Energy Vision

Networks delivering net zero

DRAFT FOR DISCUSSION PURPOSES

Appendix A: Issues Paper

Energy Networks Australia

Context for the Issues Paper

Energy Networks Australia is embarking on a co-design process to explore issues and inform positions

The draft energy vision has been crafted to articulate an agreed statement on the future roles of networks, on a collective pathway to net zero.

Energy Networks Australia's draft energy vision is a starting point to take forward to co-design with key stakeholders.

This paper provides a preliminary view of the issues emanating from changing energy uses and customer needs on the journey to net zero.

The topics and considerations in this paper will be further developed through a co-design process. The objective is to form collective positions on these issues, which will extend and strengthen the draft vision.

Contents

Issues to resolve through co-design

The co-design process will seek to gain broad level agreement to positions on the key issues outlined below.

Level of ambition: "Enable" vs "Deliver"?

Transport and storage of energy through our networks is a key 'enabler' of social and economic activity. The transition to the envisaged safe, reliable, clean, affordable and customer-centric, integrated and investable energy system will require bold steps. Preliminary engagement with ENA Committee Chairs provoked consideration of whether networks should take a more proactive stance; delivering net zero rather than enabling it.

More than just semantics, clarifying this point will signpost the role networks will play, particularly adjacent to their infrastructure. Potential positions could include:

'Enabling' net zero: investments seek to maintain reliability, affordability and safety in response to external market drivers.

'Delivering' net zero: investments proactively address areas necessary to underpin the uptake of clean energy sources and new services.

'Driving' net zero: Direct investments and partnerships into renewables, storage, fuel substitutes and new services to accelerate the move towards to net zero.

Optionality: How should networks balance uncertainty while providing a clear direction?

There is general consensus on a number of elements that will make up the future energy system. More renewable generation, digitisation of the network, DER, EVs, smart homes and devices, for example. However, there are some key inputs that will shape the future energy system which are yet to play out, and a number of technologies that have been identified for priority development within the Australian Government's Technology Investment Roadmap.

Achieving 'deep' decarbonisation – The optimal pathway for hard to abate energy uses will be a complex mix of technical possibilities, economics and timeframes – including how to transport and store new fuels.

Technology cost declines – Renewable electricity has seen significant technology costs declines over the past 20 years. We can expect batteries, fuel cells and hydrogen production technology to follow similar, yet unpredictable, cost reduction curves. How will this affect economics and how do we account for this unknown?

Consumer preferences – Consumer preferences with regards to new technology are not yet known. For example, will concerns regarding how well hydrogen can be substituted for gas within networks affect take up? Or alternatively, will consumers retain a strong preference for gas appliances that will need to be met from renewable sources? Will fuel cell vehicles play a role in the passenger vehicle fleet?

To manage these unknowns the vision maintains optionality. Sometimes exploring options with potential long term benefits for consumers involves early investment. The vision will need to address how the networks will work with consumers, developers and regulators to signal the information and frameworks that will support more robust decision making, and when.

Configuration of the gas network – how should the vision account for uncertain and likely varied roles?

The pathway to net zero will require a diversity of fuel sources, particularly to support high heat uses, refining and some transport. Hydrogen, biofuels and other products will play an important role. But at this point in time its not clear for exactly which specific uses, or where and how this fuel will be produced and cost effectively transported and stored at scale.

As such, the extent to which renewable gas is chosen by customers for household applications, or networks' ability to cost-effectively supply renewable gas for other applications remains unclear. Trials on hydrogen blending are currently underway across several distribution networks, and new opportunities from renewable gas in the network, such as grid balancing and large scale (on grid) storage, will be important considerations.

Balancing investment to achieve an affordable and reliable energy transition: How will networks manage trade-offs between vision principles?

The transition to net zero should be implemented with the least impact on the affordability and reliability of energy. However, in the context of other network investment priorities for example, hardening the network against climate change, replacing ageing assets, building resilience against cyber attacks, there will be a need to make trade-offs.

The vision's principles should guide the decisions made by networks and inform broader public policy, regulations and standards. Where trade-offs arise between principles, decisions should always be made in the long term interest of consumers. However, how will networks prioritise activities that compromise one principle in pursuit of another? How should networks best go about engaging with stakeholders on these issues? And what level of information will be expected or needed?

Households and business

Households and businesses are empowered by smart homes, hydrogen, DER and EVs to transform into dynamic, responsive market participants.

The Vision

By 2050, the way households and businesses use and consume energy will be radically different to what it is today. Driven by improving economics and a consumer desire for empowerment, AEMO projects generation from distributed solar will supply 21-33 per cent of underlying electricity demand by 2050.[1] Households and businesses will be equipped with charging stations to support electric vehicles. While business models will evolve to better support uptake in rental premises and apartment blocks.

The high penetration of solar, batteries and electric vehicles provides opportunity for aggregators or 'virtual power plants' to deliver value to both consumers and the market. This participation creates an open, two-sided energy market on distribution networks.

Smart home and office devices will be commonplace and enable more efficient and responsive use of energy, particularly for heating and cooling. This demand response, along with other system services, means individual households and businesses contribute actively to the broader needs of system, without sacrificing individual comfort.

It is likely that renewable gas is used in at least some geographical areas for heating, hot water and cooking.

Role of the networks

A future characterised by decentralised bi-directional electricity flows requires distribution networks to facilitate and manage the needs of the system, while unlocking value for consumers.

Uncoordinated and highly variable load and generation at the distribution level could compromise operational integrity of the system, suggesting a stronger role for coordination between distribution system and market operations.

Networks will similarly need to coordinate with consumers, retailers and third parties to assist in supporting value streams for smart home and office devices, and demand response to ensure they can provide network support, assist in managing demand and other system impacts from high penetration of renewables.

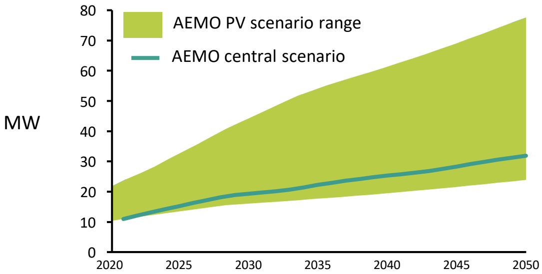
Networks will buildout capacity and be far more digitised and automated. Network providers will need to manage and share data real time, acting as the interconnective tissue between participants rapidly balancing the network while maximising customer benefits. However, the cost of this investment needs to be recovered equitably, as it will likely be the least wealthy who are unable to realise the benefit of investments into new household DER technology.

Where renewable gas is available, cost-effective and there is sufficient demand by households and businesses, gas distribution network will support customers choice of energy for heating and commercial uses. Like electricity, the gas network will be smarter, more responsive and will integrate more distributed sources of production and use (produce gas and generate electricity).

Policy and regulatory considerations
As networks move towards greater bidirectional energy flows, the regulatory framework that supports network pricing and cost recovery will also need to evolve. To support the secure and efficient operation of the system, networks will need greater visibility of load and generation at the household level.

Networks will need to work with other stakeholders on funding the investment in new options, and how to ensure continued affordability for consumers

AEMO rooftop PV capacity scenarios[1]



Source: (1) AEMO ISP projection 2020-21, demand input summary

Transport

EV charging stations and home chargers change electricity consumption patterns on the network. Heavy, long haul, shipping and aviation switch to clean fuel substitutes.

The Vision

Battery electric vehicles (BEVs) are likely to play a significant role in the fuel substitution of light vehicles. Networks of charging stations will exist across our cities and communities, creating new demand nodes around car parks, shopping centres and businesses. Household electricity demand will depend on smart charging and bidirectional storage technology, which can assist achieving network stability and balance.

BEVs are relatively heavy with lower stored energy compared to hydrogen fuel cell electric vehicles (FCEVs). This weight and distance advantage provides FCEVs and/or hydrogen combustion with a competitive advantage for some light vehicle applications, trucks, buses, long haul rail, heavy vehicles and aviation[1]. Hydrogen derived fuels such as methanol or ammonia are currently considered the most likely substitute for shipping[1].

Hydrogen production and refuelling networks will enable these uses, however these may centre around 'back to base' refuelling or key transport refuelling hubs.

Key market insights[1]

BEV advantage with less infrastructure required – FCEV longer haul, longer term potential

Favour FCEV where range, recharge time or operational flexibility is required

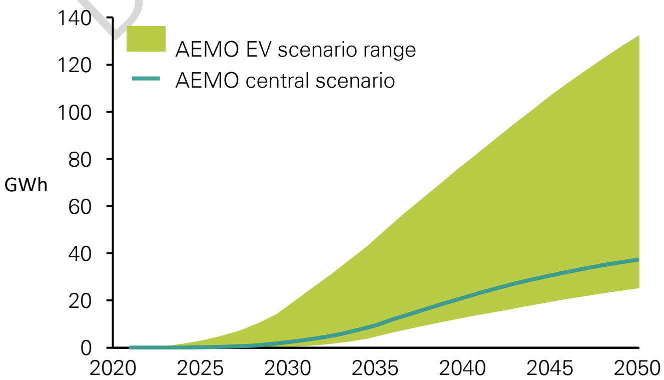
Tech battle-ground. BEV require additional infrastructure (trolley assist)

Heavy Haul Rail – FCEV more attractive

Shipping – reliant on H2, but significant barriers

Aviation – reliant on H2, but significant barriers

AEMO EV electricity demand scenarios[2]



Role of the networks

Electricity networks will need to integrate distributed and fast charging stations and technology across the network. Consumer behaviours, and the location of stations, will change the profile of demand and supply.

Charging stations will likely be supported by smart, aggregated platforms, allowing them to provide grid balancing and other beneficial services. Network management will require smarter, real-time data sharing capability to operationalise these services.

Fuel production and distribution of hydrogen for FCEV applications and the associated requirements for the network is currently less clear. This will depend on the refuelling requirements (e.g. back to base, long haul), the cost of production technology, transport options and subsequently, the optimal location of production. For example, refuelling stations could be supplied from centralised production that is transported via tube and trailer or gas networks, or alternatively produce hydrogen on-site with small scale electrolysers.

Notwithstanding the above, if there is a high penetration of distributed electrolysers, they could provide a dual purpose of servicing hydrogen-based transport and supporting hydrogen consumption in the distribution network.

Policy and regulatory considerations

- Government certainty and direction and commitment to decarbonising transport
- Regulatory flexibility to better support a very different energy asset type, and more dynamic pricing frameworks

Source: (1) Adapted from Advision, Australian Hydrogen Market Study, May 2021; (2) AEMO Draft 2021-22 Inputs and Assumptions workbook

Cities & community

A resilient, dynamic, two-way distribution networks will be balanced through flexible and responsive generation, storage and demand nodes, managed and operated in real time.

The Vision

By 2050, cities and communities will operate as dynamic, smart and integrated energy systems.

Generation from rooftop PV will be stored and used via a range of technologies, including electric vehicles (EVs), battery storage and electrolysers.

Charging points for electric vehicles could operate not only as a load used to manage periods of low system demand, but also as a dynamic power plant, contributing generation when the system needs it.

Similarly, community batteries are distributed around cities and communities. These batteries not only provide a store of energy, but provide a range of system services to strengthen the grid and support greater renewable penetration on the network. Large utility-scale batteries and flexible demand help deliver these services on the transmission network.

Electrolysers could be distributed within communities and used to soak up excess energy generation to be either converted back to electricity when needed or used to supply the gas for household consumption.

Increased distributed energy generation and storage result in standalone power systems (SAPS) being used to support cost-effective resilience for some communities. SAPS may use electrolysers to produce hydrogen for backup supply or to support consumers' demand for net zero gas. SAPS are also supported by increased peer-to-peer energy trading, matching up variations in individual consumption and generation patterns.

Role of the networks

Networks will connect and support jurisdictions with ambitions for net zero cities and communities.

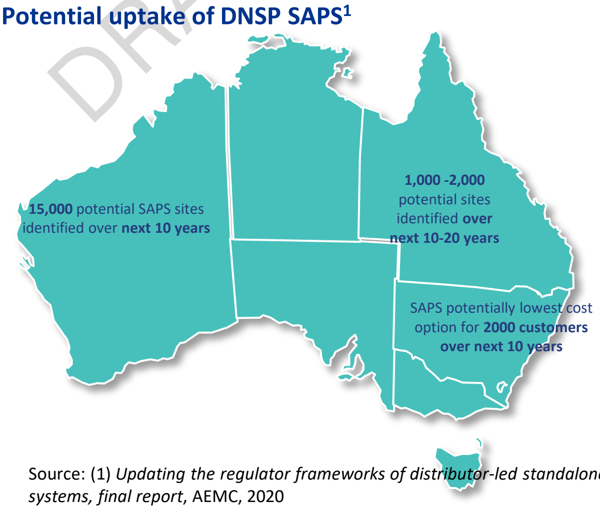
In addition to providing the infrastructure required for greater two-way energy flows, networks will actively facilitate a more open, dynamic mix of generation, consumption and storage.

Where cost-effective and in customers' interest, networks or ringfenced network entities could own and operate storage assets to provide more affordable and reliable energy. Alternatively, where third-parties operate storage assets and/or flexible demand, networks will help them to maximise the value streams available. The role of the gas network in electricity storage and generation presents an additional value stream.

Networks will work with stakeholders to provide SAPS, where it is of most benefit to customers, ensuring the have access to affordable, resilient energy supplies. SAPS connected customers have the same consumer protections as grid-connected customers.

Investments must also accommodate the impacts of climate change; greater frequency of severe weather events and hotter, drier conditions increasing bushfire risk. The extent of this investment will ultimately strike a balance between risk mitigation and cost, which will be guided by an informed conversation with customers and regulators.

Potential uptake of DNSP SAPS[1]



Source: (1) *Updating the regulator frameworks of distributor-led standalone power systems, final report*, AEMC, 2020

Policy and regulatory considerations
To support a dynamic and integrated asset mix within cities and communities, networks will need some additional flexibility in the regulatory framework to allow for innovation and greater allowances for shorter term risks in order to deliver longer term benefits for consumers. This may also include evolved responsibilities to invest and operate network storage infrastructure where it results in greater affordability for consumers in the long term.

Industrial processes

The decarbonisation of industry takes a range of pathways, most of which will drive significant new renewable energy generation.

The Vision

Industrial applications account for around 42 per cent of Australia's final energy consumption.[1] 75 per cent of this energy is currently consumed from gas, coal and oil.[1] Decarbonising Australia's industry will be challenging, involve a variety of alternative fuels developed through multiple different pathways, and approaches will vary within and across industries based on needs and opportunities.

Several lower-heat intensive industry applications (e.g. parts of the food and beverage industry) are likely to move towards electrification, supported by large-scale renewable generation. However, renewable gas is also likely to play a role.

Hydrogen and hydrogen bi-products (e.g. green ammonia) will contribute significantly to replacing emission intensive industrial processes. For example, steel production using hydrogen as a reductant instead of metallurgical coal.[1] However, it may be more economic for some industries to adopt carbon capture and storage technology and sequester carbon from emissions. While biogas, syngas and other alternatives exist and may play a role.

Ultimately, an abundance of renewable resources and onshore production of heat intensive substitute fuels such as hydrogen could create advantage, underpinning the reinvigoration of Australia's industrial, processing and refining sectors around renewable energy zones.

Role of the networks

Networks will play a crucial role in supporting the cost-effective decarbonisation of Australia's industry.

DNSPs and TNSPs are increasingly examining innovative forms of non-network solutions to defer capital expenditure to keep costs down for customers. However to support increased industrial load, there will be a need for more network infrastructure. This will ensure a continued reliable source of supply for users that electrify as well as those needing fuels converted from electrons.

The establishment of hydrogen hubs (co-location of production and industrial/export applications) allows users to benefit from scale, while also limiting transport costs. New transmission capacity to connect these regions with Renewable Energy Zones will be needed, while pipelines will likely play a role in transporting centralised production to multiple users.

Notwithstanding the above, the specific supply chain configuration for substitute fuels will vary. Hydrogen and hydrogen bi products, for example, could be produced from electricity on site, transported to site via dedicated pipelines or trucks, or received via a reticulated gas network if connected.

Australia's top 6 industrial heat users: volume and temperature intensity[2]

Alumina & other non ferrous
171 PJ/yr
Intensity: med – V. high

Food & Beverage
115 PJ/yr
Intensity: low – high

Iron & Steel
94 PJ/yr
Intensity: V high

Oil & gas extraction
86 PJ/yr
Intensity: med – high

Petroleum Refining
86 PJ/yr
Intensity: low – v high

Ammonia & chemicals
42 PJ/yr
Intensity: high – V high

Policy and regulatory considerations

- Network pricing frameworks may need to be amended to better support the needs of consumers, while balancing the risks to networks.
- Regulatory frameworks need to be amended to enable greater use of hydrogen and other forms of renewable gas.
- New investment to support net zero activities will require a degree of certainty and direction across Governments.

Source: (1) *HiTeMP-2 Outlook Report: The pathway to net zero $C0_2$ emissions for heavy industry*, University of Adelaide, 2020; (2) Renewable energy options for industrial processed heat, ITP, 2019

Energy generation and conversion

The convergence of all energy production into renewable generated electrons will erode traditional barriers between sectors. Conversion of electrons to molecules will intrinsically link electricity and gas networks.

The Vision

New, renewable pathways to produce electrons and molecules erodes the traditional barriers between the upstream energy sectors. A more integrated value chain will likely materialise, where companies expand their role to deliver both green electrons and molecules and further downstream as electricity generation links directly to exports, for example.

To achieve net zero emissions Australia will need to embrace and drastically expand its renewable generation portfolio. Penetration of solar and wind will continue to increase as the use of other fossil fuels for electricity generation starts to be phased out.

Large-scale renewable energy generation will further expand as demand for hydrogen grows, and sector convergence progresses.

Economic hydrogen production will rely on access to large quantities of cheap renewable electricity. Its production could be used as a discretionary load that can be shed when necessary to alleviate issues associated with intermittent renewable generation, at both the macro and micro network scale.

In addition, stationary energy generation, from small generation units to large scale generators could operate in conjunction with electrolysers and storage to provide balancing consumption and generation on electricity networks.

Role of the networks

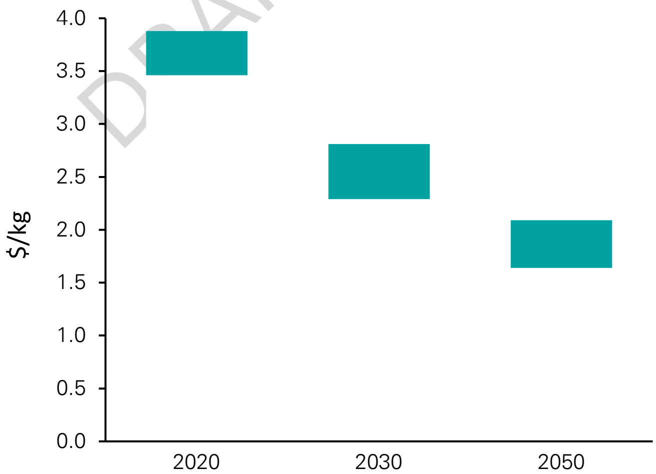
As the carriers of clean electrons, electricity transmission and distribution providers will carry significantly more renewable electricity generation to its uses, which includes the generation of green fuels such as hydrogen. It is this relationship that intrinsically links electricity and gas networks within the future energy system.

To unlock benefit from our abundant renewable energy resources, TNSPs will play an important role in ensuring there is sufficient system strength and other system services such as inertia to support the higher penetration of non-synchronous renewable generators. This could involve a role operating non-traditional network assets such as synchronous condensers.

As existing traditional thermal generators exit the market and intermittent generators contribute a greater proportion of total generation, transmission network infrastructure will need to be built to connect regions with diverse renewable generators, through interconnectors and other assets.

DNSPs will be responsible for managing many localised network issues (mentioned in other sections). While gas networks may provide services to the market in the form of balancing demand, storage and/or generation through conversion to molecules, and potentially back again.

Farm-gate green hydrogen production costs[1]



Source: (1) *Australian Hydrogen Market Study*, Advisian, 2021

Policy and Regulatory Considerations
To support a greater penetration of renewable generators, regulatory frameworks will need to allow for networks and others to play a larger role in the provision of system services.
Policy certainty and direction will also be needed to improve the coordination and planning for network, generation and energy conversion assets.

New energy exports

As a renewable energy powerhouse, the export of green (and blue) hydrogen is seen as a transformative opportunity for the Australian economy.

The Vision

The global demand for hydrogen has been forecast to increase to about 520 Mt by 2050[1]. This industry has been estimated at a value of $300b[2] globally, with an Australian export industry potentially worth up to $10b by 2040 (based on over 3 million t.p.a.)[3].

The export of Australian renewable energy in the form of 'green' hydrogen, as well as production from gas including Carbon Capture and Storage is a significant opportunity for Australia. Export demand forecasts range from 1.4m to 26m t.p.a by 2050.[2]

The scale of renewables required to meet export demands will dwarf that of the current domestic demand. 15Mt p.a. of renewable 'green' hydrogen for export by 2050[4] could equate to approximately 90GW of installed electrolyser capacity.

The production and storage of large volumes of renewable gas for export could be used to balance the domestic seasonal variation in energy demand, like LNG does today.

Key market insights

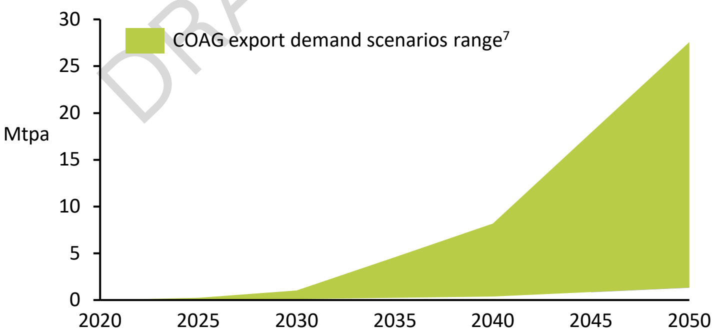
$83 bn
H2 investment globally[4]

45
National hydrogen roadmaps or policies[4]

$3.4 bn
Japan support for hydrogen supply chain projects[5]

C'th funding of
$464m towards
Hydrogen hubs[6]

Australian Export Demand Scenarios[7]



Source: (1) *Net zero by 2050*, IEA, 2021 (2) *The dawn of green hydrogen*, Strategy&, 2020; (3) *Opportunities for Australian Hydrogen Exports*, ACIL Allen, 2018; (4) *Hydrogen Insights: A perspective on investment, market development and cost competitiveness*, Hydrogen Council, Feb 2021; (5) METI announcement 28 April 2021; (6) KPMG Analysis; (7) Adapted from: Erratum: Australian and Global Hydrogen Demand Growth Scenario Analysis, COAG Energy Council, May 2020

Role of the networks

At scale, the green hydrogen export supply chain involves both electricity transmission and product pipelines. Transmission lines connect renewable generation to electrolysers, while the hydrogen products are pipelined to export terminals.

The extent of the wires or pipelines depends on the configuration of the supply chain and location of the electrolyser. For example, if the electrolyser is located at the port, then electricity transmission lines must connect from the REZ. Alternatively the electrolyser can be located inland and product pipelined to the export terminal. Configurations will likely vary across projects.

The growth of hydrogen export offers an abundance of cheap, clean energy. In the short term, networks will play a crucial role in supplying grid-connected electricity while the industry gains scale. In the long term, networks will play a role in sharing the benefit from the abundance of electricity by integrating it into the domestic energy system, rather than projects spilling electricity to optimise downstream utilisation and economics.

Policy and regulatory considerations

- Ensure that current network regulation interacts flexibly with new network and asset configurations focussed on export
- Ensure alignment with any export regulations and/or product certification process (i.e. energy source).

Policy & regulatory considerations

To enable a net zero future that benefits consumers the policy and regulatory framework that supports network outcomes will need to evolve.

Any changes to the policy and regulatory framework will need to embody the principled objectives earlier, namely they will need to promote a safe, reliable, clean, affordable and customer-centric, integrated, and investable energy network.

Networks will need to work closely with customers, governments, regulators and market bodies to ensure shifts in the regulatory framework safeguard the long term interests of consumers.

Specific policy and regulation changes required to meet the objectives and support this transition, generally fall under 5 broad categories:

1. Strong and consistent direction across governments

To support the energy transition, energy networks require strong and consistent directions across both Commonwealth and jurisdictional governments. Guidance on issues such as decarbonisation pathways and technologies, provides the assurances required to make the capital investments necessary enable the transition.

2. Regulations that are dynamic and agile

A net-zero Australian economy will require networks to change at a rapid pace. These changes will need to be supported by an agile regulatory framework that embraces a vision for a different future and can adapt to new systems, processes and technologies. The slow regulatory processes that currently apply to networks are no longer fit for purpose to meet the needs of consumers.

3. Coordination of future investment and service provision

To ensure efficient, integrated and affordable networks, investments and services need to be coordinated across transmission, distribution and gas networks. All three network types will need to work in partnership with others including generators, retailers and governments to ensure efficient outcomes (e.g. broader fiscal resources may be required to address vulnerable customers or when trialling new approaches).

Additionally, as networks play an increasingly important role in supporting new energy services, greater coordination may be required across new generation and load centres like electrolysers.

4. Evolution of cost recovery and pricing

In a dynamic and net zero future, the way that assets recover costs and price services will need to evolve. Networks will need to work with consumers and users to ensure costs can be recovered in an equitable way that reflects the changes in how networks are being used. These changes will also need to be supported by a regulatory framework that is agile, capable of embracing innovation while delivering the predictability required to underpin long-term, infrastructure investments.

5. Role definitions and boundaries need to adjust to facilitate the transition

Networks will need to embrace different roles to support an efficient, affordable and reliable net zero future. Where competitive pressures allow and when in the interest of customers, networks can leverage their unique positions to own, operate or coordinate assets and services to support the system.

For example, it may be efficient for networks to build a synchronous condenser, own and operate a grid-scale [or community] storage or coordinate distributed energy resources to ensure affordable and reliable outcomes for consumers. Governments and policy makers should be open to revisiting the roles and boundaries of networks.

Other macro trends…

The draft Energy Vision has the pathway to net zero at its core. However, we examined other macro trends that networks will need to consider and respond to during co-design (1/3)

Energy Trends shaping the Energy Vision

The trends below are a collective summary of trends that will influence the vision across the use cases previously discussed. These have a direct impact on the way networks will need to evolve to create the safe, reliable, clean, affordable and customer-centric, integrated and investable energy system by 2050 at the latest.

Distributed Energy Resources

As costs decrease and customer adoption of DER will increase – AEMO projects generation from distributed solar will supply 21-33% per cent of underlying electricity demand by 2050.

Electric Vehicles / Fuel Cell Vehicles

We will see a significant increase in the number of electric vehicles on the road with charging stations becoming more common than petrol stations. FCEVs dominate long haul transport.

Generation mix & system security

Moving away from thermal generation towards decentralised renewable energy resources creates a number of issues for system strength and other system services such as inertia.

Stand Alone Power Systems & Microgrids

Given the high cost of providing traditional forms of grid connectivity to remote communities, microgrids and Stand-Alone Power Systems (SAPS) may be a better solution to powering remote communities

Smart homes / pro-sumers

Households will have more control over their energy usage and experience, employing digital devices to manage consumption and collecting, storing and selling energy to others

Ageing assets / expenditure optimisation

A significant proportion of network assets are reaching their end of life in coming years, and affordability issues has meant the regulator has challenged spend on replacement expenditure.

Network digitisation

DER will accelerate grid modernisation and smart grid technologies will orchestrate more diverse assets, in a more dynamic, responsive energy system

Decarbonising heat / hard to abate sectors

Energy / heat intensive sectors such as heavy industry, long haul travel, aviation and shipping
will struggle to electrify. These sectors will likely require molecules (hydrogen and bi products) to decarbonise.

Other macro trends…

The draft Energy Vision has the pathway to net zero at its core. However, we examined other macro trends that networks will need to consider and respond to during co-design (2/3)

Other Global Trends shaping the Energy Vision

In order to achieve legitimacy and broad stakeholder acceptance, co-design of the Energy Vision 2050 must ensure it appropriately considers and responds to the following global trends.

Societal Divide
While advancement in technology will be embraced by a large portion of society, there may remain a portion that is unable to afford smart energy technologies, creating a divide between the energy haves and the energy have nots. To have the social licence for its vision, Networks must address equity issues.

Climate Change & Extreme Weather
Over the last 20 years, Australia has experienced many of its hottest years on record. To be legitimate, the Networks vision will need to have a stance on how they will manage more extreme weather conditions and the risk that infrastructure is damaged, or involved in bushfire.

Cyber security
As connectivity and data explodes, cyber security will become ever more paramount. Protection of critical infrastructure from cyber attack, across a more mobile 'online' workforce will become a necessary core capability of networks.

Community Trust
An increase in values-led decision-making across society. Customers consider the values and ethos of businesses they deal with and expect real and community level interactions with businesses. Networks need to consider how the Vision helps to foster trust within the community.

Talent Battle Ground
Having a strong stance on decarbonisation and sustainability are keys to attracting employees that increasingly expect more empowering and meaningful work. We are seeing an employee preference away from companies seen as socially irresponsible.

Other macro trends…

The draft Energy Vision has the pathway to net zero at its core. However, we examined other macro trends that networks will need to consider and respond to during co-design (3/3)

Global Trends shaping how we get there

When considering how networks can achieve the vision, co-design should be cognisant of the opportunities and risks that exist within in the macro trends below.

Blockchain
Blockchain will provide an infrastructure of trust and security against security issues such as data leaks, hacking and the inability to identify devices. Blockchain provides a trusted and immutable view of data that can be shared and relied upon by multiple entities, with no requirement for a central third party.

ESG
Corporate Social Responsibility will lead investors, customers, employees, and regulators to analyse environmental, social, and governance (ESG) performance to estimate future risk exposure. Networks that embody a sense of purpose and strong sustainability credentials will see greater consumer engagement and licence.

Autonomous vehicles
Driverless cars redefine the way we move, and the way we work. For example, driverless vehicles capture photos of infrastructure on route to build a digital twin of the network which is constantly being updated. This also enables better safety management and work optimisation.

Global Supply Chain
Challenges in securing critical components through COVID, as well as growing international tensions, has driven Network companies to rethink and redesign potential weaknesses in their supply chains.

Quantum computers
Quantum computers provide the ability to solve complex problems significantly beyond the capabilities of today's machines - analysing unprecedented amounts of data makes them ideal for logistical and optimisation problems. Quantum computing dramatically enhance capability to dynamically predict and operate our energy networks.

Circular Economy
The circular economy – a model in which the value of any given product is extracted fully before the product is recycled and reused - is likely to become a non-negotiable in a world where resources are finite. Networks will need to integrate these concepts into its asset management and operations.

Artificial Intelligence
Intelligent systems will transform network operations and business functions, improving efficiency and decreasing human error. Chatbots will take over simple customer support tasks online and over the phone creating capacity for staff to work on more value added services for customers (Service = Digital + Human).

Digital Revolution - Restructuring of Economies
The advancement of digital and AI, and the resultant impact on the global and national workforce, will necessitate a restructure of internal economies. Universal basic income and reduced working weeks are already a feature of economic debate. Owners of regulated assets will continue to face challenging regulatory price pressures.

Augmented reality & virtual reality
Augmented reality and virtual reality headsets, as well as holograms, will change the way we train staff, educate the public and operate high risks assets such as energy networks. Its uptake will be essential

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