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CENTRE FOR ENERGY AND NATURAL RESOURCES  
INNOVATION AND TRANSFORMATION



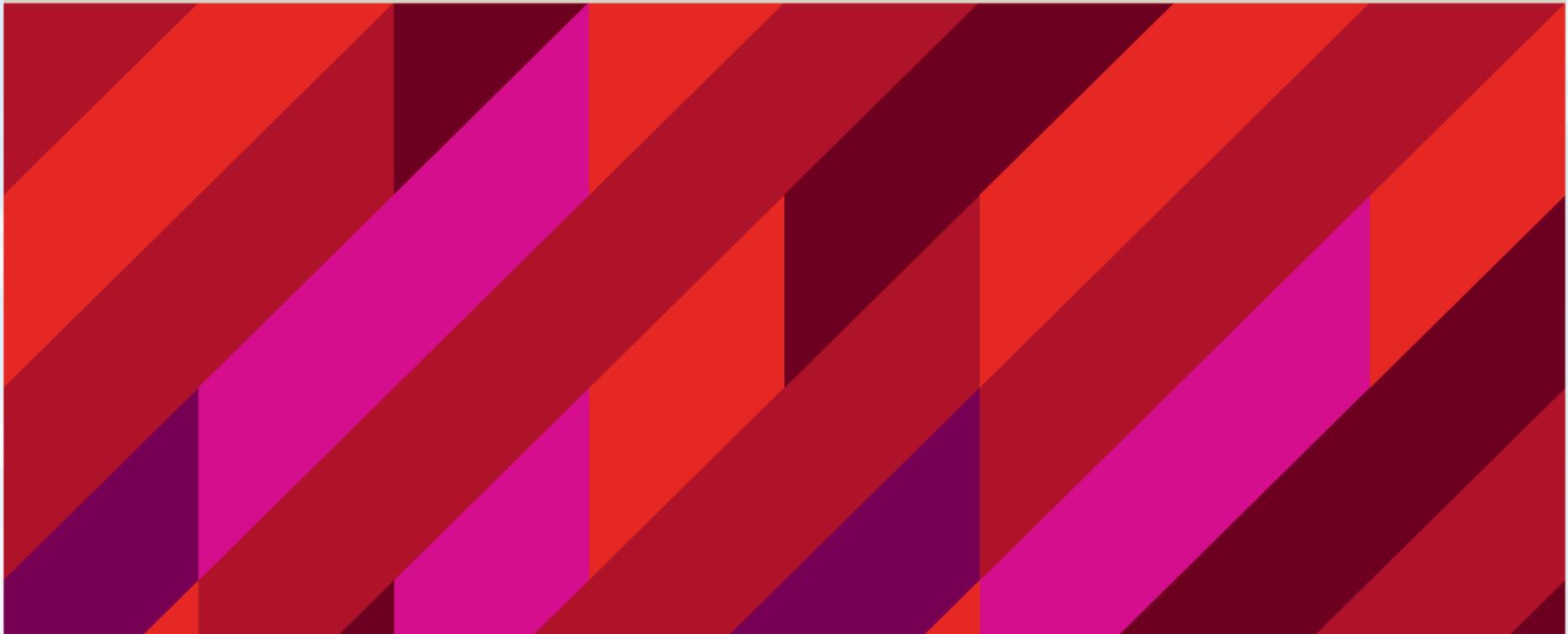
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# Short- to mid-term challenges and opportunities in innovation and transformation for the Energy Transition

BLUE-SKY WEBINAR, 22 JUNE 2022

**Professor Tina Soliman Hunter**

Director, Centre for Energy and Natural Resources Transformation and Innovation (CENRIT)



# SEMINAR OVERVIEW

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- Scope of the Webinar
- CHALLENGE 1: Energy Security
- CHALLENGE 2: Managing offshore assets
- CHALLENGE 3: NEM 2.0: Shifting from hydrocarbons
- OPPORTUNITIES ABOUND?

# SCOPE OF THE PRESENTATION

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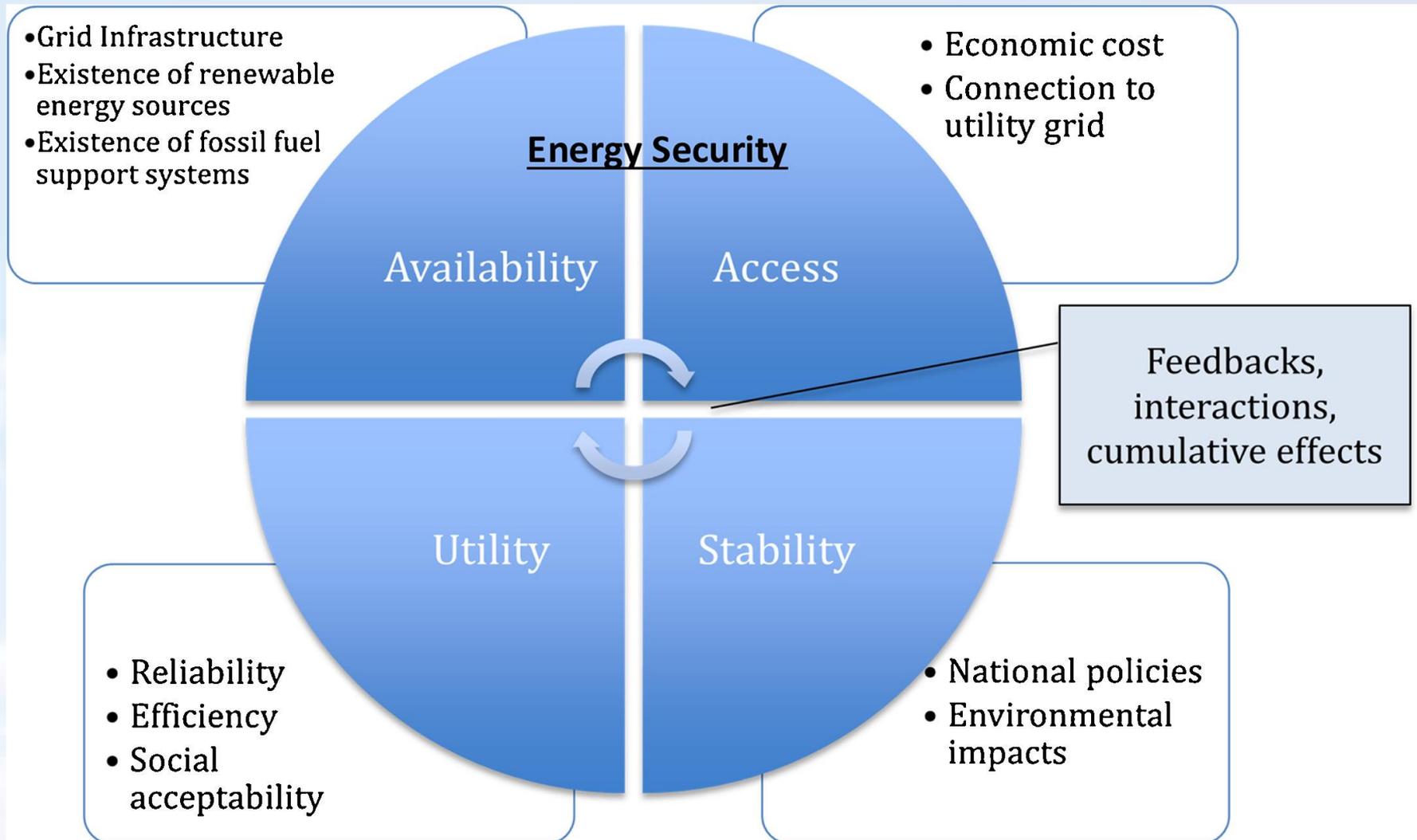
- The sky is the limit! – big picture thinking
- Australia and its place in the world
- Short-term – next 5 years
- Mid-term – next 15 years





# ENERGY SECURITY

# What is Energy Security?



# What do we mean by energy security?

No single definition but common themes

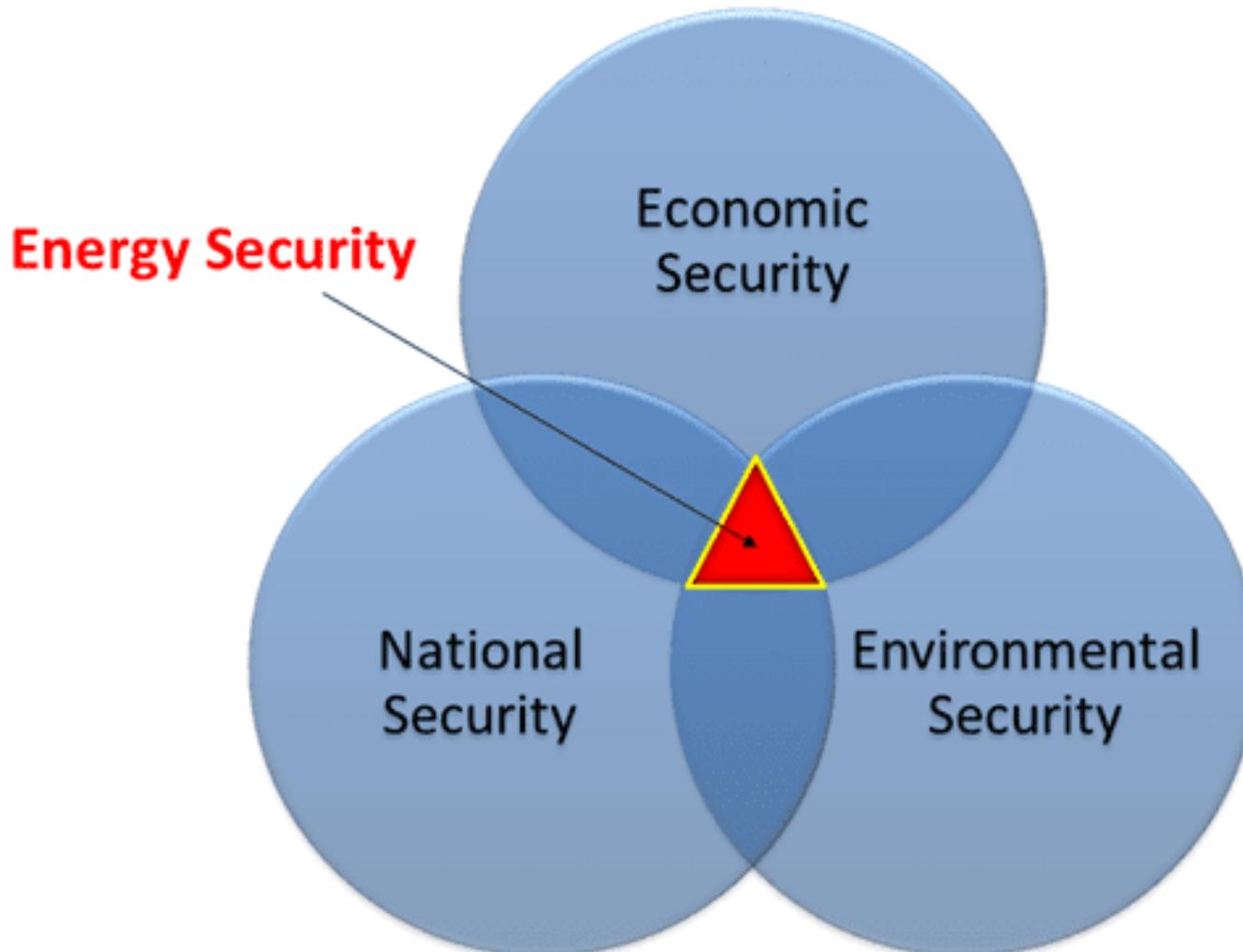
International Energy Agency (2014): The uninterrupted availability of energy supplies at an affordable price. Long term energy security is concerned with timely investments to supply energy in line with economic developments and environmental needs. Short-term energy security focuses on the ability of the energy system to react promptly to sudden changes in the energy supply-demand balance.

Asia Pacific Energy Research Centre (2007): *'the ability of an economy to guarantee the availability of energy resource supply in a sustainable and timely manner with the energy price being at a level that will not adversely affect the economic performance of the economy'*.

This definition leads to three fundamental elements and the '4 A's' of energy security:

- Physical supply: **availability** and **accessibility**
- Economic: **affordability**
- Environmental sustainability: **acceptability**

# National Security dimensions of energy security



# Issues in Australia's Energy Security



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*Journal of World Energy Law and Business*, 2018, 0, 1–22  
doi: 10.1093/jwelb/jwy026  
Article

- Did we see this coming???
  - Some of us did!
- Security of Demand
  - Who will buy our gas?
  - Who will buy our coal?
- Security of Supply – National Security
  - Liquid fuel security
  - Fuel for defence
  - Fuel for agriculture
  - Refinery capacity
  - Strategic stockpiles – IEA requirements

## A paradox of plenty: the Australian domestic gas supply regulatory dilemma

Madeline Taylor\* and Tina Soliman Hunter \*\*

### ABSTRACT

Energy security is a transitional concept heralding from traditional principles focused on security of supply. Onshore conventional and unconventional gas reserves have played an integral role in Australia's energy security since its commercial production commenced in the Cooper Basin Region in 1969. However, since 2015, the staggering increase in liquefied natural gas (LNG) exports, earning Australia its title as the second largest global LNG exporter, has heightened competition for gas supply in the Australian East Coast Gas Market (ECGM). This article examines whether the recently enacted Australian Domestic Gas Supply Mechanism (ADGSM), in imposing controls on LNG exports, marks a shift in regulation and policy by fostering gas security for the ECGM. This article advances the argument that the ADGSM is an initial temporary and short-term step in seeking to avert a domestic gas shortfall. It is argued that a market-based approach to gas regulation will not provide gas security for Australia without additional regulatory measures and infrastructure investment.

### 1. INTRODUCTION

The importance of gas as a global energy source is undisputed, in an era of climate change and The 2015 United Nations Climate Change Conference targets.<sup>1</sup> Natural gas in particular is a viable fossil fuel creating lesser emissions than more traditional fossil fuels.<sup>2</sup> In this respect, it is a 'transition fuel' paving the way to a low-carbon economy and a 'golden age' of gas. Gas is the third largest energy source in Australia. Yet, despite being a gas abundant nation, the share of Australian electricity generated through gas has declined over the past five years to reach 21.0 per cent in 2014–2015.<sup>3</sup> This decline in the domestic use of gas is attributed, in part, to a market-based approach to gas regulation and energy security policy over the past 15 years. This has created a domestic gas market shortfall in the East Coast Gas Market (ECGM) between 55 and 108 petajoules (PJ) in 2018.

\* Academic Fellow, School of Law, The University of Sydney, Sydney, New South Wales, Australia. E-mail: madeline.taylor@usyd.edu.au

\*\* Professor of Energy Law and Director, Centre for Energy Law, University of Aberdeen, Aberdeen, UK. E-mail: thunter@abdn.ac.uk. We are grateful for the comments provided by Alexandra Wawryk on an earlier draft of this article.

1 International Energy Agency, *Golden Rules for a Golden Age of Gas* (2012) <<http://www.iea.org/geo/goldenrules/>> accessed 20 June 2018.

2 In comparison to coal, gas emits 50% less carbon emissions when used to generate electricity. Jonathan Stern, *Challenges to the Future of Gas: Unburnable or Unaffordable?* (Oxford Institute for Energy Studies Paper 2017), 1–2 <<https://www.oxfordenergy.org/wp-content/uploads/2017/12/Challenges-to-the-Future-of-Gas-unburnable-or-unaffordable-NG-125.pdf>> accessed 14 May 2018.

3 IEA, *Energy Efficiency Market Report 2016* (2016) <[https://www.iea.org/eemr16/files/medium-term-energy-efficiency-2016\\_WEB.PDF](https://www.iea.org/eemr16/files/medium-term-energy-efficiency-2016_WEB.PDF)> accessed 10 May 2018.

# The critical path forward

## TECHNOLOGY INVESTMENT ROADMAP

### Australia's first Low Emissions Technology Statement

ARENA will be a key part of efforts to accelerate **priority** technologies to achieve **stretch goals**, and will continue to support **enabling and emerging** technologies

#### STRATEGIC INTENT

A prosperous Australia, recognised as a global low emissions technology leader

- Preserve and create jobs, capture new opportunities and revitalise Australia's regional economies
- Lower household living expenses with abundant, clean and low-cost energy
- Build competitiveness by leveraging our comparative advantages
- Attract and retain the best minds in priority low emissions technology research fields

#### PRIORITY TECHNOLOGIES

Stretch goals

- Clean Hydrogen
- Energy Storage
- Low Carbon Material
- CCS
- Soil Carbon

#### EMERGING AND ENABLING TECHNOLOGIES

- Low emissions heat
- Generation enablers (eg, VPPs)
- Waste to energy and recycling
- Vehicle charging / refuelling infrastructure
- Next generation Solar PV
- Innovative generation
- Demand response
- Etc ...

# Changing weather patterns and coal assets

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# Environmental Security: Energy Transition, innovation, and transformation

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## Australia's big technology challenges



Delivery of low-cost, clean and reliable energy to households and industry for transportation, heating, lighting and production



Expanding production and increasing productivity, creating jobs and substantially reducing emissions from Australia's primary industries



Preserving and expanding onshore manufacturing of energy-intensive products and capturing new export markets for low emissions commodities



Scaling geological and biological sequestration to provide globally significant sequestration of CO<sub>2</sub>

# The last 2 years:

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- **The Australian National Resources Statement (2019)**
- **The National Hydrogen Strategy (2019)**
- **The Technology Investment Roadmap (*Low Emissions Technology Statement*) (2020)**
  - **Low Emissions Technology Statement 2021**
- **Make it Happen: The Australian Government's Modern Manufacturing Strategy (2020)**
  - At the heart of this manufacturing transformation is the creation of a **competitive gas** market (\$4/GJ)
  - Focus areas include **food and agritech**, **mintech** and **rare earth minerals**, and **energy and renewables**
- **2022 Critical Minerals Strategy**

# Australia's Response:

## LOW EMISSIONS TECHNOLOGIES



## LOW EMISSIONS TECHNOLOGY STATEMENT



### Highlights



#### PRIORITY TECHNOLOGY STRETCH GOALS

- CLEAN HYDROGEN**  
under \$2 per kilogram
- ENERGY STORAGE**  
electricity from storage for firming under \$100 per MWh\*
- LOW CARBON MATERIALS**  
low emissions steel production under \$900 per tonne and low emissions aluminium under \$2,700 per tonne
- CCS – CO<sub>2</sub> COMPRESSION, HUB TRANSPORT AND STORAGE**  
under \$20 per tonne of CO<sub>2</sub>
- SOIL CARBON**  
measurement under \$3 per hectare per year

\* This would enable firming wind and solar at pricing at or below today's average wholesale electricity price



#### ANTICIPATED IMPACTS FROM THE PRIORITIES

- OVERACHIEVE**  
on our Paris Agreement commitments, with a pathway to deeper emissions reductions beyond 2030
- SUPPORT OVER 130,000 JOBS BY 2030**  
with more than half in regional communities
- PRESERVE AND EXPAND EMPLOYMENT**  
in our energy-intensive manufacturing sectors
- AVOID IN THE ORDER OF 250 MILLION TONNES OF EMISSIONS PER YEAR BY 2040**  
through deployment of priority technologies at home and Australia's low emissions exports
- SIGNIFICANTLY REDUCE GLOBAL EMISSIONS**  
from energy, transport, industry and agriculture if priority technologies achieve widespread deployment. These sectors account for around 90% of emissions and emit approximately 45 billion tonnes of CO<sub>2</sub> each year.



#### PUBLIC-PRIVATE PARTNERSHIP

- AIM TO CATALYSE \$3–\$5 OF NEW INVESTMENT FOR EACH DOLLAR OF COMMONWEALTH FUNDING**  
to achieve \$50 to \$100 billion in new investment domestically over the decade to 2030
- A TECHNOLOGY INVESTMENT FRAMEWORK**  
to improve coordination of delivery agencies – ARENA, the CEFC and CER – towards national technology priorities and expected Government investment of \$18 billion in low emissions technologies over the decade to 2030
- RETAIN ARENA ON THE FRONTLINE OF DIRECT GOVERNMENT INVESTMENT**  
in low emissions technologies, playing a central role in delivering Roadmap priorities. New funding for the CEFC to support grid reliability
- ARENA WORKING WITH THE CEFC AND OTHER AGENCIES**  
to develop a goal-oriented program for priority low emissions technologies like low emissions steel, low emissions aluminium, and energy storage
- ESTABLISH AUSTRALIA'S FIRST REGIONAL HYDROGEN HUB**  
co-locating domestic hydrogen users with an export focus to create global hydrogen supply chain linkages
- SCALE CCS**  
to support emissions reduction from power generation, oil and gas extraction, natural gas processing, industry or hydrogen production



# SHIFTING FROM HYDROCARBONS

# AUSTRALIA

In 2020

**265,232** GWh



electricity generated



**24%**

renewables share of total generation

▲ from 21%



**20%**

natural gas share of total generation



**54%**

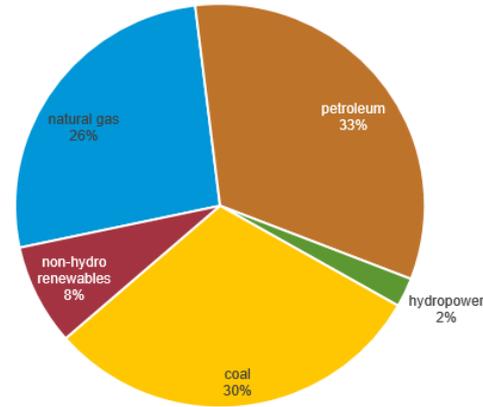
coal share of total generation

# Energy generation and use in Australia

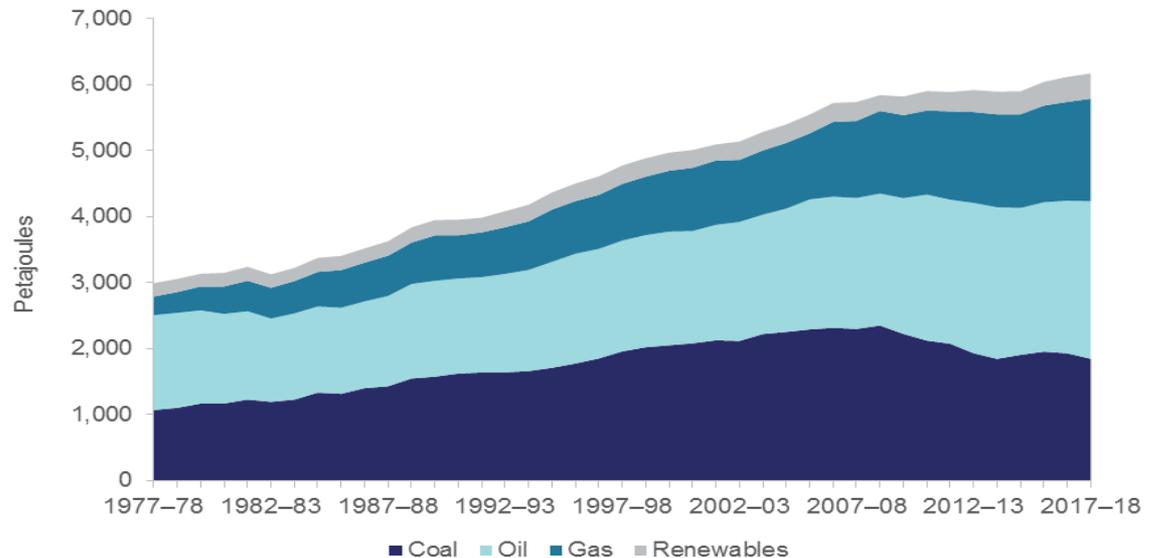


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Figure 2. Total primary energy consumption in Australia by fuel type, 2020



Source: Graph by U.S. Energy Information Administration, based on data from BP Statistical Review of World Energy 2021



# So Why Hydrogen?

## WHY HYDROGEN?



Most common  
substance in  
the universe



Produced from  
many energy  
sources



No greenhouse  
gas emissions  
in use



Can be made  
cleanly using  
water



Higher energy density  
than batteries  
when compressed



Can be stored as a  
liquid or gas



Can be stored,  
transported & exported



No more or less  
safe than petrol or  
diesel fuels



Can provide energy  
to all parts of  
the economy

# Hydrogen

## THE CRITICAL FUEL?

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### Accelerating the uptake of renewable hydrogen

Supporting the growth of Australia's hydrogen industry for domestic applications and export



Potential **major new energy export commodity**



**Sector is still in its infancy** - expensive with few large-scale systems



**Opportunities for domestic use**



**Government support needed to kickstart the industry**



Yara Pilbara Fertilisers' ammonia plant in Western Australia's Pilbara region



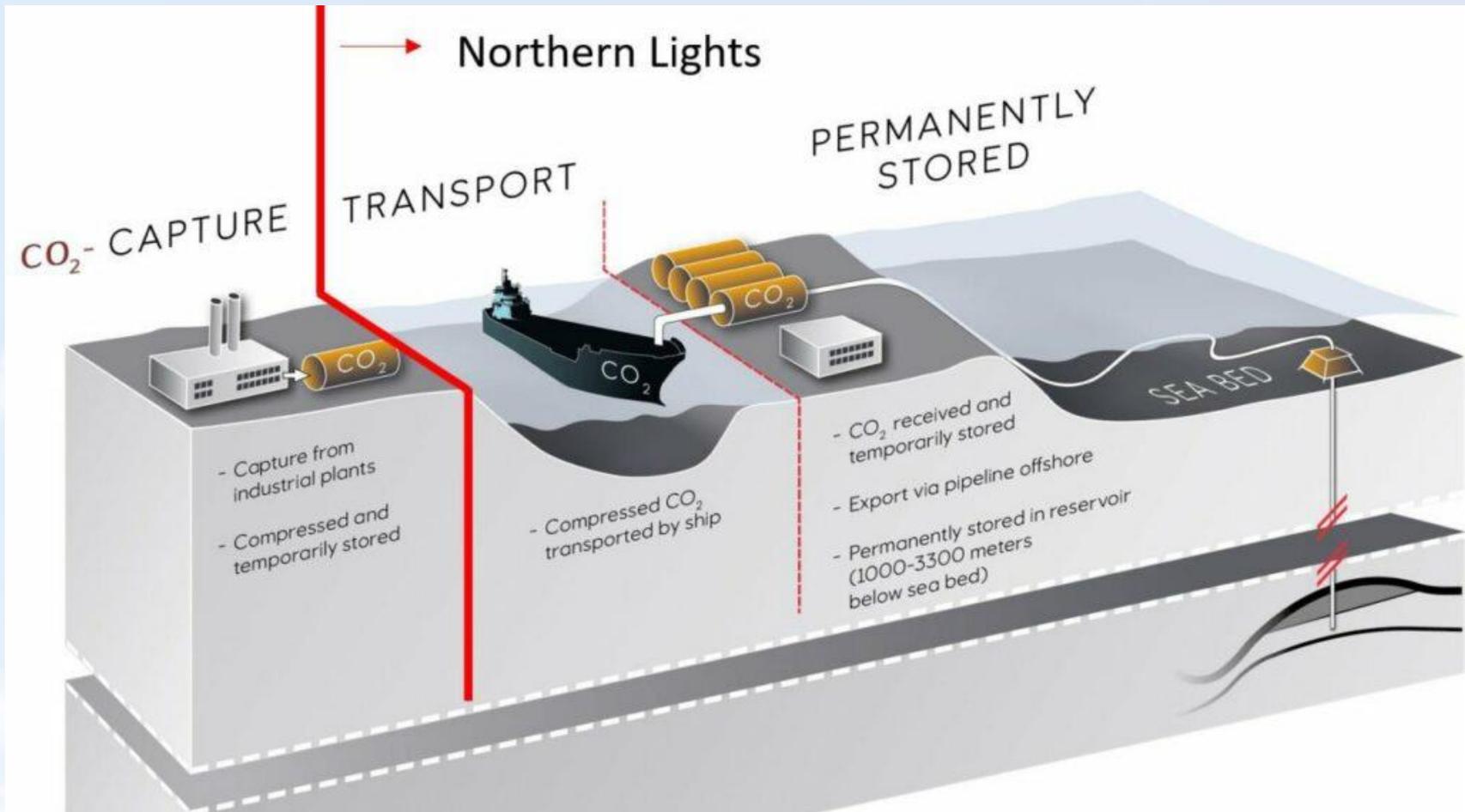
# MANAGING OFFSHORE ASSETS

# Challenge: Defunct: Remove and then ???

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# Opportunity – Innovation



# Opportunity – innovation for transformation

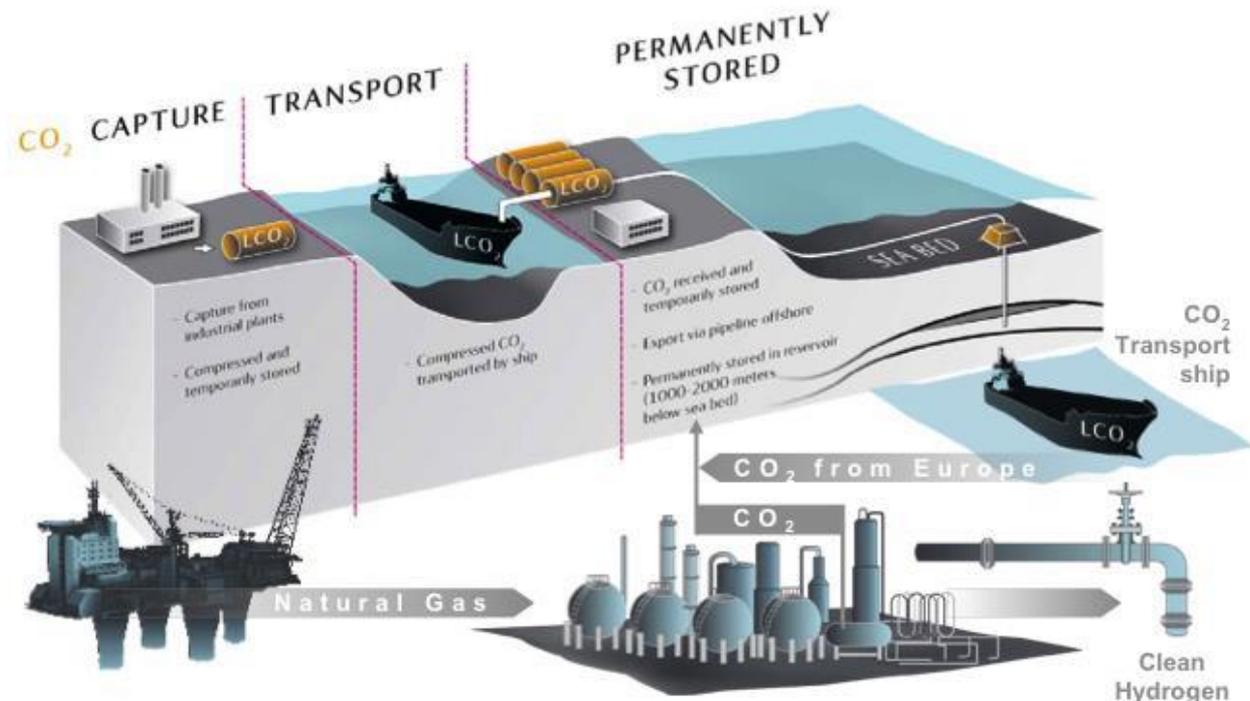
## CCS value chain as enabler for clean Hydrogen production

### Step 1

Establish CCS infrastructure

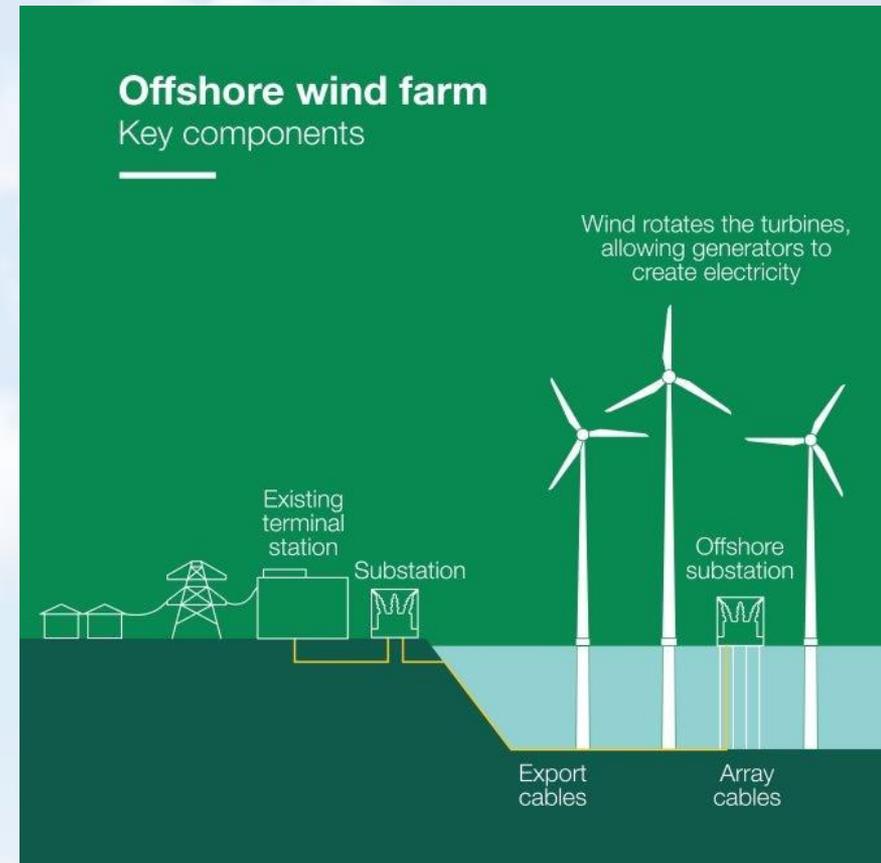
### Step 2

Utilize CCS infrastructure to produce clean hydrogen from natural gas and/or import CO<sub>2</sub> from Europe



# Offshore Wind

**BOTH AN OPPORTUNITY AND CHALLENGE!**



**But how safe is safe?**

# Opportunity through Innovation and transformation

## Mid-West Wind & Solar Project

Wind turbines and offshore substations in the ocean  
(see locator map for license area)

A transmission network transfers energy to the Western Power South West Integrated System



Mid West Wind & Solar Project

Subsea Cables transport energy to the coast

Generators create electricity from the wind that spins the turbines

Offshore Substation

20-40m deep

Array Cables

Export Cables

Onshore Substation

Solar Farm

Existing Infrastructure

Existing Terminal Stations

Power to Western Australia business and residential customers

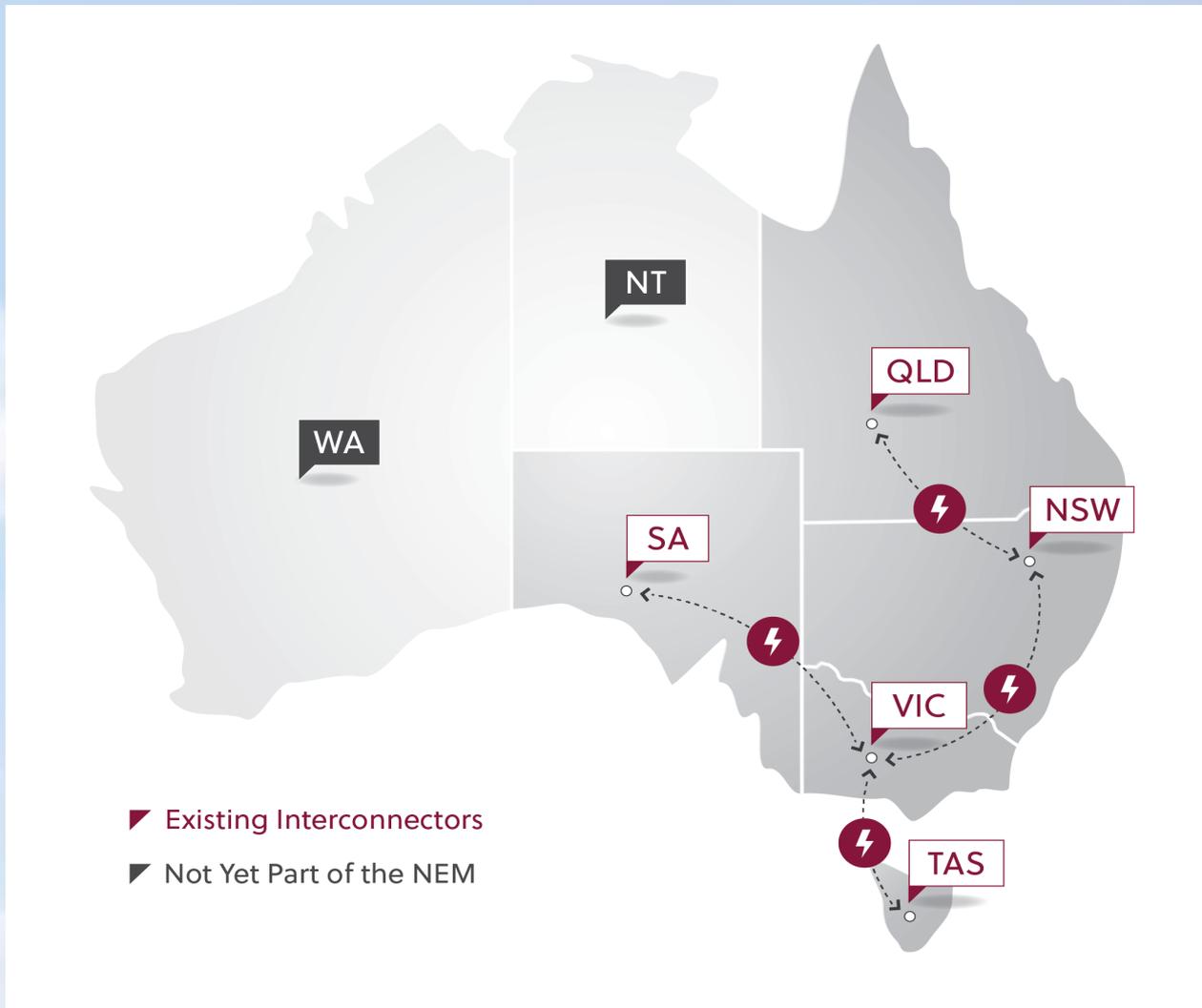
Cables and power transmission infrastructure

Diagram not to scale



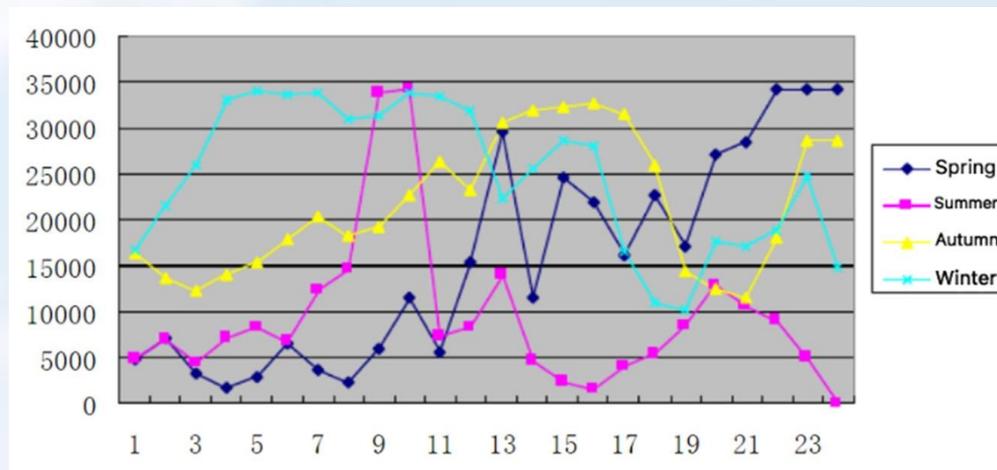
# REIMAGINING THE NATIONAL ELECTRICITY MARKET: NEM 2.0

# OUR NEM



# NEM 2.0 AND RENEWABLES

- Renewable input
  - Frequency modulation
  - Storage
  - Regulating in the NEM
- Baseload fuel, for when the sun don't shine!



# CHANGING WEATHER PATTERNS: TOO MUCH WATER

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# Challenges



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- Infrastructure upgrade!
- Critical need for energy storage – provide opportunities for new forms of storage
- Marinus Link – Bass Link 2
- Role of the State – intervention or market?
  - Batteries – Tesla, etc
  - Snowy 2.0
  - Tasmania's 'Battery of the Nation'



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**Thomas J. Dimitroff**  
Roland Berger GmbH;  
Infrastructure Development Partnership LLP

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**Prof. Kim Talus**  
Tulane Center for Energy Law,  
Tulane Law School.

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Oil, Gas & Energy Law Intelligence

**The National Electricity Market 2.0:  
The Role of Energy Storage in Managing  
Australia's Energy Trilemma**  
by T. Soliman Hunter and by M. Taylor

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**OGEL** (Oil, Gas & Energy Law Intelligence): Focusing on recent developments in the area of oil-gas-energy law, regulation, treaties, judicial and arbitral cases, voluntary guidelines, tax and contracting, including the oil-gas-energy geopolitics.

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OGEL is linked to **OGELFORUM**, a place for discussion, sharing of insights and intelligence, of relevant issues related in a significant way to oil, gas and energy issues: Policy, legislation, contracting, security strategy, climate change related to energy.



# OPPORTUNITIES

# Opportunities for Australia

- **Net zero emissions by 2050**
- Deliver through **innovation** and **new technologies**
  - **Gas-led recovery** of the Australian economy post-COVID, including government investment in gas pipelines, reforming regulations and developing five new strategic gas basins
  - **Hydrogen** for less than \$2 per kg
  - **Low emissions steel** production at \$900/tonne
  - **Low emissions aluminium** production below \$2700/tonne
  - **Soil carbon** below \$3/hectare/annum



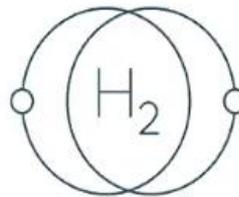
## INTEGRATING RENEWABLES INTO THE ELECTRICITY SYSTEM

Delivering technology and business model solutions to enable higher shares of renewables in the electricity sector



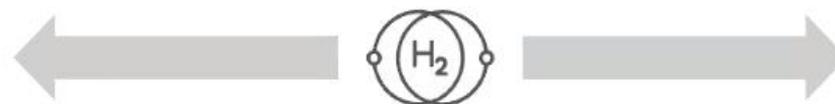
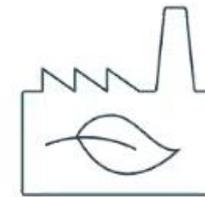
## ACCELERATING HYDROGEN

Supporting the growth of Australia's hydrogen industry for domestic applications and export



## SUPPORTING INDUSTRY TO REDUCE EMISSIONS

Progressing technologies to reduce costs and reduce emissions



# Energy Storage and technology in Australia

## ENERGY STORAGE BOOM

**PROJECTS OPERATING, IN CONSTRUCTION & PLANNING**

Australia is investing heavily in new energy storage projects and we may be on the cusp of an energy storage boom. There are already three operational pumped hydro facilities, with a number of batteries and a solar thermal plant under construction. A variety of other projects are being planned.

**DEGRUSSA COPPER & GOLD MINE, WA**

**Battery**  
Sandfire's West Australian mine has a 6MW/1.8MWh battery

**EYRE PENINSULA, SA**

**Pumped Hydro**  
Planning underway for largest saltwater pumped hydro facility in the world

**PORT AUGUSTA, SA**

**Concentrating solar thermal with storage**  
Australia's biggest solar thermal plant, to open in 2020

**JAMESTOWN, SA**

**Battery**  
The world's currently biggest lithium-ion battery (100MW/129MWh) began operating on the 1st December

**YORKTOWN & RIVERLAND, SA**

**Battery**  
A 30MW/8MWh battery will be operational in mid-2018, while a 100MW/400MWh battery is planned



**ALICE SPRINGS, NT**

**Battery**  
5MW/3.3MWh battery under construction in Alice Springs

**LAKE WIVENHOE, QLD**

**Pumped Hydro**  
Queensland's first pumped hydro facility, built in 1984

**KENNEDY ENERGY PARK, QLD**

**Battery**  
A 2MW/4MWh lithium-ion battery is being constructed alongside a solar and wind farm

**KIDSTON GOLD MINE, QLD**

**Pumped Hydro**  
Converting an old gold mine into pumped hydro

**ADELAIDE, SA**

**Hydrogen**  
Tender underway for 6 hydrogen fuel cell buses

**STAWELL, VIC**

**Battery**  
Plans to build 20MW/34MWh battery to power glasshouse

**SHOALHAVEN SCHEME, NSW**

**Pumped Hydro**  
240MW storage facility, built in 1977

**TASMANIA**

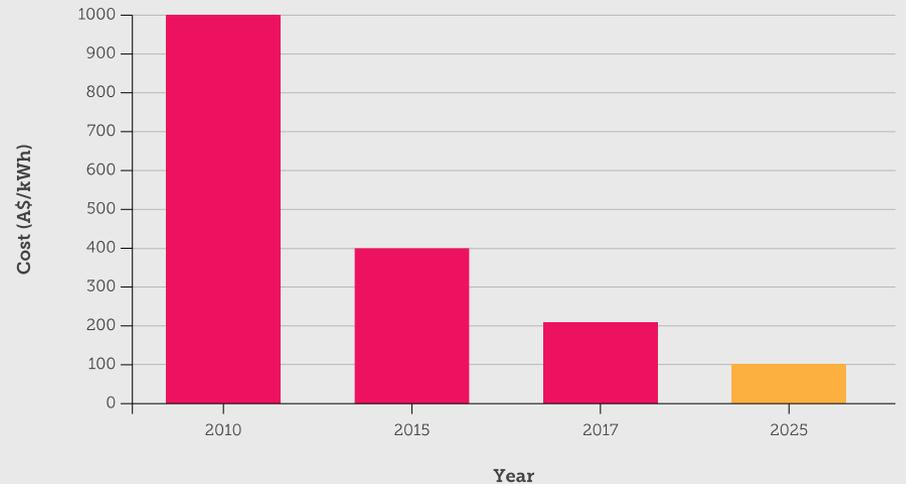
**Pumped Hydro**  
Feasibility study for expansion of Tasmanian Hydro

**SNOWY MOUNTAINS, NSW**

**Pumped Hydro**  
Australia's first pumped hydro facility was built in 1973. Feasibility study recently completed into the potential expansion of the Snowy Hydro scheme

Note: This map does not include all storage projects planned in Australia. Only grid-scale projects are included.

THE FALLING COST OF LITHIUM-ION BATTERIES



Source: Bloomberg New Energy Finance 2017b; SunWiz 2017.

# 'Battery of the Nation'

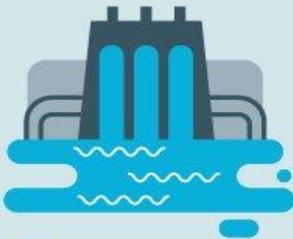
## A NEW CONNECTION

The Basslink interconnector carries electricity between Tasmania and the mainland in both directions. A second interconnector would allow more power to flow, enabling Tasmania to add new wind and pumped hydro generators and act as a "battery for the nation".



1

Tasmania sits amid the 'roaring 40s,' a high-quality resource that blows at different times to SA and Vic winds and could provide power to the NEM at those times.



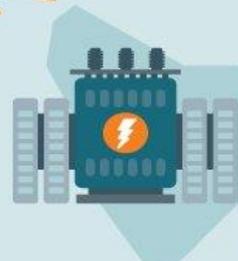
2

Existing hydro schemes (and future pumped hydro) can provide dispatchable power when it is needed

A **second interconnector** would allow renewable energy to flow from Tasmania to the mainland, supplying the NEM when needed.

It also allows the NEM to power pumped hydro systems in Tasmania and provides backup in event of local shortfall.

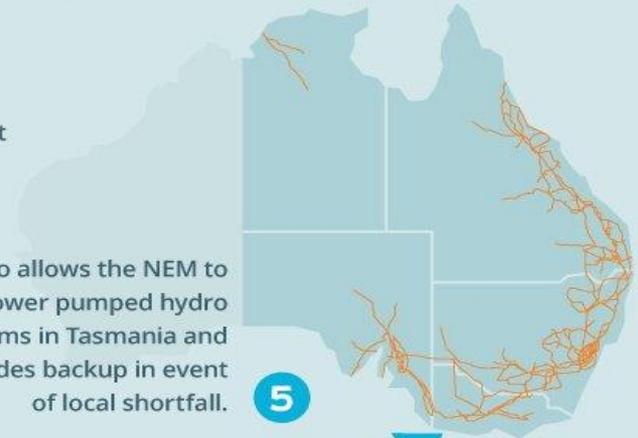
4



3

Tasmania's ability to feed power into the NEM is constrained by the capacity of the **Basslink interconnector**

5



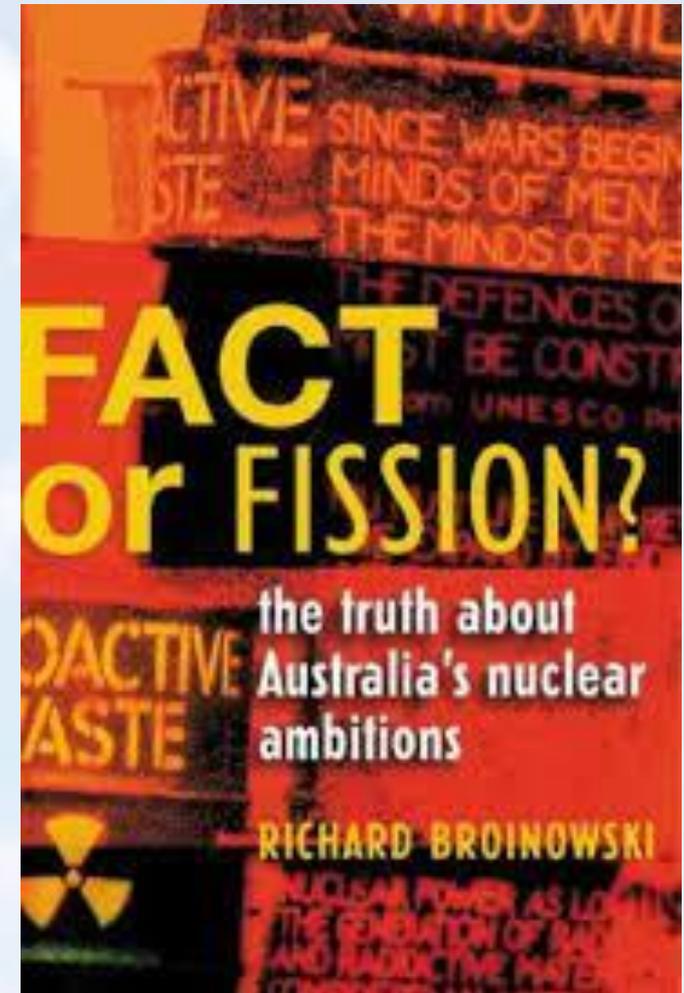
# BLUE HYDROGEN vs GREEN HYDROGEN

## Clean hydrogen is a priority technology

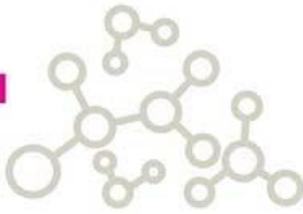
H<sub>2</sub><\$2 supports other **priority** technologies and is facilitated by **enabling and emerging** technologies



# IS nuclear the answer?



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# Thank you

**Keep in touch:**

[tina.solimanhunter@mq.edu.au](mailto:tina.solimanhunter@mq.edu.au)