.

Work at the University of New South Wales by Dr Mark Diesendorf, based on over six years of NEM data, suggests that Australia could generate all its power from renewables, although this would require a revolution in thinking. In 2012, he called for a 'radical 21st century re-conception' of the electricity supply-demand system.[30] Instead of base load coal, reliability would be maintained by maximising the diversity of renewable sources, backed by a large array of turbines or electricity storage.

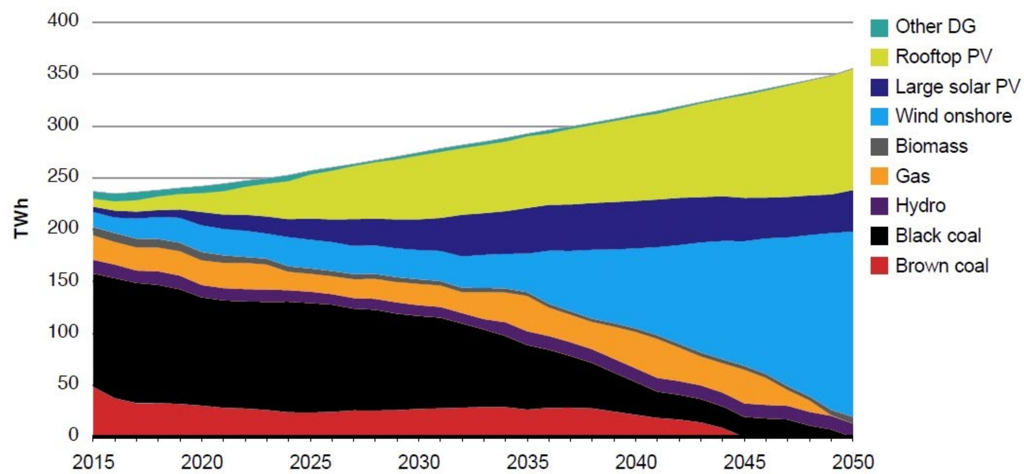
The Bureau of Resources and Energy Economics suggests that the most cost-effective mix in 2030 would be:

- 46% wind
- 22% concentrated solar thermal with thermal storage
- 20% solar PV
- 6% hydro
- 6% gas turbines burning renewable fuels[31]

The graph below, from the Electricity Network Transformation Roadmap report[32], offers a similar spread of generation sources in 2050, with the phasing of coal and greatly expanded rooftop PV and onshore wind power.

(cc) Global Access Partners Pty Ltd, 2017

**Figure ii:** Plausible projection of Australia's changing energy mix to 2050




# Impact of Changing Technologies

Germany now sees traditional base load as a concept of the past and looks forward to a future dominated by renewables.[33] This view is shared by many European countries, including Denmark and Scotland, while at home South Australia, Victoria and Queensland have set ambitious renewable targets, although they recognise the need for a balance to ensure security of supply. This is echoed in countries such as Poland, which is also seeking a balance between renewables and base load due to concerns over reliability. [34]

The rapid growth in Poland's wind power has stalled as a debate over land use led to restrictions on future wind farms which rule out almost all suitable sites. Poland will therefore burn more biomass with coal in existing conventional plants to ensure a reliable supply. Poland's Minister of Energy had warned that wind generation of just 12% raised concerns over reliability. [35]

Australia must identify its optimal mix of generation sources and modes of delivery, given the market, administrative and operational opportunities and constraints which apply. These considerations should ensure that consumer and national needs are met by fit-for-purpose administrative, operational and regulatory frameworks working to achieve a refreshed NEM objective.

This will require a total-systems approach to the NEM, rather than tinkering at the edges of the current system. The South Australian blackout shows the importance of understanding the differences between various forms of generation and the complex ways in which generation, distribution and market forces interact.

(cc) Global Access Partners Pty Ltd, 2017

Synchronous generators, such as coal fire base load stations, maintain steady levels of output, while the power generated by renewables, such as wind and solar, can vary widely depending on the weather. Thermal generation plants cannot simply be replaced on a one-to-one basis with renewable capacity, and a mix of sources will be required to ensure reliable supply under a wide range of conditions. This diversity should be seen as a strength, not weakness, of the new system.

The greatest challenge is one of regulation and management, rather than technology. The more complex, diverse and multifaceted the NEM becomes, the more it must be approached as an analytical challenge to ensure the right signals are sent to the market to achieve the operational and social goals required.

Many argue that the challenges, complexity and critical importance of redesigning the NEM require the establishment of a new network planning authority. It is argued, with some justification, that the market alone will not generate the optimum set of solutions as operators are motivated by the profit motive and will not take social and environmental externalities into account unless forced to by regulation.

Prof Ross Garnaut has also endorsed the establishment of a grid planning authority. At the RePowering NSW conference in October 2016, he said:

> "If you have decisions on new investment whether they're replacement investment or expansion of capacity, in the hands of an authority looking at things in the public interest you can then put out to tender new investments and reduce the costs of providing them." [36]

Given recent outages, it is perhaps surprising that AEMO believes the closure of Victoria's Hazelwood coal-fired station in March 2017 will have a negligible effect on the reliability of the Victorian and South Australian grids as Hazelwood currently supplies some 14% of scheduled and semi-scheduled generation capacity.[37] Their modelling suggests that reliability standards will be comfortably met if the 'market responds in the manner expected', but given the evidence of rogue behaviour and gaming of the system in recent times, this confidence may be misplaced.

A paper by Synergies Economic Consulting[38] discussed a range of interesting and complex issues around energy transmission and the performance of the NEM against the Hilmer principles in a period of disruptive change:

> "Australian energy markets are changing in response to a combination of factors including technical change, price change (some of which is driven by government subsidy), policy imposts, most notably driven by climate change policy, and consumer preferences. For example:
>
> - A notable shift towards wind generation driven by combined forces of technological improvements in wind generation and renewable energy targets,
> - Rapidly rising electricity prices and reductions in solar PV prices have resulted in a substantial uptake of behind the metre solar installations, which impacts on network service providers and centrally coordinated generation,

(cc) Global Access Partners Pty Ltd, 2017

- Storage, either in front of or behind the meter is growing as a viable adjunct to renewable generation and a substitute for new generation, transmission and distribution capacity."

A shift towards pricing which better reflects network costs and time-of-use metering would help customers make better decisions. Indeed, demand management will increasingly be placed in the hands of the consumer, as more behind-the-meter investment and opportunities arise. The NEM will become a more distributed and sectionalised market, but will still require a high degree of connectivity to protect against distribution shocks from man-made and climatic events, as well as performance failures.

The Synergy Economic Consulting paper argues that the natural monopoly of the network businesses will shrink over time, and economies of scope - such as the use of batteries at sub-stations - will become more important in determining customer outcomes. This will produce significant regulatory challenges, as one of the core drivers of the Hilmer reforms was to disaggregate business to reduce economies of scope.

Hilmer and Harper recognised the benefits of creating competitive electricity markets to drive efficiency and reduce prices to encourage economic growth and job creation in the wider economy. Choice is now being expanded through a range of technological innovations, rather than merely increasing the number of retail sellers, and regulation should now encourage this trend in turn.

Developments that will challenge the current suite of rules and regulations include:

- Smart meters to encourage more efficient energy use and provide the detailed real-time data which providers will need to balance load in a much more complex system, with different generators producing varying amounts of power balanced by network storage and behind-the-meter batteries.
- Energy management services. Smart meters will need new software and platforms to allow customers to take full advantage of the new flexibility they provide. Such software would help regulate the use of home appliances and control the flow of electricity between solar PV units, battery storage and the grid. New-generation aggregators could package these services for customers and optimise their performance by selling surplus supply to the grid or into broader battery storage.
- Micro-grids. Local energy grids powered by distributed generators, batteries and/or renewable energy can not only meet the needs of customers within the grid, such as a large university campus or small communities and towns, but can also increase the reliability and resilience of wider power networks.

(cc) Global Access Partners Pty Ltd, 2017

- Smart networks and sensor networks will help network operators monitor their energy distribution and network performance and optimise energy flows. Smart networks have the ability to gather data, analyse it and choose the best course of action in a complex set of options and scenarios to maximise the benefit to the individual consumer, as well as the network at large. Smart networks will increase network flexibility and help shape ongoing investment streams.
- Distributed System Platforms (DSPs) are being developed in the USA to allow the integration of activities in formerly separated supply chains. DSPs do not undertake the normal asset-related functions of network businesses, but do allow networks which operate under different regulations to interact.
- The Internet of Things (IoT) will help combine the use of smart meters with devices in the home to optimise their use of electricity and exploit off-peak tariffs.

The telecommunications dark fibre embedded within electricity supply networks is a rich and untapped source for innovation not just within the network, but between the network businesses and the consumer. The smart house envisioned and built by CISCO some 20 years ago as a marketing tool in Rozelle, Sydney is now a readily achievable goal for the house builder or renovator.

It is unfortunate that the NSW government did not separate the dark fibre within fibre optic cables from their recent sale of electricity assets. The potential of dark fibre has not been tapped as a result, and measures to encourage its use for data transfers should now be encouraged to benefit all stakeholders.

# Network Design and Performance for Security and Reliability

The NEM once involved one-way flows of power from large thermal-power generators to consumers on a single network. A modernised NEM will be a complex web with multiple sources of thermal and renewable generation, distributed storage and two-way flow of energy. While the original NEM could balance the production of its coal-fired synchronous generators to mitigate against network faults, shocks and disruptions, this 'self-correcting' network must be replaced by more sophisticated techniques in the future as the number, location and type of renewable, non-synchronous sources increases.

One of the main short-term options exercised to maintain frequency control is load shedding; however, this technique does not address long-term security and reliability issues, has a direct impact on consumers and masks the fundamental problem of frequency control within an increasing diversified network. The Finkel Preliminary Report[39] outlines the technical answers available, and wind turbine controllers, synchronous condensers and strategically located batteries within the network and behind the meter can all contribute to the solution. However, their introduction will require updated frameworks, new technical standards and perhaps refreshed NEM rules. As the decommissioning of thermal-power generators continues, the retention of some of their spinning capacity at strategic locations should also be considered to buttress network security and reliability on a local and regional basis.

Network transition must be planned, rather than left to the market, to ensure it remains technically robust, reflects the changing needs of society and embraces the full range of options available. A framework of choice optimisation within a total-systems approach is required as the investment market should not be left to drive the location, type and integration strategy of future generation and network capacity alone.

If such investments are undirected and uncoordinated, the problems apparent in the NEM today will be exacerbated rather than solved. This underscores the importance of creating a new authority with overall responsibility to design and plan the technical and engineering transition of the NEM. Only this type of body will be able to consider all the geographic, technical and operational issues of electricity generation, transmission and distribution involved.

The advice of the International Energy Agency to the Finkel Review[40] views the central challenge as designing markets that are fit for purpose in a world of more renewables:

> "Achieving cost-effective and secure integration of VRE generators by transforming electricity systems requires better integration of VRE generators through the development of flexible technologies that provide dispatchable generation, improved grid infrastructure, storage and demand side management. Successful system transition involves:
>
> - improving short-term system and market operations to ensure efficient dispatching and ensure security of electricity supply;
> - ensuring resource adequacy in the longer term, including system-friendly VRE deployment to maximise the benefits of VRE and investment in additional flexible resources;
> - better coordinating policies and actions across several jurisdictions on a regional basis; and
> - tapping the potential of distributed resources to boost retail competition and supply security: micro generation, demand response, storage, behind the meter."

(cc) Global Access Partners Pty Ltd, 2017

# An Engineering Perspective

The following summary of technical points on generation and system design, security and reliability explored by engineering members of the NSCEE shows the complexity of the challenge ahead.

One of the big concerns about the coming transition to a largely renewable electricity supply is ensuring reliable and robust generation. Cost is becoming less of an issue, as wind and solar are already cheaper than gas and new coal plants on a simple cost-per-kWh basis. The question is how to match supply with demand for 525,600 minutes every year across 9.5 million customers and at what cost, given the need for back-ups and grid enhancements.

While this is a complex market and regulation problem, it is also a huge engineering challenge. Hundreds, if not thousands, of engineering professionals are currently designing and building the Melbourne Metro, for example, but redesigning the electricity grid will be one if not two orders more complicated. Furthermore, the parameters will continue to change while the process is underway.

For example, with the arrival of Tesla's Powerwall 2, the cost of home storage has fallen by 60% in two and a half years. In ten years, typical wind turbine output has increased by a factor of ten. It is difficult to build a 15 or 20-year plan when the environment is changing so quickly, akin to designing a transport system for vehicles weighing no more than 10 tonnes and discovering half way through that people now want to run 60-tonne B-double trucks over all the lightweight bridges.

A concentrated effort to bring Australia up to current international levels of energy efficiency could reduce primary energy consumption by 30-40% over the next 10-15 years. While there would be some substitution from gas and liquid fuels to electricity, a sustained push for energy efficiency could reduce electricity use by an average of 4-5 TWh per year, while electrification of transport and heating would add 1-2 TWh to demand. Thus, in ten years' time annual demand on the NEM should be no more than 175 TWh and may be as low as 150 TWh.

The question is how to supply it. A new 600 MW coal-fired power station would cost about $1.2 billion today, while a new 600 MW wind farm costs about $1.5 billion. The wind farm produces about two thirds of the power, but saves about $110 million a year in fuel costs.

Without even considering the costs of pollution or cooling water, it is clear that the lifetime cost of power from a wind farm is less than power from a new coal-fired power station before grid and back-up costs are factored in.[41]

Solar PV is only slightly more expensive, but the gap is closing rapidly as confirmed by a new study by CSIR – the equivalent of the CSIRO in South Africa.[42]

(cc) Global Access Partners Pty Ltd, 2017

As a result, it is difficult to see an economic justification for new coal plants, although considerations of environmental impact and reliability of supply clearly affect such decisions.

The situation with gas is similar, although for different reasons, as Australian gas prices are two or three times higher than those in the USA where gas is making strong gains. Export parity pricing for gas will continue to affect its use to drive generation in the future.

### Back-up Capacity

There are three scenarios where back-up is required:

1. A lack of capacity where more demand means more generation must be available at short notice;
2. Grid faults;
3. Generator failure.

A lack of capacity can occur for many reasons. Drought not only affects hydro schemes, for example, but can reduce the amount of cooling water available for coal-fired plants, and scheduled maintenance can take any sort of generator offline. Problems with fuel, cooling or maintenance are usually known at least a day in advance, and so other generators can be scheduled to shoulder the burden in an orderly way. This lead-time also applies to wind and solar production, as state-wide, 24-hour weather forecasts allow projections of wind and solar output which are usually within 2-5% of actual production figures. This is a tighter tolerance than forecasts of demand, and allows the system operator to accurately schedule enough supply accordingly.

The big problem is unexpected outages, and to cover this possibility, there should be enough spinning reserves to cover the loss of the biggest generator or power plant. As an example, if Torrens Island is operating all its generators, it can supply about 1.2 GW and so somewhere in the system there must be generators or interconnectors online which can increase output by 1.2 GW if the transmission line from Torrens Island was cut.

The largest wind farms in the country can produce between 50 and 80 MW, and so around 100 MW of spare capacity is required to support them in the short term.

Studies by the Electric Reliability Council of Texas have shown that the cost of providing and running spinning reserves for coal-fired generators exceeds the cost of cold back-up for solar and wind. By the end of 2017, Texas will have installed enough wind power to cover 35% of total NEM demand.

At a notional mix of 40% wind, 40% solar, 10% gas and 10% hydro, biomass, geothermal wave and tidal, Australia would need to install an additional 25 GW each of wind and solar capacity.[43]

(cc) Global Access Partners Pty Ltd, 2017

At least half of the solar capacity can be on roofs and over carparks and other amenities. In fact, NREL studies in the US show that all peak demand could be covered by roof-mounted solar.[44] This suggests that no more than about 12 GW might come from solar farms. A single axis tilt solar farm can produce around 35 MW per square kilometre while using 20-25% of the land. Grazing and some horticulture are quite compatible with solar farms. The total area of the solar farms required would be about 460 square kilometres, or an area less than 22 kilometres' square. Another way of looking at it is that the area of solar farms needed in Australia is about 7% of the area currently covered with water in major water supply dams.

New-generation wind turbines can produce 12-20 GWh per year each, so there will be a need for 3,600 to 5,000 units. While the farms would cover an area of about 350-400 square kilometres, the actual land use is less than one quarter of 1% of the total.

NSW, for example, would need around fifty 30-40 turbine wind farms to generate 40% of its power needs. These can be located throughout the state, but in total, the area would amount to 145 square kilometres – the area of Lake Eucumbene or around 1% of the Liverpool plains.

In the case of Victoria, an area the size of the existing coal precinct in the Latrobe Valley would generate 40% of the state's power from either wind or solar farms.

This shows there is ample opportunity to place renewables close to centres of demand, and should change the perception of the NEM being one long elongated network. A modernised NEM should be seen as a series of strategically located energy-generating sources, located according to a series of technical, climatic and operational parameters, and interacting within a planned and coordinated redesigned network.

Change therefore requires a fundamental rethink of the way the NEM is designed and reconfigured. The transition from one large integrated network to a network of multifaceted diverse sources of energy generation will require 'a systems within systems' approach.

### Interconnectors

The huge amount of ready space available also means that, unlike Germany, the USA or China. Australia has no need to build long, high-capacity transmission lines from good sources of renewable energy to population centres. While interconnections are always positive, it can be argued that with optimally distributed generation and storage, new links to South Australia or Tasmania could be unnecessary. However, strengthening the NSW/Queensland and NSW/Victoria interconnectors may be very useful, considering the drive to a high dependency on renewables in both Queensland and Victoria, and an additional NSW/South Australia link should also be considered.

By way of comparison, the link from South Australia to Victoria can handle around 25% of peak demand, and Tasmania to Victoria around 20%. Internationally, the links between various grids in Europe and the US range from about 4-15%, with the probable exception of Denmark.

(cc) Global Access Partners Pty Ltd, 2017

Based on recent contracts for 200 MW of storage on the UK national grid[45], South Australia could probably install 500-700 MW of distribution grid storage for the cost of a new South Australian interconnector. This would supply faster fault response and improve the utilisation of local generation more than another interconnector.

Similarly, for the cost of Basslink 2, Tasmania could install 400 MW of wind and solar which would complement the capacity of the existing hydro to the extent that Basslink 1 was normally only used for exports.

Because Australian energy density is so low, renewable resources can be widely spaced from north to south and east to west and ensure constant supply as at any one time they will be subject to a wide range of weather.

### Storage

There will be a need for storage, but much less than normally supposed. The first step should be to reposition the role of hydro power to support other renewables. Current hydro capacity could already meet 25-30% of projected peak demand. Further, US research suggests that peak hydro capacity could be expanded a least 10-15% from existing dams, and as numerous studies have shown, there are hundreds, if not thousands, of sites where pumped storage can be installed around the NEM. In a limited study in 2012, for example, ROAM Consulting identified more than 34 GW of potential pumped hydro capacity within the NEM, i.e. 25-30% more than projected total peak demand.[46]

In addition, consumers and distributors are already installing batteries. By the end of 2017, there will be around 200 MW of new storage behind the meter in Australia. It is likely that over the next 10-12 years there will be 2-3 million systems installed to store customer-generated power and avoid peak-demand charges. The announcement of pricing for Tesla's 7kWh Powerwall 2[47] means that home battery storage is now an economic decision, not just a green or emotional one. There will also be hundreds, if not thousands, of systems across the distribution grid to minimise investment in poles and wires and avoid the expense of peak gas generation. In total, it is likely that there will be 6-10 GW of site storage in addition to hydro/pumped hydro.

### Demand Shifting

There are also significant opportunities for household demand shifting in heating, cooling and water pumps as well as battery charging for electric vehicles. Converting power to heat is a cheap and efficient way of storing energy. A 400 L double-insulated smart hot water service can store the equivalent of 21 kWh of energy at around one tenth the cost of batteries and not draw power from the grid for three days if necessary. Smart controls can allow it to take advantage of any cheap time window to top up, rather than only the middle of the night.

(cc) Global Access Partners Pty Ltd, 2017

By the same token, ice can be made with excess power for air-conditioning and refrigeration to reduce demand at peak times. If hot water is produced during the afternoon solar peak - or ice is produced in the cool early morning - then heat pumps will also use a third less energy than at times of peak demand.

Demand shifting can also be applied in commerce and industry – so much so that in Norway the industrial demand response market can reduce demand by 10%. In total, demand shifting could reduce peak demand by another 6-10 GW on low wind or overcast days.

Most electric cars will need to be charged for 5-8 hours every three days. This period can usually be shifted to suit cheaper power availability, and if charging turns on and off for five minutes at a time to capture peaks, then costs will be reduced even further.

### More Efficient Generation and Distribution

On-grid storage can also improve the efficiency of existing generation and distribution. The bulk of the storage to be installed under the recent National Grid contract is at combined cycle and biomass plants. This means the plants can start generating before peak demand to charge their batteries, run with batteries to sell even more power at the peak, and then ramp down later after recharging the batteries, so the plant runs for six to eight hours at a time, rather than four or five hours. It also means that plants can be stopped, but still be classed as ‘spinning reserve’, because they can ramp up to full power while their batteries are supplying electricity flat out for 1 to 30 minutes.

If other storage is available at distribution transformers or on premises, even if it is installed in front of the meter by the utility, it can significantly reduce the size of wires and transformers, which otherwise must be designed for 40 hours’ peak demand every year. Further, it reduces line losses, which are proportional to the square of current, because the storage will be recharged at periods of low demand.

Finally, there is the option of solar thermal with storage. While this appears expensive at $130 MWh, it compares very favourably with the cost of peak gas which can have a break-even at over $320 MWh when gas prices reach $25 GJ which they regularly do in Australia. [48, 49]

### Summary

Modern control systems, incorporating storage and demand response, rather than inertia and spinning reserves, can therefore improve system reliability while reducing operating costs, transmission losses and emissions.

However, achieving the most appropriate mix of generation, location and network design is a hugely complex engineering challenge which the market cannot and will not respond to in a coherent and structured way. Nor will individual market decisions necessarily be in the best long-term interest of the consumers or the NEM as a whole.

(cc) Global Access Partners Pty Ltd, 2017

This underlines the need for the creation of a single authority tasked with overall network design and transmission planning. Such a body would not only model and design the optimised network design, but release proposals that the market could respond to.

International experience shows that, if the will exists, a grid based on distributed generation and storage can be cheaper, more reliable and more robust than a traditional coal and gas-fired system. During the South Australia blackout, for example, 220 MW of South Australian wind farms went offline in the first interruption, but the rest did not go offline until the system started to crash and protection systems disconnected the remaining wind generators as well as the overloaded Heywood interconnector. The entire power system was brought down by a cascading failure when the emergency gas turbine failed to provide the frequency support they were contracted to offer. However, it is possible that if AEMO had followed American practice and restricted power on the interconnector and increased local generation, then the system south of the faults would have recovered in seconds without going black.

The alternative to conventional hot 'spinning reserves' of turbines running just in case is storage. Batteries, flywheels, pumped hydro storage and hot water all have far better ramp rates than gas turbines and so provide a better bridge to hold up voltage and frequency. Storage also offers stable and predictable prices, unlike gas turbines which are subject to wide fluctuations in the price of their fuel. Gas turbines are better able to cover long outages because they can run for days or weeks if necessary, but short-term fluctuations should be increasingly covered by storage. Short-term response can also be garnered from asynchronous flywheels on turbines, geared to $100^{th}$ of their size, to produce a spike of energy as required.

Whatever path is chosen, the South Australian incident proves that diversity of supply is the solution, rather than the problem. When large changes of load can be expected, it is prudent to limit supply from any single source and spread the burden across a range of generators. If thunderstorms, heat waves or winter storms are forecast, this will allow other parts of the grid to take up the slack if a particular generator or set of high-voltage lines goes down. Furthermore, if power stations, transformers and transmission lines are running below their peak capacity, they are much less likely to fail in the first place.

(cc) Global Access Partners Pty Ltd, 2017

# The Need for a Network Audit

The current NEM is hampered by a lack of awareness of the scope, type and number of renewable energy initiatives and a lack of data on customer-solar and behind-the-meter opportunities.

An audit of the NEM's five operational regions would allow the mapping of its ever-more diverse sources of power, including household PV, and allow areas of concentration and synergy to be leveraged more efficiently. More accurate information would help accelerate change in a more ordered way and boost investor confidence.

Ultimately, the NEM should not be regarded as a five-region network, but as a multitude of interconnected micro-, mini- and sub-regional networks. Each locality will have its own mix of generation, distribution and dependency on external network sources, but if properly organised, the parts should be more than the sum of the whole.

AEMO publishes a series of National Transmission Network Development Plans, with the latest released in November 2015[50]. These plans offer a strategic view of the national transmission grid's development over the next 20 years. Whilst it is certainly detailed, it relies on industry data rather than customer information, and so cannot offer the full picture. The 2015 report[51] comments on rooftop PV and other domestic generation technologies that:

> "these devices are typically not registered and controlled in the same way large generators are. Information on the location, extent and operation of these technologies will be needed to accurately forecast operational consumption, manage the supply/demand balance on the system and plan the power system for the future".

This underlines the need for a more comprehensive audit of generation sources and localities to include those within households and micro-grids.

# Climate Change

Australia has struggled to produce a coherent policy towards climate change for a number of reasons. The issue has caused significant political problems for both sides of Parliament, and while many politicians would rather ignore the issue as a result, climate change measures and energy policy must be integrated and harmonised to improve the outcomes of both.

The lack of a consistent market-based approach to carbon pricing has been a major stumbling block, and the absence of a coherent federal policy has encouraged states to pursue their own individual renewable targets, further distorting the performance of the NEM.

Australia's ratification of the Paris Agreement to reduce emissions by 26% to 28% on 2005 levels by 2030 must drive broad reform in the electricity sector, as emissions from coal-fired stations are a major contributor to carbon pollution.

The Australian Government is now committed to a renewable energy target of 23.5% by 2020, whilst Labor has a target of 50%. The harmonisation of Federal and State targets would be a major step forward, but the states have much more ambitious goals than Canberra. Victoria aims to achieve 40% by 2025, Queensland 50% by 2030 and South Australia 50% by 2025.

In November 2016, NSW joined Victoria, South Australia and the ACT in a pledge to reduce carbon emissions to a net zero by 2050, although it has not set a specific aim for renewable energy. The NSW Climate Plan looks to a number of policy directions to reduce emissions, including enhancing investment certainty for renewables, boosting energy productivity and growing new industries. Specific initiatives will be outlined in a set of actions plans, including a climate change fund and an energy efficiency plan.[52]

The Climate Change Authority produced a Special Review of Climate Policy Options[53] which recommended a coordinated set of policies to reduce emissions. This 'policy toolkit' approach would build on existing schemes, including the Emissions Reduction Fund. The Review also recommended an emissions intensity scheme for the electricity sector which would set an emissions baseline which should reach zero well before 2050. Generators would purchase credits from energy efficiency projects to help them meet their baseline obligations.

The announcement of a Review of Climate Change Policies by the Australian Government on 5 December 2016[54] is a major step forward. The Minister for Energy said the review would focus on electricity price rises, energy security and cutting greenhouse emissions and will also look at the introduction of an emissions intensity scheme for electricity generators.

(cc) Global Access Partners Pty Ltd, 2017

However, subsequent announcements by the Prime Minister made clear the Climate Change Review would not contain an emissions intensity scheme, and divisions on the subject within the Coalition, and the nation as a whole, threaten to once again derail progress towards decisive action or anything which smacks of a carbon tax.

The Minister for Industry, Innovation and Science[55] directed CSIRO to help create a more coherent approach to climate change challenges, and it can only be hoped that a genuine commitment to address issues of public good will arise from additional research.

While concern over climate change is sometimes seen as an issue of interest to sophisticated urbanites, there is significant support in rural communities for greater action. A survey of 1,300 primary producers[56] conducted by Farmers for Climate Action with the cooperation of the National Farmers Federation found that 88% of respondents wanted rural and regional politicians to take up the issue. These farmers also detailed the effects of climate change they had already noticed on their land:

- 67% of respondents noticed changes in rainfall,
- 47% found more frequent and worse droughts,
- 42% observed increased temperatures, and
- 22.5% noted more severe bushfires.

On 27 November 2016, CSIRO and the Bureau of Meteorology released climate change projections based on data drawn from 40 global climate models. They noted that Australia's average surface air temperature has increased by 0.9% since 1910, while sea levels have risen about 20cm over the past century.[57] Northern Australia has become wetter over the last 40 years, South Australia drier, and the number of fire days has increased in many areas across the nation.[58] Many areas of the country have sweltered through an exceptionally hot summer this year, and Sydney suffered its hottest month on record in January 2017[59].

Australia has committed to reducing its carbon emissions; however, it is less clear how that will be achieved within a market-based economy with an inconsistent approach to emission policy and a reluctance to explicitly link climate and energy policy.

Continued delay and uncertainty in this vital sphere of policy will undermine the confidence of investors as well as the public and hamper the ordered transformation of the electricity sector from thermal power stations to renewables over the next two decades. Australia deserves a stronger and more consistent policy approach on an issue of global significance.

Data presented at the 2016 Australian Clean Energy Summit by Bloomberg New Energy Finance[60] shows the importance of consistent policy settings to encourage long-term investment. Total clean energy investment in Australia declined from US$6,708 million in 2011 down to US$2,562 million in 2014, following the election of the Coalition government in late 2013.

(cc) Global Access Partners Pty Ltd, 2017

Just as governments took action to encourage the uptake of household solar panels to meet both environmental and power production goals, so a similar approach should encourage new behind-the-meter energy solutions. Pilot schemes to showcase the potential of micro-grids, battery storage and behind-the-meter schemes could be funded to encourage more areas to take an integrated and renewable approach, not only reducing their own energy prices and increasing local energy security, but contributing to the national effort to combat climate change. Such schemes should be pursued in concert with transformational change of the NEM to maximise results.

The Australian water industry has seen water treatment and desalinisation plants financed within a strong public policy approach. The private sector responded with Build, Own and Operate (BOO) structures, as well as Build, Own, Operate and Transfer (BOOT) public-private partnership-funded initiatives to increase capacity and meet environmental aims.

The water supply crisis that forced governments to act is not dissimilar to the current problems in power and could provoke a similar response. The question for government is not whether new investment is needed, but the technologies and areas where it should be directed. Public-private partnerships transfer some of the risk of funding and operations from the government to the commercial sector, while allowing the public sector to fulfil its duty of 'keeping the lights on'.

Existing government R&D and industry development schemes should initiate a call for proposals in relevant areas, not least the software and tools which customers need to understand and exercise their choices. Such software is critical to the expansion of micro-grid and will help customers' manage their demand in the future, reducing the burden on generation and reducing emissions and costs.

(cc) Global Access Partners Pty Ltd, 2017

# The Consumer Perspective

A customer-driven approach to the future of the NEM will influence the growth, design and operations of electricity generation, use and management for years to come.

Customers want reliable and secure supplies at fair prices and the information they need to make better choices. The NEM's purpose to increase competition between suppliers was not properly supported with the regulations and transparency customers required to make the most of that choice. Customers have continued to be price-takers within a labyrinth of wholesale and financial market interactions which have not reduced prices to the extent hoped, although they have usually maintained security of supply.

Consumer bills have not outlined the costs of production and distribution, leaving customers open to exploitation by transmission, distribution and retailing companies. Network and distribution charges account for over 40% of residential customer bills[61], but these are average figures and do not reflect the location of the generation source or distance of transport required to the individual customer. The introduction of cost-reflective pricing that reflects the actual cost of network services to the customer has therefore been suggested to enhance transparency and improve efficiency.

Merely having a range of retailers to choose from is not the answer when customers generally lack the ability or resources to make informed decisions about their suppliers and their bills.

Increases in rooftop solar panels, behind-the-meter battery storage and opportunities for consumers to go off grid or join micro-grids will revolutionise the market place. The NEM has not been able to respond appropriately to change since its formation, and there is a great deal of pent up demand for alternative solutions to increase choice and transparency and offer independent and environmentally friendly options.

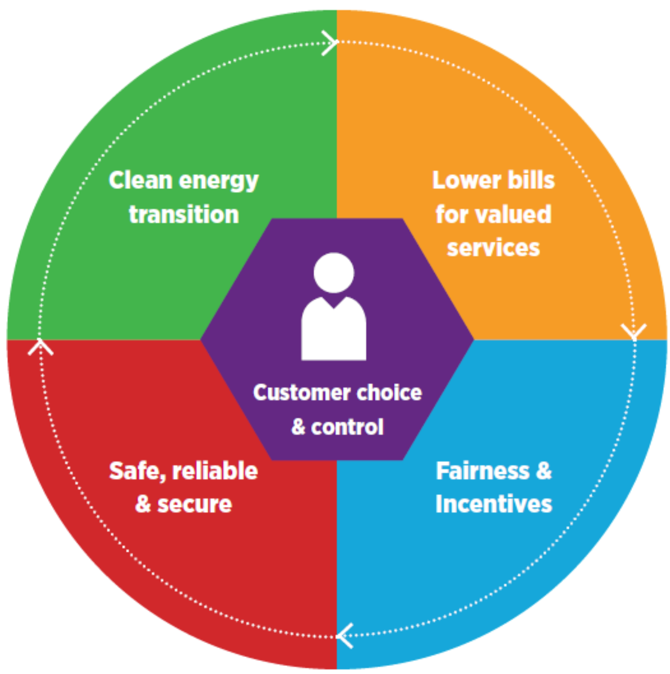
Access to new analytical tools and the convergence of electricity and ICT networks through the IoT will allow consumers to benefit properly from disruptive technological change. 'Intelligent' systems will allow customers to use their domestic energy production from solar panels and behind-the-meter battery storage to manage their use of grid energy and sell energy to the system, allowing them to capture the price benefits of change.

There will be an increasing market for value-added services from new entrants which will further challenge the role and operation of current network and transmission operators. A range of rules and operational constructs within the current NEM must change, if the customer and current and future companies are to work effectively within this diverse and hybrid situation.

(cc) Global Access Partners Pty Ltd, 2017

The 'Balanced Scorecard of Customer Outcomes' reproduced below was developed by the Electricity Network Transformation Roadmap report[62]:

**Figure i:** Balanced Scorecard of Customer Outcomes




The report underlines that

> "changes will be needed to retain power system security, while saving customers money through efficient use of distributed energy resources, standalone systems and micro-grids. The timely development of technical standards and new information platforms will be required to animate new distributed energy resources markets and support enhanced customer services." [63]

# Conclusion

While the NEM has largely fulfilled its original objective of micro-economic reform, its success has been tarnished by the inability of its policy, administrative, regulatory and operational structures to recognise and adjust to continued change in a coherent and timely fashion. The dogmatic reliance on market principles to solve social and environmental problems and inflexible regulation has created an unnecessarily unreliable and expensive grid.

The South Australia blackout and Australia's Paris commitment to emissions control offer a fresh opportunity for a whole-of-systems approach to transformation. The complexity of the issues involved should increase the urgency of reform, rather than be used as an excuse for political inaction. This is not merely an appeal for the spending of more public money. Markets as diverse as Texas and Spain show that rule changes can reduce costs, increase reliability and tackle pollution.

The NEM of the future will be very different to the market of today. It will have higher levels of renewable generation, strategically placed storage, repurposed hydro, faster demand response, multiple micro-grids, behind-the-meter initiatives and significant two-way flows of electricity.

The most appropriate combination of these and other factors, and the effects of their local and national interactions, is still to be defined, and better data will inform improved decision-making for both consumers and policy makers. Rather than the government or market dictate solutions to each other, the complexity of the issues requires genuine cooperation between government, industry and community partners to maximise benefits for all.

Technological disruption and consumer empowerment will demand a dismantling of the hierarchical structures of the current NEM to a more open framework which engages stakeholders, rewards innovation and encourages investment. Transformational change requires bold, far-sighted and strong leadership, but it also demands an abandonment of dictatorial impulses for a more collaborative approach.

The Finkel Review should deliver a final report which provides a suitable blueprint for change and identifies the structural, policy and administrative changes required to meet the challenges of today and tomorrow. Progress will require its acceptance and implementation by Federal and State governments, as well as the industry. Suspicions that the Review was ordered to postpone difficult decisions will not be allayed if its final report is ignored.

The recommendations in this paper are intended to complement those of the Finkel Review, but whatever the differences between the two documents, they will share the same plea for urgent action in the national interest. Environmentally responsible energy security at a fair price should be a politically bipartisan aim. While politicians will inevitably disagree about specific methods, they should all share the same goal of a better energy grid for all Australians.

(cc) Global Access Partners Pty Ltd, 2017

# Appendices

## NSCEE Membership

Mr Brad Archer
Assistant Secretary, Climate Change
& Renewable Energy Division
Department of the Environment
Australian Government

Mr Jack Archer
Chief Executive Officer
Regional Australia Institute

Mr Stephen Bartos
CEO, Australian Research Alliance
for Children and Youth (ARACY)

Mr Leo Bator
Chief Operating Officer
Indigenous Business Australia

Mr Stephen Blaney
Strategic Communications
NSW Department of Industry

Ms Olga Bodrova
COO & Director of Research
Global Access Partners

Mr Peter Carre
Principal
BioHub

Ms Alison Crook AO
Chair, Enova Community Energy
Managing Director, Waterview Consulting

Mr Ted Dow
Chief Investment Officer
Clean Energy Finance Corporation

Mr Chris Dunstan
Research Director
Institute for Sustainable Futures
University of Technology Sydney

Mr Peter Fritz AM
Chairman, Global Access Partners
Group Managing Director, TCG Group

Ms Catherine Fritz-Kalish
Co-Founder & Managing Director
Global Access Partners

Dr Stephen Hollings
Director
The Heart Research Institute (HRI)

Dr James Horne PSM
Principal
James Horne & Associates

Dr Bill Hurditch
Sustainable Business
Development Specialist
Founding Principal & Director
The Fifth Estate

Mr Fergus Neilson
Co-founder & Managing Director
The Futures Project

Mr Tim Nelson
Head, Economic Policy & Sustainability,
AGL Energy

Mr John Rickus
Chairman
Epic Energy SA

(cc) Global Access Partners Pty Ltd, 2017

Dr Don Russell
Chief Executive Officer
Department of State Development
South Australia

Mr Carl Scully
Chair
Mine Safety Advisory Council

Mr Simon Smith
Secretary
NSW Department of Industry

Ms Louise Thurgood-Phillips
Non-Executive Director
Moorebank Intermodal Company

Mr Warwick Watkins
Director
WW & Associates

Dr John White
Chairman
ThyssenKrupp Marine Systems Australia

Mr Rod Wiese
Managing Director
Storm Consulting Australia

Ms Eva Willmann de Donlea
Director
Sustainability Intelligence

Mr Christopher Zinn
Consultant, Consumer Engagement
& Media Strategies
CEO, Private Health Insurance
Intermediaries Association

(cc) Global Access Partners Pty Ltd, 2017

# References and Sources


1 A reference to the 1974 TV commercial "Heineken refreshes the parts other beers cannot reach".

2 COAG Energy Council (2016), 6th COAG Energy Council Meeting Communique, 7 October 2016, http://www.coagenergycouncil.gov.au/publications/6th-coag-energy-council-meeting-communique

3 Ibid.

4 Electric Future – Wiring for Progress; Dr Alan Finkel's speech at the annual Zunz Lecture at the Sydney Powerhouse Museum, 3 November 2016; http://www.chiefscientist.gov.au/2016/11/speech-electric-future-wiring-for-progress/

5 Ibid.

6 Finkel A. et al. (2016), Preliminary Report of the Independent Review into the Future Security of the National Electricity Market, 14 December 2016; http://www.environment.gov.au/energy/publications/energy-market-preliminary-report

7 Ibid.

8 Productivity Commission (1991), Energy Generation and Distribution, Industry Commission inquiry report, 17 May 1991; http://www.pc.gov.au/inquiries/completed/energy-generation

9 AEMC, KPMG (2013), The National Electricity Market: A case study in successful microeconomic reform; http://www.aemc.gov.au/getattachment/8c426f7d-ea5c-4823-9b86-510dfd4e82dd/The-National-Electricity-Market-A-case-study-in-mi.aspx

10 Hilmer Report (1993), National Competition Policy, Report by the Independent Committee of Inquiry; http://ncp.ncc.gov.au/docs/National%20Competition%20Policy%20Review%20report,%20The%20Hilmer%20Report,%20August%201993.pdf

11 Synergies Economic Consulting (2016), Applying the Hilmer Principles on economic regulation to changing energy markets; www.energynetworks.com.au/sites/default/files/hilmer_principles_in_changing_energy_markets_040416.pdf

12 Nickolas S. (2015), What is the difference between economies of scope and economies of scale?; http://www.investopedia.com/ask/answers/042215/what-difference-between-economies-scope-and-economies-scale.asp

13 Harper I. et al. (2015), Competition Policy Review, Final Report; http://competitionpolicyreview.gov.au/files/2015/03/Competition-policy-review-report_online.pdf

14 https://economics.uq.edu.au/profile/779/professor-john-quiggin

15 Electricity privatisation 'a dismal failure', Australian Financial Review, 20 February 2014; http://www.theaustralian.com.au/business/latest/electricity-privatisation-a-dismal-failure/news-story/308ef62b51db38fd0ad5a777af9f85b5?nk=2d71f29de35c090a23d30a36901946ff-1485925795

16 CSIRO, Energy Networks Australia (2016), Electricity Network Transformation Roadmap: Key Concepts Report; http://www.energynetworks.com.au/sites/default/files/summary_key_concepts_report_2016.pdf

17 Abbott, M. (2002), 'Completing the introduction of competition into the Australian electricity industry', Economic Papers, Vol. 21, pp.1-13

18 Carbon + Energy Markets, 'Privatisation and the regulatory valuation of electricity distribution network service providers in New South Wales: Evidence and issues' (Report, Public Interest Advocacy Centre, Sydney, 2014).

19 Nelson, T. et al. (2016), The changing nature of the Australian electricity industry, October 2016


(cc) Global Access Partners Pty Ltd, 2017

[20] Carbon + Energy Markets (2016); South Australia's wholesale electricity market: what really happened in July 2016?; http://cmeaustralia.com.au/wp-content/uploads/2013/09/160815-FINAL-south-australia-7-july-getup-report-.pdf

[21] Ibid.

[22] Ibid.

[23] https://www.aemo.com.au/Media-Centre/-/media/BE174B1732CB4B3ABB74BD507664B270.ashx

[24] http://www.aemc.gov.au/Australias-Energy-Market/Markets-Overview/National-electricity-market

[25] Black Saturday cost $4.4 billion – by Darren Gray, The Age, 1 Aug 2010, http://www.theage.com.au/victoria/black-saturday-cost-44-billion-20100801-11116.html

[26] http://www.abc.net.au/news/2016-08-18/endeavour-energy-to-pay-18-million-over-springwood-bushfires/7762224

[27] http://www.townsvillebulletin.com.au/business/sun-metals-calls-for-reform-of-electricity-market-to-lower-costs/news-story/0a0b17dcabe701e3f6326e8cf4266ade?nk=2d71f29de35c090a23d30a36901946ff-1485950784

[28] https://www.theguardian.com/australia-news/2016/dec/01/bhp-billiton-raises-power-security-fears-after-latest-south-australia-blackout

[29] The Complex Project Management Task Force Report, titled Global Perspectives and the Strategic Agenda to 2025, was an initiative of the International Centre for Complex Project Management (ICCPM) and Global Access Partners (GAP); https://iccpm.com/content/taskforce-report

[30] http://www.ceem.unsw.edu.au/sites/default/files/documents/simulations.pdf

[31] https://theconversation.com/renewable-energy-is-ready-to-supply-all-of-australias-electricity-29200

[32] CSIRO, Energy Networks Australia (2016), Electricity Network Transformation Roadmap: Key Concepts Report; http://www.energynetworks.com.au/sites/default/files/summary_key_concepts_report_2016.pdf

[33] Renewables drive German energy plan switch from baseload power to flexibility; by Angela Macdonald-Smith, Australian Financial Review, 4 November 2016; http://www.afr.com/business/energy/electricity/renewables-drive-german-energy-plan-switch-from-baseload-power-to-flexibility-20161123-gsvs8j

[34] Ibid.

[35] Ibid.

[36] As reported by the Australian Financial Review - see "Why we are lagging in large-scale batteries" by Angela Macdonald-Smith on 26 October 2016

[37] "Hazelwood closure won't impact reliability, says AEMO"- by Sophie Vorrath & Giles Parkinson, 28 November 2016, http://reneweconomy.com.au/hazelwood-closure-wont-impact-reliability-says-aemo-30390/

[38] Synergies Economic Consulting (2016), Applying the Hilmer Principles on economic regulation to changing energy markets; www.energynetworks.com.au/sites/default/files/hilmer_principles_in_changing_energy_markets_040416.pdf

[39] Finkel A. et al. (2016), Preliminary Report of the Independent Review into the Future Security of the National Electricity Market, 14 December 2016; http://www.environment.gov.au/energy/publications/energy-market-preliminary-report

[40] Finkel A. et al. (2016), Independent Review into the Future Security of the National Electricity Market

[41] In January 2017, AGL has signed a five-year fixed-price PPA for a 200 W wind farm at a price of $65 MWh, less than the 2018 futures price for coal-fired power in NSW; http://www.townsvillebulletin.com.au/business/breaking-news/agl-to-sell-silverton-wind-farm-to-parf/news-story/2c4a659f6e7a002db56334314ec18ded

(cc) Global Access Partners Pty Ltd, 2017

[42] Comparative Analysis: The cost of new power generation in South Africa, by Chris Yelland,18 October 2016; https://www.dailymaverick.co.za/article/2016-10-18-comparative-analysis-the-cost-of-new-power-generation-in-south-africa/

[43] By comparison, China, which economy is ten times larger than Australia's, installed 34 GW of solar in twelve months (2016). In other words, on a comparative basis, China is installing solar at three times the rate Australia needs to have a 90% renewable grid; see also https://cleantechnica.com/2017/01/18/china-installed-34-gw-new-solar-pv-2016-nea/ and https://www.pv-magazine.com/2017/01/17/china-claims-34-2-gw-of-pv-installations-in-2016/

[44] Rooftop Solar Photovoltaic Technical Potential in the United States: A Detailed Assessment - Pieter Gagnon, Robert Margolis, Jennifer Melius, Caleb Phillips and Ryan Elmore, NREL (2016); http://www.nrel.gov/docs/fy16osti/65298.pdf

[45] What we know about the UK's 200MW storage tender - by John Parnell, 31 August 2016; http://www.energy-storage.news/interviews/what-we-know-about-the-uks-200mw-storage-tender

[46] AEMO (2010), ROAM report on Pumped Storage modelling for AEMO 100% Renewables project; http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.437.1231&rep=rep1&type=pdf

[47] Powerwall 2: Tesla doubles up on battery storage and slashes costs – by Sophie Vorrath, 31 October 2016; http://reneweconomy.com.au/powerwall-2-tesla-doubles-up-on-battery-storage-and-slashes-costs-42738/

[48] AES Distributed Energy will build a solar-plus-storage 'peaker plant' on the Hawaiian island of Kauai. This plant shows that solar plus storage is now cheaper than OC gas in Australia; https://www.greentechmedia.com/articles/read/aes-puts-energy-heavy-battery-behind-new-kauai-solar-peaker

[49] The recently announced $150 million, 75 MB solar plant in Victoria to power Melbourne's tram network could be a great project to demonstrate that reliable and economical renewables are possible in Australia; http://www.theaustralian.com.au/national-affairs/state-politics/victorian-taxpayers-to-fund-first-solar-trams/news-story/de1eafb3508ea02266af7156f77c21c5. However, while storage is high on the state government's agenda, there is no specific storage project associated with the Solar Tram initiative.

[50] http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/National-Transmission-Network-Development-Plan

[51] https://www.aemo.com.au/-/media/Files/PDF/2015-NTNDP_executive-summary.ashx

[52] What role for the states on climate and energy policy? NSW enters the fray - The Conversation, 24 December 2016; http://theconversation.com/what-role-for-the-states-on-climate-and-energy-policy-nsw-enters-the-fray-69039

[53] http://climatechangeauthority.gov.au/special-review

[54] http://www.environment.gov.au/climate-change/review-climate-change-policies

[55] http://www.smh.com.au/national/science-minister-greg-hunt-tells-csiro-to-maintain-pure-public-good-science-20161118-gss95u.html

[56] http://www.smh.com.au/federal-politics/political-news/farmers-demand-the-coalition-government-does-more-on-climate-change-20161128-gszkja.html

[57] http://ozewex.org/state-of-the-climate-2016-bureau-of-meteorology-and-csiro/

[58] CSIRO (2015), New climate change projections for Australia; http://www.csiro.au/en/News/News-releases/2015/New-climate-change-projections-for-Australia

[59] http://www.news.com.au/national/breaking-news/jan-was-sydneys-hottest-month-ever-bom/news-story/663b93a7b5462d8f07d6398f75e456b0

[60] Kobad Bhavnagri (2016), Six energy policy issues Australia must address, Presentation at the 2016 Australian Clean Energy Summit, 27 July 2016

(cc) Global Access Partners Pty Ltd, 2017

[61] NSW Industry & Investment (2010), NSW Electricity Network and Prices Inquiry Final Report, http://www.dpc.nsw.gov.au/__data/assets/pdf_file/0005/118904/NSW_Electricity_Network_and_Prices_Inquiry_Report.pdf

[62] CSIRO, Energy Networks Australia (2016), Electricity Network Transformation Roadmap: Key Concepts Report; http://www.energynetworks.com.au/sites/default/files/summary_key_concepts_report_2016.pdf

[63] Ibid.

(cc) Global Access Partners Pty Ltd, 2017