Australian perspective on Technology as a driver for the energy transition

CENRIT Blue Sky Seminar Series

Dr Cameron Kelly
General Counsel | ARENA
13 July 2022

ARENA's Purpose

ARENA is the Australian Renewable Energy Agency.

The Agency was established by the Australian Government in July 2012 to improve the competitiveness of renewable energy technologies and increase the supply of renewable energy in Australia.

Our purpose is to support the global transition to net zero emissions by accelerating the pace of pre-commercial innovation, to the benefit of Australian consumers, businesses and workers.

INVESTED
$1.77B

PROJECTS
602

VALUE
$7.75B

INVESTMENT LEVERAGE
$1:$3.38

INVESTMENT BY TECHNOLOGY

BIOENERGY	GEOTHERMAL	GRID INTEGRATION	HYBRID	HYDROGEN	OCEAN	SOLAR PV	SOLAR THERMAL	STORAGE - BATTERIES/PHES
$131M	$42M	$287M	$111M	$60M	$44M	$725M	$178M	$190M

RECENT ACTIVITY

$47M for Genex to build Australia's first pumped hydro energy storage system in 37 years

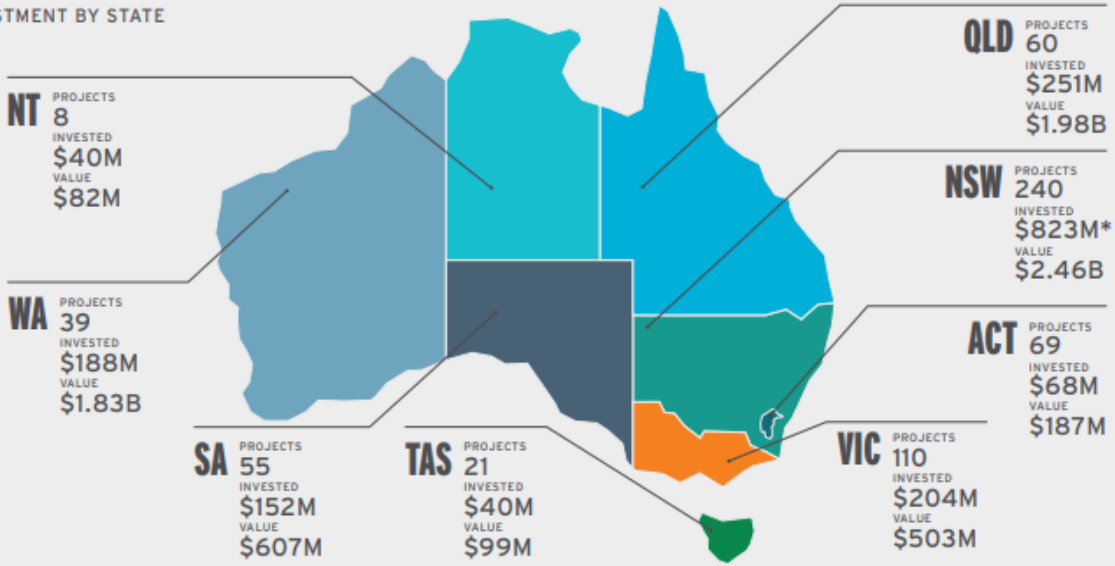
$15M for RayGen to build a world-first solar hydro power plant comprising 4 MW of solar PV generation and 3 MW / 50 MWh of dispatchable storage

$11.3M to demonstrate electrifying steam production in Alcoa's alumina refining process

$2.6M for Luceo Energy to help DNSPs to overcome challenges in managing distributed energy

579K for Rio Tinto to reduce emissions in alumina refining using renewable hydrogen

INVESTMENT BY STATE



NT
PROJECTS 8
INVESTED $40M
VALUE $82M

WA
PROJECTS 39
INVESTED $188M
VALUE $1.83B

SA
PROJECTS 55
INVESTED $152M
VALUE $607M

TAS
PROJECTS 21
INVESTED $40M
VALUE $99M

VIC
PROJECTS 110
INVESTED $204M
VALUE $503M

QLD
PROJECTS 60
INVESTED $251M
VALUE $1.98B

NSW
PROJECTS 240
INVESTED $823M*
VALUE $2.46B

ACT
PROJECTS 69
INVESTED $68M
VALUE $187M

* Includes $567 million contributed to projects inherited by ARENA in 2012.

INVESTMENT LEVERAGE ALONG THE INNOVATION CHAIN

STUDY
$1:$1.68

R&D
$1:$1.63

DEMONSTRATION
$1:$1.84

DEPLOYMENT
$1:$6.37

30 JUNE 2021

The Blueprint:
AEMO's Integrated System Plan (ISP) – June 2022

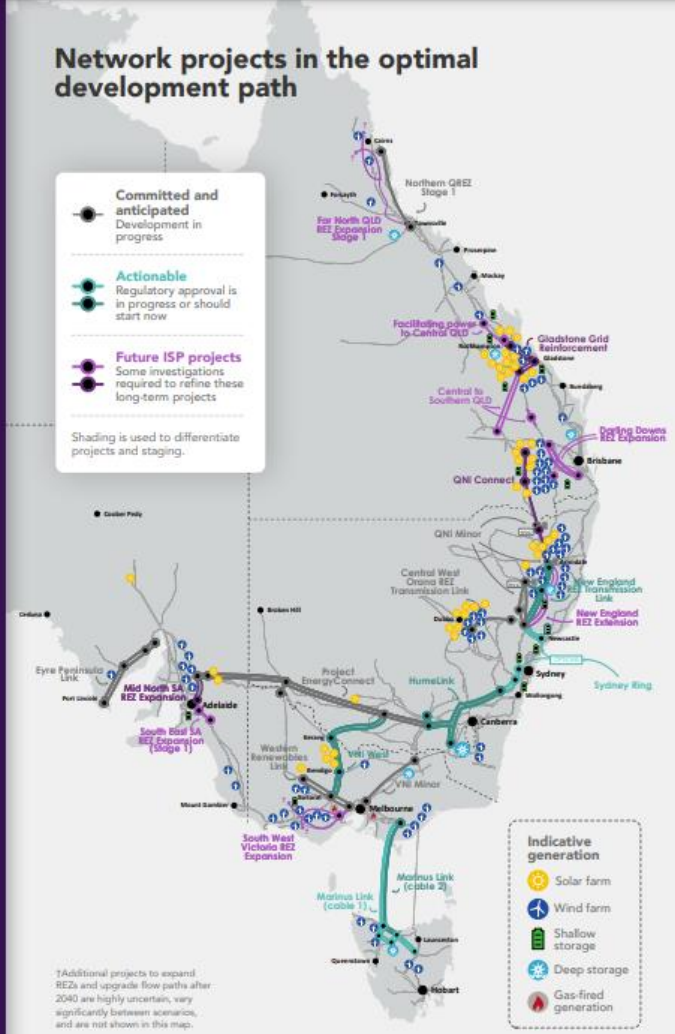
AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

2022 Integrated System Plan (ISP)

The Australian Energy Market Operator (AEMO) has published the 2022 ISP, a 30-year roadmap for essential and efficient investment in the National Electricity Market (NEM).

The 2022 ISP supports Australia's highly complex and rapid energy transformation, switching from higher-cost, high-emission energy to lower-cost renewable energy, doubling capacity to power transport and industry, and at all times providing consumers with reliable, secure and affordable power.

Network projects in the optimal development path



1 Consultation

The 2022 ISP is based on rigorous economic and engineering analysis, and almost two years' in-depth stakeholder engagement with energy consumers and providers, State and the federal governments, and energy regulators and analysts.

- Over **1,500** individual stakeholders
- Discussions convened through **31** webinars and **39** reports
- Detailed feedback received through **198** submissions

2 Considerations

- Market reforms
- Government policies
- Economic growth
- Emission targets
- Grid technologies and services
- Consumer investment in DER

3 Expected energy transition to 2050

('Step Change' scenario)

Storage capacity **to increase by a factor of 30**
(Batteries, virtual power plants, pumped hydro.)

NOW	2030	2050
2 GW	15 GW	61 GW

Grid-scale wind and solar **to increase 9-fold**

NOW	2030	2050
16 GW	44 GW	141 GW

Distributed solar PV **to increase 5-fold**

NOW	2030	2050
15 GW	35 GW	69 GW

Electricity usage from the grid **to nearly double**

NOW	2030	2050
180 TWh	194 TWh	320 TWh

Gas-fired peaking plants **to increase**
While current mid-merit plants will all retire within that period.

NOW	2050
7 GW	10 GW

Coal generation **to be withdrawn**
Capacity to be retired by:

2030	2043
60%	100%

4 Optimal development path (ODP)

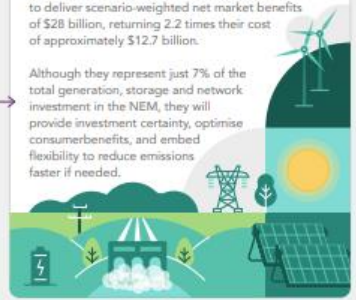
The ODP identifies five projects as immediately actionable which should progress as urgently as possible – HumeLink, VNI West, Marinus Link, Sydney Ring and New England REZ Transmission Link.

While delivery dates are as advised by project proponents, earlier delivery would provide valuable insurance for any faster transition or additional benefits to consumers. Supporting policies and mechanisms from the Commonwealth and jurisdictional governments may be able to assist in earlier delivery.

Net benefits

The transmission projects within the ODP are forecast to deliver scenario-weighted net market benefits of $28 billion, returning 2.2 times their cost of approximately $12.7 billion.

Although they represent just 7% of the total generation, storage and network investment in the NEM, they will provide investment certainty, optimise consumerbenefits, and embed flexibility to reduce emissions faster if needed.



ISP Step Change Scenario

- The ISP forecasts that **VRE capacity** will increase 9X by 2050 (from 16 GW to 141 GW). *That is over a doubling of capacity every decade*.

- **Distributed PV:** forecast to increase more than 4X (from 15 GW to 69 GW) over same period.

- To firm that VRE and distributed PV, 63 GW of **firm dispatchable capacity and additional power system security services** will be needed by 2050.

Figure 1 Forecast NEM capacity to 2050, *Step Change* scenario

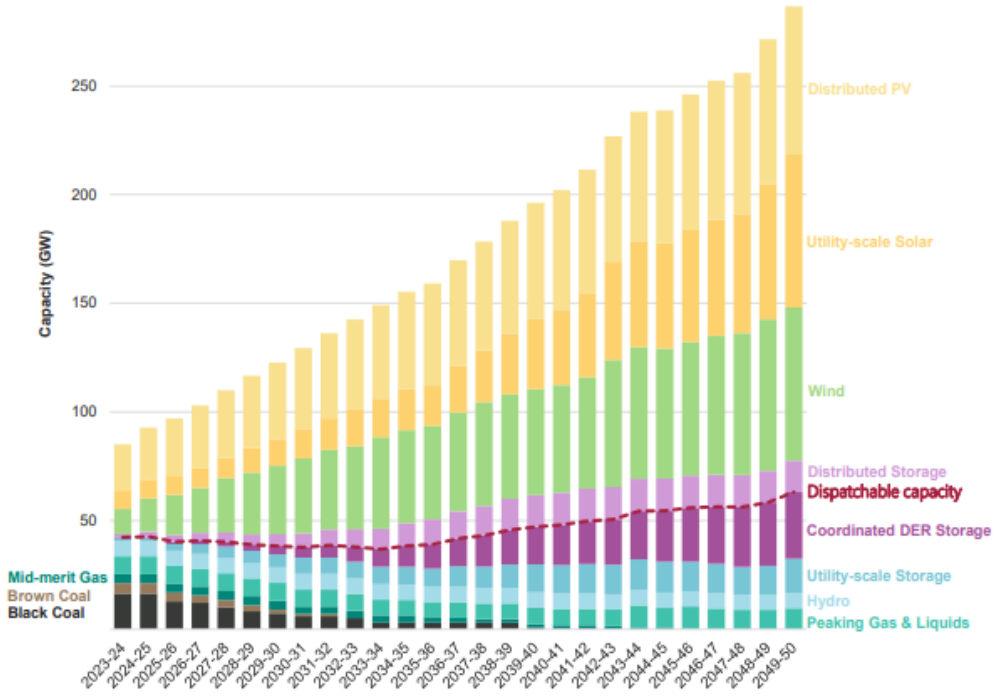


Image: Page 9, 2022 ISP.

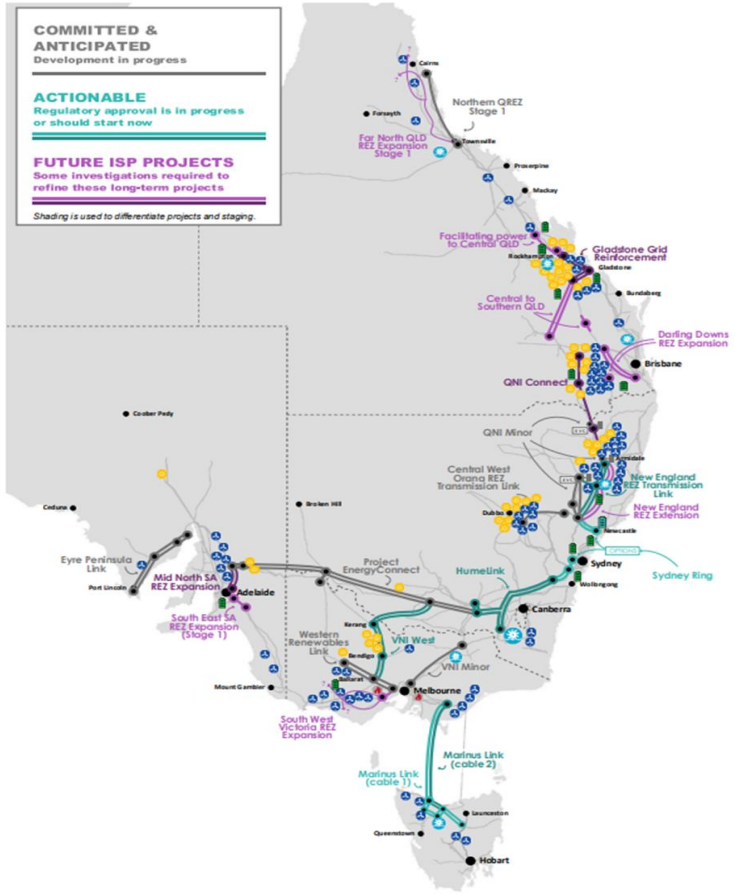
Power system requirements considered in the NEM

Need	Operational requirements considered when developing the ISP	
Reliability	**Resource adequacy and capability** • There is a sufficient overall portfolio of energy resources to continuously achieve the real-time balancing of supply and demand.	Energy resources provide sufficient supply to match demand from consumers at least 99.998% of the time.
		Operating reserves exist to provide the capability to respond to large continuing changes in energy requirements.
		Network capability is sufficient to transport energy to consumers.
Security	**Frequency management and inertia response** • Ability to maintain system frequency within operating standards.	Frequency remains within operating standards – considering primary frequency response and frequency controls, minimum inertia requirements, and the availability of alternatives; the system is maintained within transient and oscillatory stability limits.
	Voltage management and system strength • Ability to maintain voltages on the network within acceptable limits. • System strength is above minimum levels.	Voltage remains within operating standards, fault levels are below equipment ratings, and system strength/fault levels are maintained above minimum requirements.

ODP: Transmission in the NEM

- Outlines a plan for NEM must deliver ‘a once-in-a-century transformation in the way electricity is generated and consumed in Australia’.
- Deliver $28 billion in net market benefits
  - 50% are from deferring or avoiding the capital cost of generation and storage projects
  - 40% from fuel cost savings).
- Insurance against further early coal exits (e.g. Eraring Power Station).

Figure 2 Map of the network projects in the optimal development path



† Additional projects to expand REZs and upgrade flow paths after 2040 are highly uncertain, vary significantly between scenarios, and are not shown on this map. See Appendix 5 for more information.

Image: Page 14, 2022 ISP.

The Challenge: NEM Carbon Budget in Step Change

- New ISP mechanics for tailoring outcomes:
  - REZ Design Report
  - Resource Adequacy Mechanism (including a Capacity Mechanism)
- Need to respond to:
  - Social licence and First Nations consultation
  - Workforce requirements
  - Supply chain issues

Figure 8 NEM carbon budgets and the resulting emission trajectories

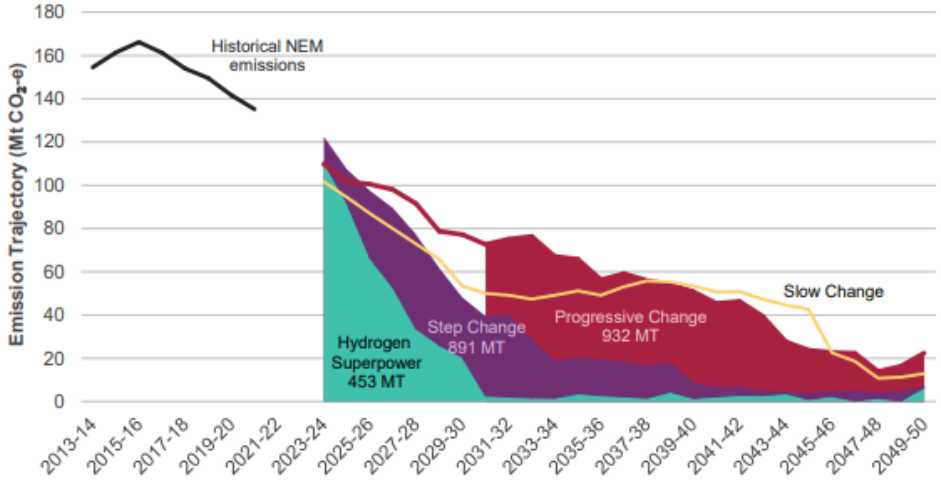
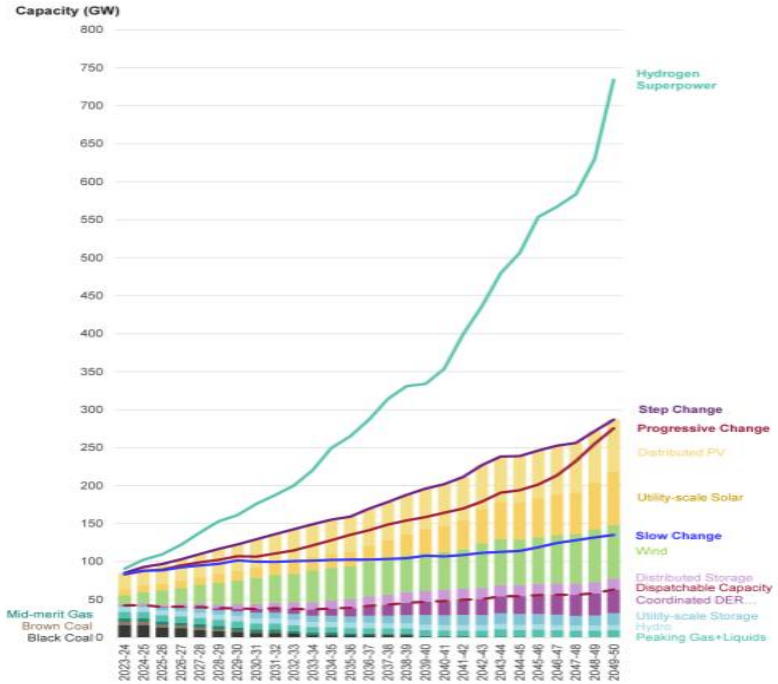


Image: page 32, 2022 ISP.

Development opportunities to 2050 in *Step Change*, compared to total capacity required in *Progressive Change* and *Hydrogen Superpower,* are impressive…



…And all involve a retirement of coal fired power (all scenarios versus announced retirements)

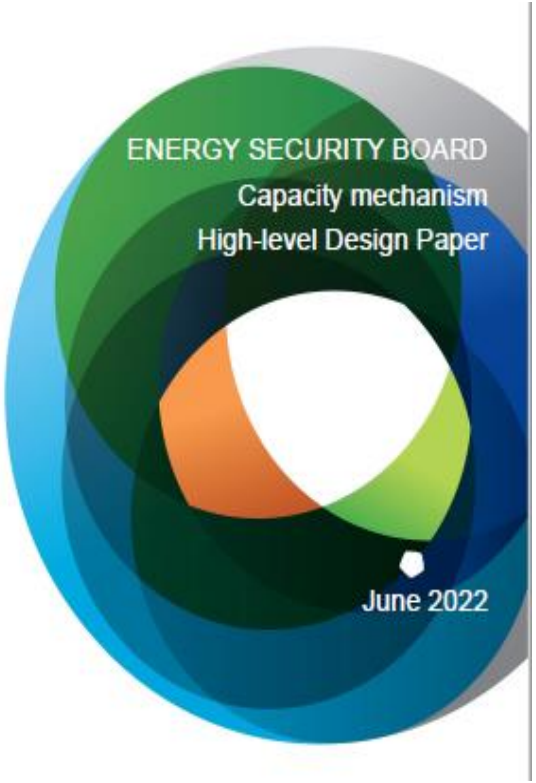
Supporting dispatchable capacity investment

- The NEM is an energy only market

- Enhancing NEM capacity price signals
  - Retailer Reliability Obligation
  - Emergency or operating reserves

Capacity Mechanism – a way forward?

- **ESB, Capacity mechanism - High-level Design Paper** (June 2022)
  - "*A capacity mechanism, in which providers of capacity are paid to have their capacity available during certain periods, will help reduce the risk of a disorderly transition*…
  - How will it function?
    - Eligibility
    - Centralisation
    - Capacity Certificates
    - Auctions/Interstate Trade



Dispatchable technologies ensuring the transition to net zero by 2050

What are dispatchable technologies?

- Australian Energy Council Definition:

  Zero emissions dispatchable plant has two characteristics.

  1. Dispatchable plant is plant that can be **relied upon to run when called on to do so**. Its availability is not weather dependent.

  2. Ideally it has **fast ramping capabilities**; that is, it can increase its output quickly.

- A need for zero emissions dispatchable plant to complement the growth of renewable energy and the retirement of existing dispatchable coal and gas generation.

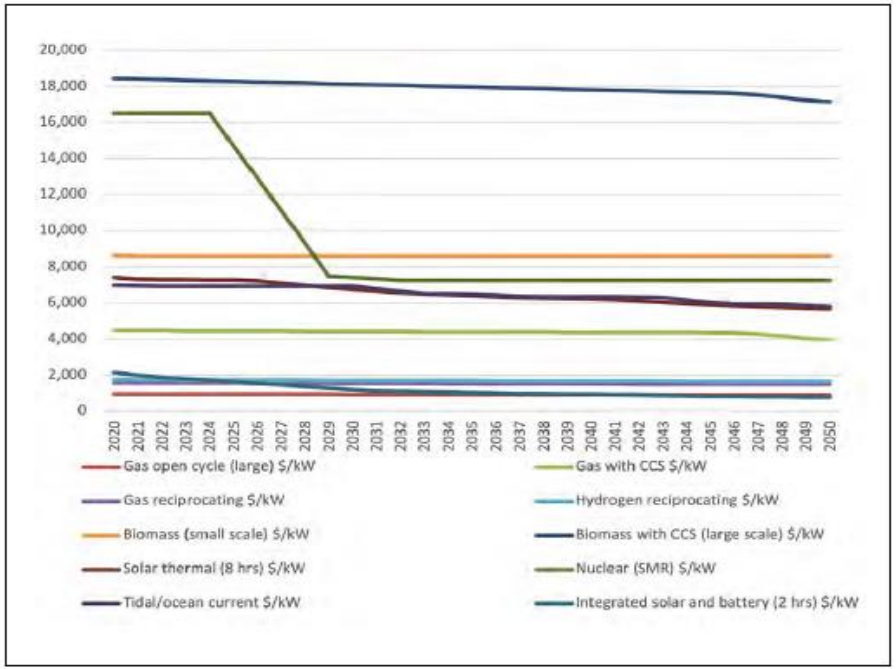
Forms of dispatchable technologies

- AEC: ‘The realistic options for providing zero emissions dispatchability divide into two basic types: **energy storage plant** and **fuelled plant**.’
  - Regarding nuclear, geothermal and fossil fuelled plant with carbon capture and storage (CCS) ‘… at present *none of these look likely candidates for the period to 2035*.’
- AEMO Categories:
  - Distributed Storage
  - Coordinated Distributed Energy Resources
  - Shallow Storage
  - Medium Storage
  - Deep Storage

Hornsdale Power Reserve, South Australia

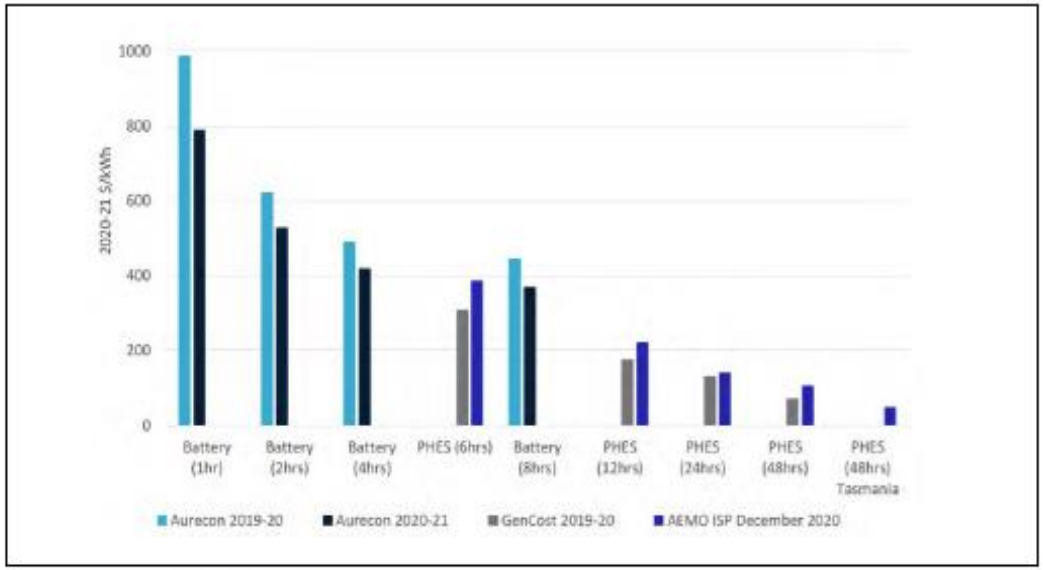
Image supplied by Neoen

Capital cost estimates of various low/zero emission technologies, $/kW



Source: GenCost project data, CSIRO, 2021

Capital costs of storage technologies in $/kWh (total costs basis)



Source: GenCost 2020-21, CSIRO, June 2021

Battery Storage

- ARENA Competitive Funding Round to fund a minimum of three large-scale battery storage (LSBS) projects with advanced inverter capability (e.g. grid-forming inverters).
- Financial Close: December 2023; Commissioning Date: >18 months following Financial Close.
- 2022 ISP: ‘advanced inverters not yet demonstrated at necessary scale to completely replace services provided by synchronous generation in the NEM’.

Hydro Energy Storage

- Currently, 7GW of non-pumped hydro in the NEM (23GW from coal, 11GW from gas or liquid fules), and 1.5GW from pumped hydro and battery storage.
- Dispatchable storage to manage seasonal and daily variations in solar and wind generation.
- Kidston Pumped Hydro Project (Genex Power).
- Snowy 2.0 – 2,000 MW dispatchable, 350k MWh of storage (but not until 2025).

Pictured above: Kidston Pumped Storage Project at disused goldmine near Townsville, Queensland

Offshore Wind

- **ISP 2022:** Offshore wind has great potential due to resource quality, possible lower social license hurdles. However, this emerging technology is currently a higher cost solution than on-shore options.

- Alternative grid-firming alternative: offshore wind can assist in directly powering future demand centres such as H2 hubs and REZs.

- Public and private sector – 19 projects with a capacity of 24GW in the pipeline, and Vic targets of 9GW of capacity by 2040.

- ***Offshore Electricity Infrastructure Act*** commenced 2 June 2022, Regulations in draft form.

Renewable Hydrogen

- Overcoming debt finance challenges for sponsors without existing infrastructure and demand (unlike solar and wind).
- S&P Global Platts: undertook first hydrogen price assessment in 2019, still no spot price market available.
- Role of ARENA and government in supporting emerging hydrogen markets.
- Hysata: H2 under $2?

Pictured above: ENGIE-YARA Renewable Hydrogen and Ammonia Deployment in Pilbara, Western Australia

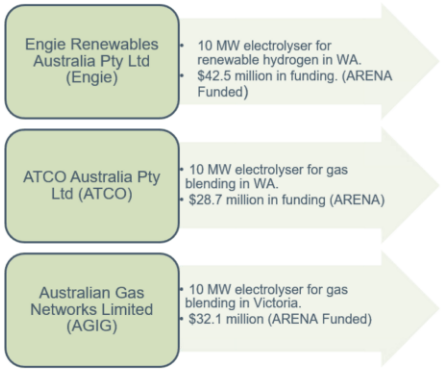
Feasibility study leading to ARENA funding approval for deployment of a renewable hydrogen and renewable ammonia production and export facility (using a 10 MW electrolyser).

Feasibility - 2020 - $995k ARENA funding | Deployment - 2021 - $42m ARENA funding

Australia a renewable hydrogen superpower?

Australia's intent to lead the hydrogen market

- An added investment of AU$1.2 billion has been provided to ARENA through the Budget 2021-22, that focuses on five priority technologies, hydrogen supply chain being a key part of it.
- CEFC is supporting the development of hydrogen by investing AU$300 million via Advanced Hydrogen Fund.
- Since 2017, ARENA has provided funding to 34 projects reaching an investment of AU$17.49 million.
- ARENA recently approved three commercial scale renewable hydrogen projects worth AU$103.3 million dollars.



Low Emissions Metals

- **Together the production of Steel and Aluminium accounts for approx 32% of emissions from industry**

- **Global trends increasing pressure on Australian producers**
  - Global commodities impacted by global markets
  - Global trend favouring low emissions supply chains and potential carbon border adjustments

- **Practicalities of heavy industry make decarbonisation difficult**
  - Capital intensive, slow moving, long asset lives, complex infrastructure
  - Low risk appetite, Limited price premium for green products
  - Decarbonisation technologies are not proven at scale and not yet commercially viable

What is the role of gas in a net zero grid?


Jemena
bringing energy to life


apa

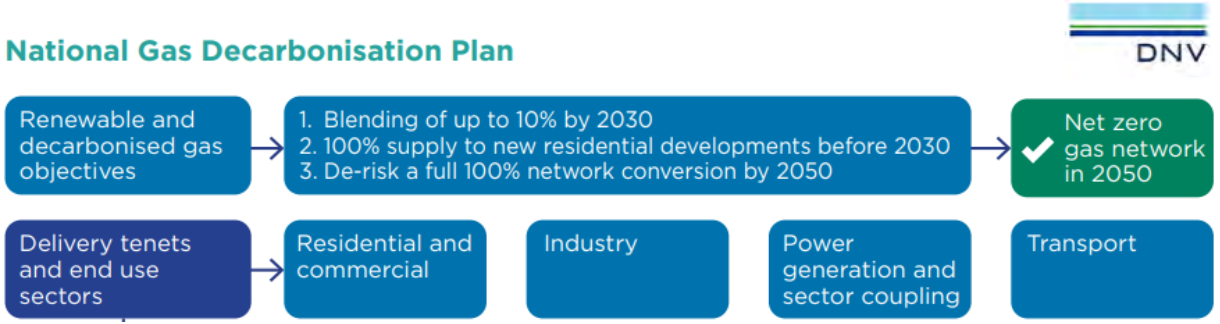

ATCO


Australian Gas
Infrastructure Group


evoenergy

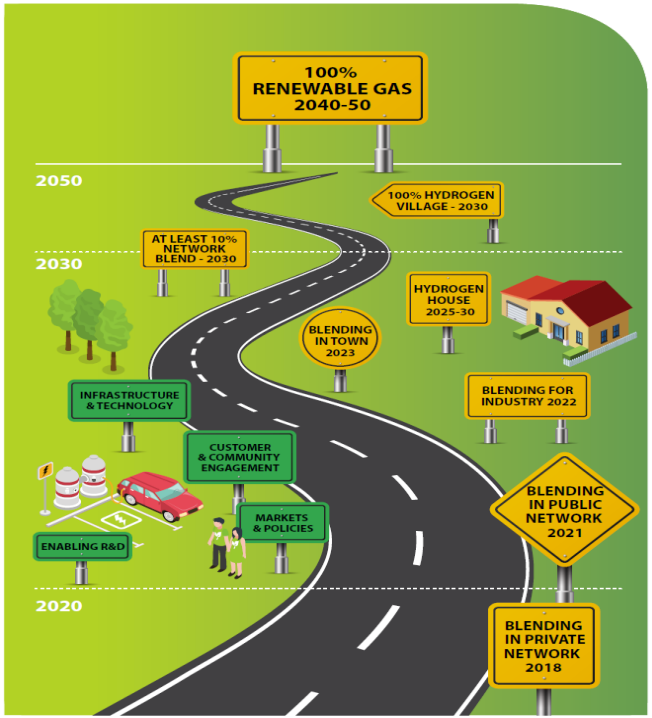
Gas Vision 2050

- Gas Vision: Benefits?
  - Natural gas supports Australia across many parts of the economy. It is used as a feedstock and fuel in industrial processes to support the agricultural and manufacturing sectors. It is used in businesses and homes to provide services such as heating, hot water and cooking.
  - A decarbonised energy system that continues to utilise existing gas infrastructure is a cheaper option than full electrification and decommissioning the gas network.
- Options: Bio- and renewable methane, hydrogen and direct electrification.



- Image: Gas Vision 2050, page 7.

High level roadmap to reach 100 per cent renewable gas by 2040 to 2050.



Incentivising Net Zero Gas Options

- Funding of demonstration and commercial scale projects (ARENA role).
- Developing renewable gas targets and certification schemes (GoOs).
- Reverse auctions for renewable gas or gas offtake agreements.
- Developing best practice and fit-for-purpose regulation.

Australian National Gas Law Reform

- National Energy Laws Amendment (Other Gases) Bill 2022

Timeline

- 19 May 2022: Consultation on all three work streams papers closed.
- Mid 2022: After consideration of the feedback received to the consultation package, present draft legislative amendments to Energy Ministers for consideration.
- Late 2022: Consultation on proposed initial Rules, Procedures and other subordinate instruments.
- By 2023: New measures intend to take effect subject to agreement by Energy Ministers and subsequent passage through the South Australian Parliament.

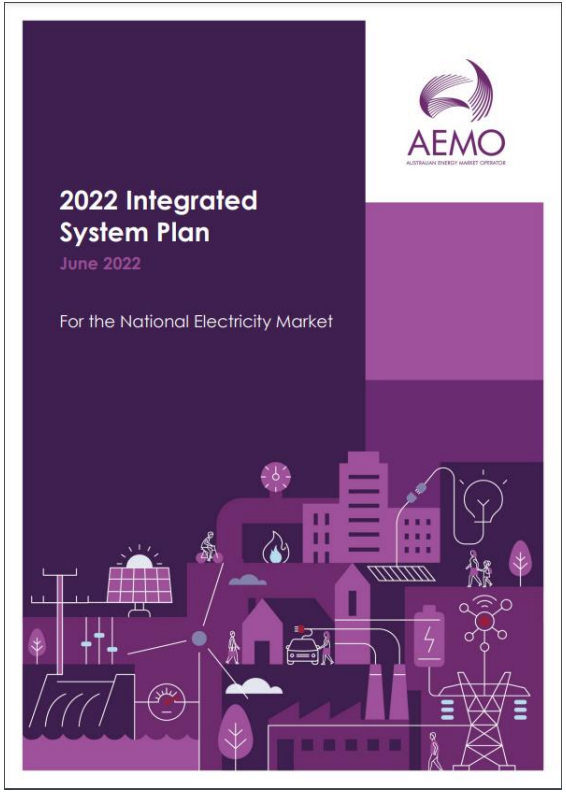
- Source: DISER (10 December 2021) https://www.industry.gov.au/news/trials-start-for-hydrogen-guarantee-of-origin-scheme

Synergy of Natural Gas and Renewable Energy?

- Kelly, C. ‘Harnessing Opportunities for Synergy Between Natural Gas and Renewable Energy: Trends and Legal Requirements’ in D.S Olawuyi, E.G. Pereira (eds.), *The Palgrave Handbook of Natural Gas and Global Energy Transitions* (Springer, 2022) 501-523.
  - Natural gas-fired assets may effectively complement power systems with increasing shares of VRE, assisting to maintain system security.
  - Ideal back-stop in high VRE systems due to ramp up function in turbines or reciprocating engines.

ISP 2022

- Role of peaking gas-fired generators:
  - On-demand fuel source during low VRE output as significant coal-fired generation ceases.
  - Power system services for grid security and stability.
  - Use case for where equivalent investment in deep storage is prohibitively expensive.
  - Investment in storage and peaking gas (in conjunction with VRE and DER).



Conclusion – can Technology drive the net zero transition?

- Yes, but with targeted support.
- National Gas Law Reform and ISP 2022 provide guidance, but the transition will benefit from Federal oversight (possibly in the Climate Change Bill to be tabled in late July).
- CSIRO 2022 GenCost report – ‘integrated wind and solar, including the cost of storage and transmission, still by far the cheapest source of new electricity generation’, as well as a ‘rapid fall in the cost of hydrogen electrolysers’.
- Recent international example: Energy Security Bill UK (introduced 6 July 2022) prioritises CCS and hydrogen, and a new 'Future System Operator' that will oversee the development of the electricity and gas sectors.

Thank you

Dr Cameron Kelly

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