Australia United Arab Emirates
Business Council

Renewable & Alternative Energies Working Group – Final Report

Strengthening Alternative and Renewable Energy Pathways: Investment and Collaboration Opportunities Between Australia and UAE

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CONTENTS

FOREWORD

Australia and the United Arab Emirates (UAE) may be in opposite hemispheres, however they share the same commitment to playing a leading role in the global transition towards a low-cost carbon future.

It is this commitment to the alternative and renewable energy sector that the Australia UAE Business Council has chosen this sector as the focus of its inaugural Working Group. This Final Report by the Renewable and Alternative Energies Working Group highlights and showcases the vital and deepening bilateral investment opportunities across the renewable and alternative sectors between our two great nations.

We believe this report, **Strengthening Global Alternative and Renewable Energy Pathways: Investment and collaboration opportunities between Australia and UAE,** is a conduit for greater collaboration and contributions from all stakeholders – from government to investors, and asset managers to engineers. We believe collaboration will harness the fullest possible integration of impactful and innovative sustainable pathways into future energy security strategies.

We would like to thank especially the Co-Chairs of the Australia UAE Business Council Working Group on Renewable and Alternative Energies, Mr Sam Pearce (QIC) and Mr Przemek Lupa (Masdar), as well as the Members of the Working Group for their work on bringing together a comprehensive overview of the renewable and alternative energy markets across Australia and the UAE, as well as viable investment opportunities.

We look forward to seeing the outcomes and successes of future partnerships between Australian and Emirati companies in this space.

The Hon Christopher Pyne
Australia UAE Business Council
Australian Co-Chair

His Excellency Badr Al-Olama
Australia UAE Business Council
Emirati Co-Chair

	GOVERNMENT	BUSINESS
SUPPLY	Government support – such as input cost controls, tax incentives and subsidies – for exportable green energy and hydrogen supply chain development	Develop projects through the execution and bringing to scale and renewable energy and H2 value chain's key components
DEMAND	Support for offtakers through fostering demand for cheapest exportable green energy in the world. Policy development to drive the utilisation of H2 as a transport fuel e.g. freight and logistics	Stimulate H2 demand in large scale industrial processes requiring significant energy input

TECHNOLOGY AND R&D

Manufacturing H2 to scale

Developing the necessary technology for efficient H2 storage and transport

Increasing capability to utilise current infrastructure e.g. gas transmission and distrution systems

About the Australia UAE Business Council

The Australia UAE Business Council provides unparalleled access to senior decision makers in business and government with the aim of deepening bilateral trade and investment, expanding opportunities for Australian and Emirati businesses and strengthening the ties between two great nations.

The primary objectives of the Australia United Arab Emirates Business Council are to:

- Provide members with unparalleled access and networking opportunities with senior Australian and Emirati officials, government bodies and government-linked entities;
- Assist member companies and organisations in Australia and the UAE connect with their counterparts;
- Promote Australian and Emirati businesses and foster opportunities and enterprise; and
- Build and develop stronger ties and understanding between Australia and the UAE.

	Australia	United Arab Emirates
GDP (2020)	$1331bn USD	$354bn USD
GDP per capita (2020)	$56,307 USD	$31,948 USD
Real GDP Growth	2.2% (2019) -0.3% (2020)	1.7% (2019) -6.6% (2020)
GDP Growth (YoY)	9.60%	1.7% (2019)
Trade with respective country (2020) - merchandise	$3.32bn AUD	$1.95bn AUD
Primary Trade Sectors (merchandise)	Meat (excl. beef) $248m Vehicle Parts & Accessories $155m Telecom Equipment & Parts $136m Beef $98m Includes $1.7b of confidential items & special transactions (estimated to include mainly alumina), 51% of total exports.	Crude petroleum $902m Refined Petroleum $260m Fertilisers (excl crude) $193m Copper $124m
Trade with respective country (2020) - services	$0.45bn AUD	$2.55bn AUD
Primary Trade Sectors (services)	Transport $298m Personal Travel (excl education) $65m	Transport $2.15bn Personal Travel (excl education) $227m

INTRODUCTION

Australia and the UAE share a common legacy. We are both energy-rich nations which have historically produced and exported commodities to power the world's homes, manufacturing, transport, commercial and industrial complexes.

Yet we believe we also share a common future, one in which we can play a significant role in the energy transition that is under way and embrace the rising renewable and alternative energy sector. This transition is rapidly accelerating, through both policy initiatives by government and through the efforts of the energy market participants; be it customers looking for pathways to decarbonise, developers looking to commercialise new technologies, existing players looking to meet customer demand and manage future risk, or from other sectors such as the finance and insurance markets which are needed to enable this journey.

Through this report **Strengthening Alternative and Renewable Energy Pathways: Investment and collaboration opportunities between Australia and UAE** we provide guidance to each nation's respective investors or managers wishing to enter or deepen their allocations to the sector in Australia and UAE.

As this sector is marked by continuous innovation and the advent of new technologies, we will not cover these developments but instead focus on the current and future markets as they exist in both nations, the associated policies, risk and return profiles, future trends, investment roadblocks, and entry strategies.

Sam Pearce

Australia UAE Business Council
Working Group on Renewable and Alternative Energies
Australian Co-Chair

And while green hydrogen is dominating headlines for this sector, we also broaden it out to position a spectrum of renewable and alternative energies to include:

» Utility-scale renewable energy and battery storage

» Green hydrogen and fuels

» The Australian waste to energy segment.

The report will then provide an overview of the investability positioning through a matrix which summarises the size of the opportunities on offer, as well as a timeline for current project development.

We believe this report sets out some of the most important considerations for investors and managers to participate in the energy sector transition in Australia and the UAE. It has been developed from key inputs from the noted authors who have shared their expertise and knowledge with us for each section. We would like to sincerely thank each of them for their contribution.

If there are any questions or requests for contact details, please contact enquiries@ausuaebc.com.

Przemek Lupa
Australia UAE Business Council
Working Group on Renewable and Alternative Energies
Emirati Co-Chair

AUSTRALIAN OPPORTUNITIES FOR UAE INVESTORS

Australia's Green Hydrogen Investment Landscape

Australian Hydrogen Opportunities: Looking outward

The global market for hydrogen / green ammonia projects can be split across two time-horizons:

Current demand is in fertilisers, explosives and specific industrial use cases

Future demand will come when pricing for the hydrogen economy is able to compete with fossil fuels, for example, as a replacement for diesel, natural gas, or coal

To date, Australia's policy backdrop has focused on the supply of hydrogen opportunities with political capital expended on promoting the nation's hydrogen export economy, especially to target markets such as Japan and South Korea. At the Federal level, policy has focused on supporting project hubs and technologies while States and Territories have provided grants and permit support for supporting hubs, notably in Queensland and New South Wales.

This push has resulted in considerable opportunity for UAE investors to deploy capital into Australian green hydrogen/ green ammonia projects.

There has not been strong demand side policy and it is unclear when progress might be made. Australia has no carbon price to subsidise a switch to green fuels. Climate change awareness amongst industries including mining and manufacturing has also seen increased shareholder activism leading to many of Australia's largest corporates committing to Paris-aligned net zero targets, though few have published credible pathways to achieve those targets.

Risk/Return Profile

Australia's risk profile of hydrogen investments is high as commercial returns are not expected until the second half of the 2020s. In addition, commercial off-takers require green hydrogen and ammonia prices to drop significantly before any volume off-take agreement will be available – meaning capital finance for commercial projects is unlikely to be available until this occurs.

By the middle of the next decade, it is expected commercial equity and debt opportunities will likely emerge upstream with those parties already involved having privileged access. Interested parties can gain access by joining consortiums to jointly undertake research and development or upstream project origination. Such activities are not necessarily capital intensive and may create future investment opportunities.

Technology investment opportunities in Australia are limited, as many European and Japanese developers are further ahead, across the value chain.

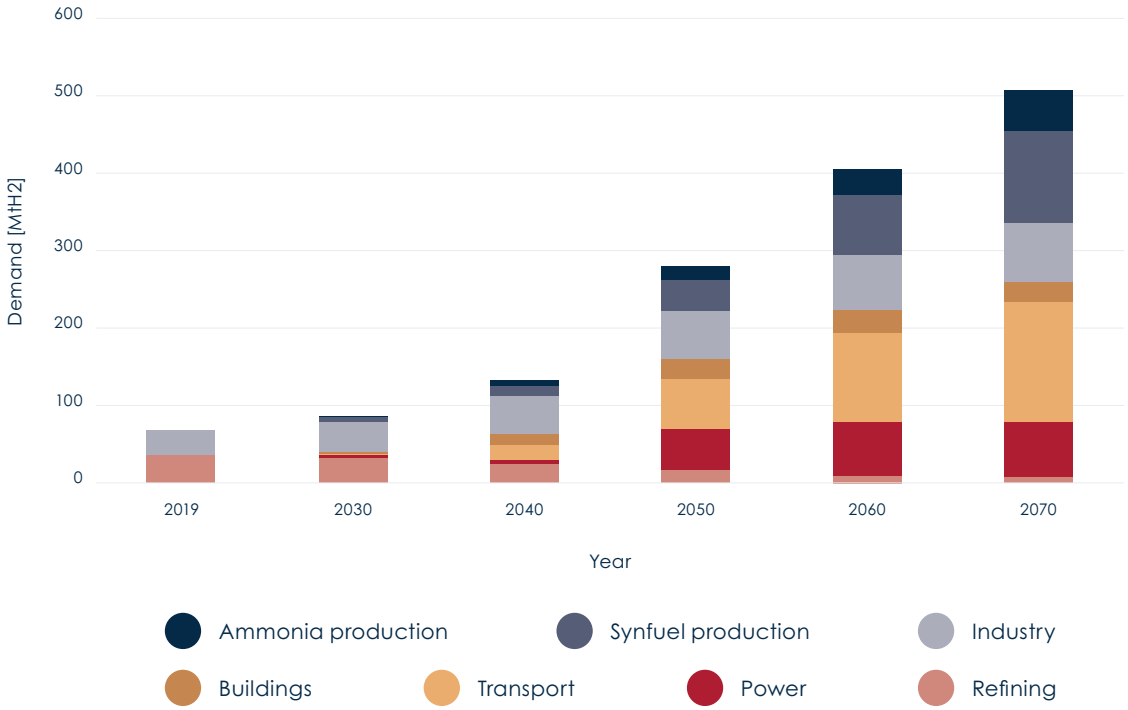
2020–2030 Trends

To replace one LNG facility, approximately 15GW equivalent of solar and wind production is required. The state of Western Australia has land, natural resources and infrastructure which could comfortably support the equivalent of three LNG facilities through the production of green ammonia or hydrogen from solar and wind for export.

Commodities

The International Energy Agency's (IEA) 2020 forecast highlights multiple demand forecasts for hydrogen as an energy transition commodity across various sectors:

Hydrogen Demand Forecast by Sector



Source: IEA Hydrogen

Use cases

Up until 2030, the core use cases for Australian hydrogen will likely emerge from the following three sectors:

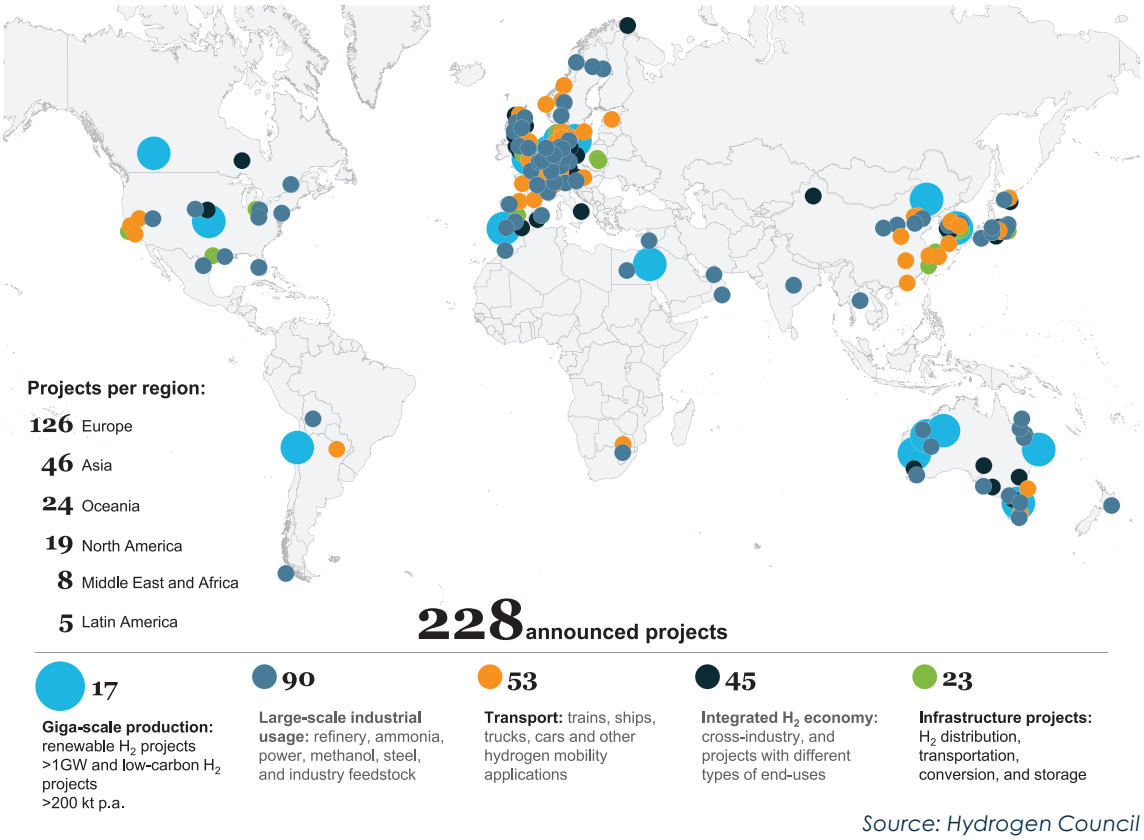
1. Export markets – with a focus initially on ammonia – for a wide range of uses such as energy, shipping and fertilizers
2. Domestic fertilizer and urea – the Nitrogen Cycle support
3. Blending into the Natural Gas network

Projects

Australia currently has over 70 green hydrogen projects in the pipeline totalling over 50 GW, including four of the world's largest:

1. Asian Renewable Energy Hub (14.0GW)
2. Murchison (5.0GW)
3. Pacific Solar Hydrogen (3.6GW)
4. H2-Hub Gladstone (3.0GW)

Figure 1: Existing hydrogen projects and infrastructure



Source: Hydrogen Council

These projects are targeting a variety of commodity markets with a focus on hydrogen mobility, hydrogen in gas networks and industrial process-ammonia production. More information can be found on these projects from the Australian Federal Government's portal [AusH2 - Australia's Hydrogen Opportunities Tool.]

Figure 2: Screenshot of current Australian hydrogen projects

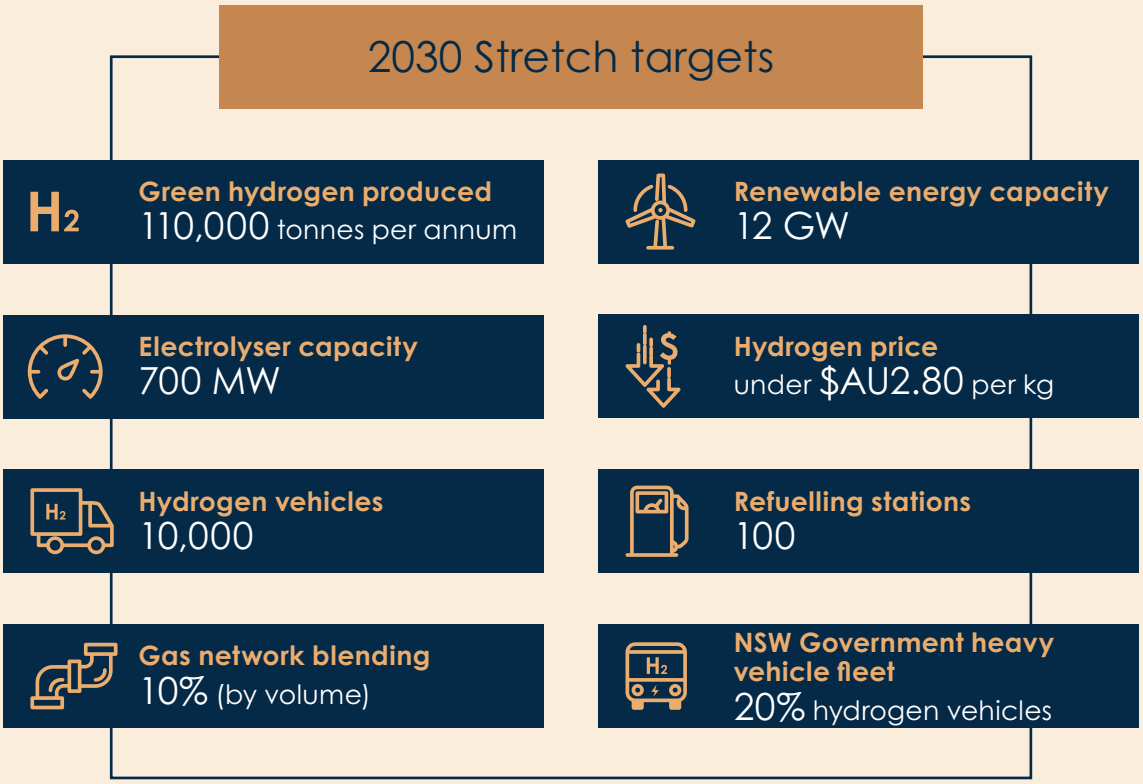
States & Territories	Hydrogen Strategies
Northern Territory	» Released a five point plan in 2020 focused on government and industry collaboration to capitalise on NT's geographical proximity to export markets and enabling infrastructure. » Strategy is focused on (i) Local industry development, (ii) resource management, (iii) improving demand, (iv) supporting innovation and (v) responsive regulation. » Recently released plans for an export-oriented hydrogen production hub fuelled by solar photovoltaic and battery storage in Darwin
Western Australia	» Defined H2 goals across export, hydrogen blending in gas networks, remote applications and transport use cases for both near-term (2022) and medium-term (2030) » Initial Renewable Hydrogen Fund will provide $10m of funding for new feasibility studies, pilot generation projects and hydrogen refuelling stations; $5m will be provided for a 2nd round of funding » WA i) will provide project facilitation services (assisting industry players to navigate government regulation and requirements), ii) is reviewing existing legislation / regulations to reduce barriers for the industry and iii) is identifying training pathways to support a hydrogen ready workforce
South Australia	» SA Govt has co-invested more than 17m in grants and provided 25m in loans to several hydrogen production projects; and was the first state to publish a hydrogen strategy (2017) » SA intends to be a net 100% renewables generator during the 2030s and generate 90% of its power from renewables by 2025 » Defined H2 goals across infrastructure development, regulatory outcomes, trade relationships and supply capabilities, fostering workforce and skills development; and the integration of hydrogen into our energy system » SA is home to the nation's largest electrolyser (Hydrogen Park SA (1.25MW) – already operational
Tasmania	» Already 100% self sufficient in renewable generation, TAS aims to achieve 200% by 2040 » $50m Renewable Hydrogen Development Funding Program » Targeting export of renewable hydrogen by 2025 and implementing the Australian Government funded $17m "Energising Tasmania" initiative to provide training in major energy related skills needs areas » Other support measures being considered for hydrogen businesses include concessional electricity pricing, discounted loans and payroll tax relief

States & Territories	Hydrogen Strategies
Queensland	» Released Hydrogen Strategy in 2019 focused on the five key areas of (i) supporting innovation, (ii) facilitating private sector investment, (iii) ensuring an effective policy framework, (iv) building community awareness and confidence; and (v) facilitating skills and development » In 2019, established $15m Hydrogen Industry Development Fund (HIDF) to drive investment and accelerate project development (now fully committed) » In late 2020, the Queensland Government committed a further $10m to the HDIF
New South Wales	» Released its Hydrogen Strategy in 2021, designed to make NSW one of the most attractive regions for green hydrogen production in the world through a $3bn investment plan » Policies focus on integrating green hydrogen into existing industry, developing infrastructure at major ports and developing a hydrogen refuelling network on major roads. » Specific aims and targets include: ○ Reduce green hydrogen prices to $2.80/kg (currently ~$8.60) within the next decade; ○ Provide incentives to reduce production costs and support industry development (e.g. electrolysers) ○ Deliver on a stretch target of 110,000 tonnes of annual green hydrogen production by 2030; and ○ Drive decarbonisation in the transport, industrial and energy sectors to help NSW reach NZE by 2050
Australian Capital Territory	» Strategy has been formed under the ACT's Government's Sustainable Energy Policy 2020-25, with a particular focus on hydrogen vehicles and injection of hydrogen into the natural gas distribution network » In March 2021, the ACT opened Australia's only publicly available hydrogen refuelling station, enabling the deployment of 20 newly acquired Hyundai Nexo hydrogen vehicles as part of the ACT government's fleet
Victoria	» Released Hydrogen Strategy in 2021 » $6.2m grant support for renewable hydrogen pilots, trials and demonstrations; part of a broader $108m funding package to prepare Victoria for innovative and transformational renewable energy and hydrogen projects » World first liquified hydrogen supply chain demonstration from Victoria to Japan » $10m to support development of the Victorian Hydrogen Hub » $20m over 3 years to trial zero emission bus fleet technologies » Key regions identified to partake in the Hydrogen economy include Grampians, Loddon Mallee, Barwon South West, Greater Melbourne/Port Phillip, Hume and Gippsland

Case study: NSW Hydrogen Strategy: Making NSW a global hydrogen superpower

In October this year, the New South Wales (NSW) Government released its highly anticipated hydrogen strategy which signalled an ambition to develop power emissions industries that sell clean fuels and products to the world. They will deliver this ambition by supporting industry to rapidly achieve scale and increase the competitiveness of hydrogen against existing emissions intensive fuels and technologies. This will trigger a virtuous cycle of investment, technology development and cost reductions that will enable market forces to drive deep decarbonisation and transformation of industries across the NSW economy.

Figure 3: 2030 target for NSW hydrogen strategy



The government has fuelled this strategy through the provision of up to A$3bn in support via a mix of direct funding and incentives directed via the below pillars.

Pillar 1: Enable industry development

Key actions under this pillar include:

State-wide strategic hydrogen infrastructure masterplan

Upfront strategic planning and port infrastructure assessments

Hydrogen-ready regulatory frameworks

Skills development

Hydrogen innovation

Pillar 2: Lay industry foundations

Key actions under this pillar include:

Developing hydrogen hubs through a A$70 million investment

Rolling out a hydrogen refuelling network

Developing precinct decarbonisation roadmaps

Supporting Australia's first green hydrogen and gas power plant through an A$78 million funding provision to create a foundational hydrogen offtake at the new gas/ green hydrogen-powered Tallawarra B power station.

Pillar 3: Drive rapid scale

Key actions under this pillar include:

Network concessions which will significantly reduce the cost of hydrogen by about $1.33 per kg and incentivise investment at scale to further reduce costs

Electricity scheme exemptions which aim to reduce the cost of producing hydrogen by a further $0.80 per kg.

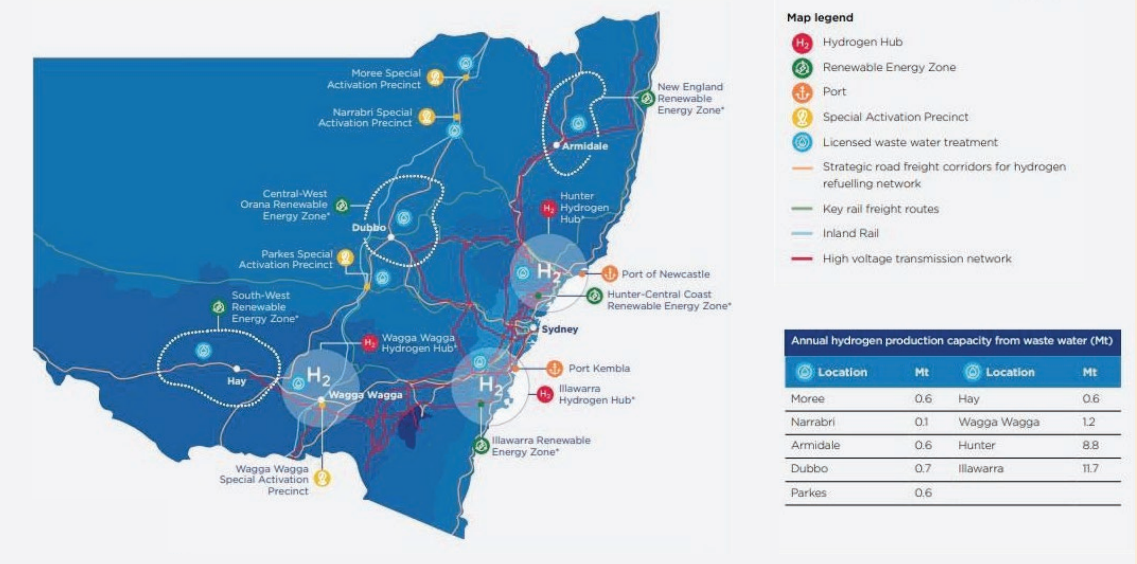
Setting a hydrogen target in the Energy Security Safeguard

Supporting transformative industry projects

Market engagement model

NSW Government hydrogen fleet target and trials

Figure 4: Snapshot of planned and potential NSW hydrogen hubs



Annual hydrogen production capacity from waste water (Mt)

Location	Mt	Location	Mt
Moree	0.6	Hay	0.6
Narrabri	0.1	Wagga Wagga	1.2
Armidale	0.6	Hunter	8.8
Dubbo	0.7	Illawarra	11.7
Parkes	0.6		

Technology

There is a focus in Australia on advancing the technology which underpins the nation's hydrogen offering with the Federal Government providing funding support for hydrogen technology development.[1]

- May 2021: Federal Budget funding to accelerate development of hydrogen hubs and carbon capture and carbon capture, use and storage (CCUS)
- May 2021: ARENA invests $103.3m in three projects developing 10 MW electrolysers
- September 2020: Hydrogen identified as a priority technology for investment in Australia's Technology Investment Roadmap.
- May 2020: To 'support the growth of a clean, innovative, safe and competitive Australian hydrogen industry', CEFC launches a $300m Advancing Hydrogen Fund
- April 2020: To accelerate hydrogen electrolyser technology in Australia, ARENA releases a $70m Renewable Hydrogen Deployment Funding Round
- November 2019: Australia releases its National Hydrogen Strategy to position the country as a major global player in the hydrogen industry by 2030

The Australian Government has also recently passed legislation allowing its green sovereign fund to invest in CCUS technologies and projects.

Many oil and gas companies are pursuing blue hydrogen production from their existing resource assets as well as originating new green hydrogen and ammonia projects to participate in the emerging hydrogen space.

Case study: Queensland's bid to become a world leader in hydrogen production

In October 2021, Fortescue Future Industries (FFI), the hydrogen subsidiary of Australian iron ore producer Fortescue Metals Group, made two back-to-back announcements regarding their investment and confidence in the future of hydrogen production in Queensland, Australia.

The first was the construction in Gladstone of one of the world's largest hydrogen-equipment manufacturing facility with an initial capacity to manufacture up to two gigawatts (GW) of electrolysers annually.

FFI plans to expand both electrolyser manufacturing and other renewable energy components, which is expected to support other regional investment including in hydrogen production.

The following day, FFI and Incitec Pivot announced an agreement to study the feasibility of green ammonia

[1] A comprehensive list can be found here: https://www.allens.com.au/insights-news/insights/2021/07/hydrogen-technologies-timeline-in-australia/#april-2020

production and whether industrial scale manufacturing at Gibson Island, Queensland, is technically and commercially feasible on an existing brownfield site.

The study will specifically investigate building a new water electrolysis facility on the site to produce around 50,000 tonnes of renewable hydrogen per year, which would then be converted into green ammonia for Australian and export markets.

These announcements followed other recent hydrogen industry initiatives in Queensland which include:

» The formation of a consortium, which includes generator Stanwell and Japan's largest hydrogen supplier Iwatani, to export $4.2 billion in renewable hydrogen from Gladstone

» Sumitomo Corporation formalised its partnership with Gladstone Ports Corporation, Gladstone Regional Council, CQ University Australia and Australian Gas Infrastructure Group to develop Australia's first hydrogen ecosystem in Central Queensland

» In Townsville, Sun Metals plans to use hydrogen in their refinery operations and trucking fleet with their ambitions to move zinc refinery operations to 100% renewable energy by 2040

» Hydrogen export facilities are also being investigated at a large number of Queensland's ports including the Port of Gladstone, Port of Townsville and Port of Hay Point.

Aside from the recent FFI announcement, Australia has limited manufacturing capability and is likely to still require a large volume of manufactured hydrogen technology products to service upstream projects, mid-stream distribution businesses and a range of end-use cases. As such, there may be Investment opportunities for UAE investors in providing hydrogen technology product imports into the country. The table below reflects some of the key OEMs by solution type and how it is relevant to four use cases.

		Electrolyzer Manufacturers	Hydrogen Infrastucture and Solutions	Fuel Cell Manufacturers	Industrial Gas / Energy Transition
		nel · ITM POWER McPhy	PLUG POWER Bloomenergy	BALLARD fuelcellenergy ceres POWERCELL	THE LINDE GROUP · Air Liquide AIR PRODUCTS CHART · NewFortress energy
Considerations	Clean Hydrogen Pure-Play	✓	✓	✓	✗
	Hydrogen Equipment Manufacturer	✓	✓	✓	✓
	Hydrogen Production Capabilities	✓	✓	✗	✓
	End to End Solutions & Services	✗	✓	✗	?

Key Stakeholders

There are a range of key stakeholders across the green hydrogen value chain, all which hold bespoke interests and highlights the supportive investment ecosystem available for UAE investors.

Stakeholder	Interest
Project developers	The number of experienced and early-stage developers in this space will consolidate due to lack of financing rendering them unable to secure off-take agreement or progress their projects towards construction.
H2 Customers	There are many customer segments in Australia. The chemical feedstocks and processes sector has been identified as most promising for green hydrogen, with road transport and mining equipment also showing high interest due to cost competitiveness compared diesel and natural gas.
Energy majors	All of Australia's large energy majors are based on a large energy export economy in the form of coal and LNG. These will become hydrogen and ammonia customers at some point, but most likely will be a large supplier of hydrogen.
Oil and Gas Majors	In Australia, this segment is "greening up" current hydrogen used in extraction. This trend is driven by community sentiment. Beyond extraction, oil and gas has a significant interest in providing the new fuel of the future and will be a major player in the sector driven in particular by a need to diversify asset bases.
Renewable Energy Majors	Avid supporters of large green hydrogen projects, they will be a critical part of the supply chain in providing services to install vast amounts of renewables in the coming three decades.
OEMs & Technology providers	A critical part of the value chain due to needing access to products in time for a project to be successful. They already have long order books and this will only increase significantly as the giant green global projects come online but strong cost reduction from competitiveness and demand growth is needed to hit $/kg price benchmarks. To be determined as to how much will be constructed locally in Australia.
EPCs	Outside Oil and Gas EPCs, Australia is more diverse in the number and type of EPCs. The large projects will require a consortium of EPCs to execute the projects. A critical part of the value chain involves an understanding of costs and risks, particularly around a performance guarantee.
State and Federal Governments	Typically provide support via grants, subsidies and mechanisms which support the hydrogen economy. A vested interest in creating manufacturing jobs as the projects proceed.

Development and investment roadblocks

We have mapped the below main roadblocks for UAE hydrogen investment in Australia:

» **No bankable off-takers** ready to take a long-term fixed price contract. This is critical in the development cycle.

» **Project financing** will be significantly more complex compared to an O&G or Solar/ Wind project alone. In addition, projects are too big to support with equity alone and debt providers are still modelling risks. Government subsidies will be critical at the start to get project financing over the line.

» **There is a lack of momentum due to no large projects ready to produce green hydrogen at scale.** There are few approvals for new projects as a result of this uncertainty.

» **The economics of input energy are rapidly changing.** As Europe faces recent energy security issues, it has changed the dynamic of energy consumption and increasing investors' awareness of the risk of energy price increases.

Challenges of building end-to-end value chain deals

In addition, various work needs to be undertaken to strengthen the existing value chain.

» **Hydrogen Technical Gaps:** The technology exists but it is no regard for OPEX and CAPEX to make the final hydrogen or ammonia affordable. Cost reduction trajectories will need to match other technologies like solar PV and batteries.

» **Scale:** How do developers, EPCs and investors make money as the projects scale up? It's a long cycle between investment and return.

» **Pricing:** How to manage non-fixed prices, especially to fossil fuels as the global market is being weaned off it.

» **Costs:** Comparing costs between UAE and Australian projects, UAE investors will potentially find pricing differences between projects in the two countries.

Cost increases:
- Cost of capital in Australia, particularly for debt, will likely be higher
- Labour costs are significantly more in Australia
- Import taxes likely to be higher

Cost Parity
- Engineering costs are likely to be in the same range, pending how much is global verses locally executed

Cost reduction
- Australian projects with some of the lowest LCOEs in the world from a renewable resource perspective and would be on par with UAE renewable energy LCOEs if not slightly better. Particularly night-time wind.

Potential Entry Strategies

There are four critical components for UAE companies to consider when investing in Australian green hydrogen and fuels.

1. Technology: Having the most efficient and adaptable technology as it comes online will be key, especially where 1MWh efficiency per tonne for the electrolyser makes all the difference. UAE investors and developers will need to keep abreast of global technology evolution and upgrades as they relate to green hydrogen projects.

2. Project origination: There are many projects being announced on a regular basis, with many underdeveloped and lacking the critical components key to success such as off-takers and access to a port and water.

3. Pilot projects: All large projects will have to prove themselves with a successful pilot project to proceed and prove an investment consortium can fund and execute. Yet pilot projects are complicated to finance and find a short term off-taker at a higher price ready to receive longer term product.

4. Project hubs: The Australian Federal government recently announced the allocation of $A150M to seven regional hubs which will host potential shared infrastructure opportunities of interest for UAE investors. These regions will potentially have the benefit of common infrastructure and support from the Federal government in various ways[2].
   - Bell Bay, Tasmania
   - Gladstone, Queensland
   - Latrobe Valley, Victoria
   - Hunter Valley, New South Wales
   - Darwin, Northern Territory
   - Eyre Peninsula, South Australia
   - Pilbara, Western Australia

[2] Source: https://www.pv-magazine-australia.com/2021/09/21/hydrogen-hub-shortlist-expanded-as-feds-commit-additional-150-million/

Australia's Renewables and Battery Storage Landscape

Market Overview

Since the introduction of the Renewable Energy Target (RET) in 2001, the Australian energy market has been on a constant trajectory of capacity growth. Despite the COVID epidemic, 2020 and 2021 saw continued deployment of new solar and wind projects, albeit at a much slower rate than the peaks of 2017/18. This is attributable to a strong interest in the Australian investment landscape and continued incentives and programs from Australian state and federal government in both large- and small-scale wind, solar, and batteries.

Renewable generation in 2021 contributed over 30% of the total generated energy in Australia. A significant contributor to the generation resulted from the ever expanding small-scale solar – residential, commercial and industrial – which alone has reached 15.7GW cumulative capacity by 1H 2021[3]. New large-scale generation added a further 2.5GW in 2020/21 with 35 projects reaching commercial operations, of which 28 were solar and seven were wind.

Driving the Transition

The energy sector is undergoing an extreme transformation with the shift to renewable energy, particularly to replace ageing coal plants due to end of technical life. Up to 25GW of coal plants across Australia are expected to retire by 2051, starting with Liddell Power Station in 2023 and Yallourn Power Station in 2028. Whilst this is the most up-to-date plan of retirement as per the generator's announcements, it is likely that many of the coal generators will retire earlier than forecast due to the market performance and challenges facing traditional thermal plants.

[3] Bloomberg New Energy Finance

Policy Framework

Almost all states and territories have net zero emissions (NZE) targets in place with some states having legislated a renewable energy plan to tackle the decommissioning of coal while ensuring system reliability is maintained. The Federal RET of 33 TWh was met in 2019. Federal Government policy is now focused on accelerating low emissions technology. The post 2025 reform agenda is the largest seen in Australia's National Electricity Market (NEM) for decades and the proposed pathways and reform options focus on four key areas:

1. **Resource adequacy:** ensuring the best mix of resources is available to the system to deliver lowest cost and reliable supply to customers.

2. **Essential system services:** maintaining system security by ensuring technical services like frequency control, operating reserves, inertia and system strength are available.

3. **Distributed energy resources and demand response:** delivering benefits through the most efficient integration of rooftop solar, battery storage, smart appliances and other resources.

4. **Transmission and access:** reconfiguration of transmission to facilitate renewable generation and large-scale storage This will provide networks that meet future needs, including early implementation of renewable energy zones, as well as longer term arrangements ensuring efficient use of the national transmission network.

Final recommendations on the pathways are due at the end of 2021. The pathways put forward will present a package of interrelated reforms that best achieve a fit for purpose market design for the NEM for 2025 and beyond.

Investment Trends

Renewable energy investment has increased significantly in the Australian market since 2012, contributing to a continuing shift in the energy generation mix away from traditional thermal power sources. In the longer term, the transition towards clean energy is expected to continue. It is assumed Australia will replace the significant coal-fired generation capacity expected to be retired over coming decades with clean energy; both due to environmental pressure and economic benefits of large scale solar and wind farming, working alongside distributed energy resources.

While Australia has seen a slowdown in new capacity additions since the peak of 2017/18, the market is forecast to continue to deliver an average of 2.4GW of new utility scale solar, wind and battery storage projects per annum from 2024 to 2030. This is on top of the 2.5GW of annual small scale solar and 2.5GWh small scale storage additions per annum over the same period.

The below table highlights the number of key attractive factors for investing in Australia's wind, solar and batteries opportunities:

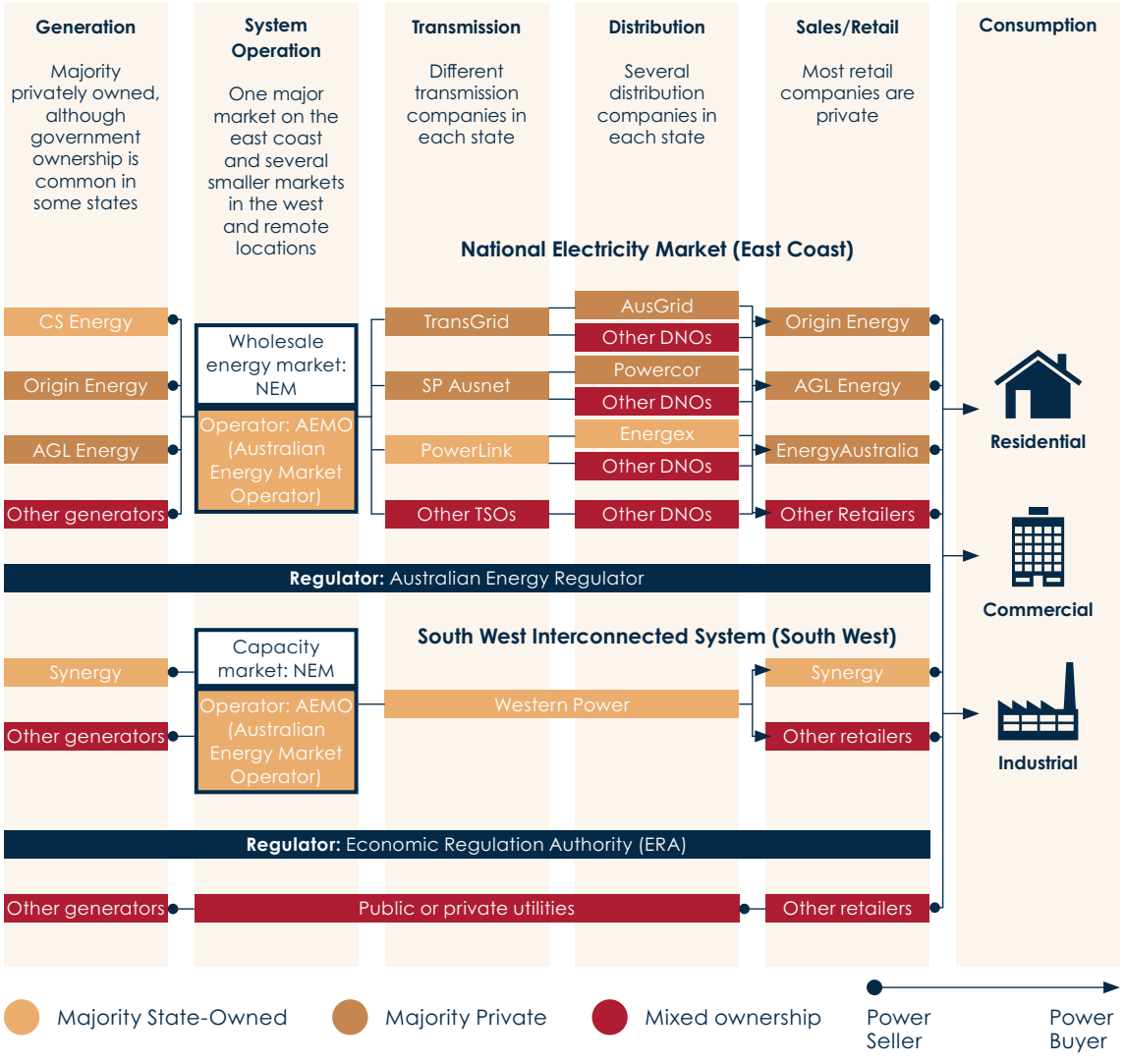
Attraction factor	Detail
Increasing wholesale electricity market	The NEM is an energy only market based on a balance of supply and demand. With the forecast decommissioning of the coal fleet, which has contributed as high as 92% of the electricity market mix in the past, it is expected that the 2030s may see a supply shortage putting upward pressure on electricity prices. Similarly, net zero targets, largely driven by state government policies are likely to increase electricity demand from electrification of sectors such as transport and continue to put upward pressure on prices from 2030 and beyond.
Climate and topography	As well as having vast onshore and offshore wind resources, Australia is unique in that it has more solar potential than any other developed nation. Australia receives an average of 58 million PJ of solar radiation per year, approximately 10 000 times larger than its total energy consumption. Mean / average wind speed of appropriate sites varies between 6.7-9.6m/s, with turbines increasing in size, this has meant projects can offer a capacity of factor of 37-55%.
Reducing Levelised Cost of Energy	Solar, wind, and batteries have already seen significant reductions in cost of generation due to increasing panel/turbine/battery size, increasing asset life, reducing degradation, additional optimisation throughout life, and other external and internal factor. While cost labour is high compared to other OECD countries, land and other development costs are comparatively low.
Variety of Investment Entries	With a growing sector, opportunities to invest in solar, wind, and batteries can be found in at a range of asset maturities, from early stage to mature stage greenfield to established brownfield assets.
Support from Federal & State Governments	A number of bodies such as ARENA, CEFC, and NAIF as well as state bodies offer a range of support for projects development and investment. There is a race between the states to attract investment for clean energy, and this can work in the investors' favour.
Strong Governance / Stability / Finance	Australia is one of the most stable investor markets with a favourable tax, investment, legal rules underpinning a strong investment framework. Tax structures for funds are particularly attractive for asset investors. As a result, finance is readily available from both onshore and offshore financiers with large pools of capital to deploy. Government, retailer and corporate offtakes are available to provide further confidence for financing projects.

Attraction factor	Detail
Favourable Green Returns	Most of the projects in wind and solar depending on the stage and maturity of acquisition offer investors a pre-tax IRR of between 6-10%. Batteries are expected to achieve similar targets in the next 5 years with increased asset life and capex reductions. While competition for high quality clean energy assets remains strong, returns are generally considered higher than other comparable countries due to the fragmented policies surrounding the transition away from traditional generation.
Coal transition	Driven primarily by owners' economic decisions (high cost of capital and low energy price cycle), Australia's existing coal generation fleet is expected to decline rapidly over the coming two decades.
Development trends	Most project developers in solar and wind would likely develop a battery-ready project alongside the variable generation to increase asset utilisation. The Australian market also has many solar opportunities, opposed to a shortage of wind assets which can be explained by longer gestation periods. Out of the seven development milestone – securing land, planning approval, grid connection, construction strategy and contracts, maintenance contracts, financing, asset management and offtake agreement – grid and offtake are the most value-added to the project as offtake can be retailers, corporates and governments.

Key Stakeholders

In addition to state and federal government agencies and departments, stakeholders will vary depending on the position of the investor in the market. Early-stage investors focused on development assets will be more involved with planning rules and connection approvals, as opposed to owners of operating assets more focused on market rules and potential policy changes. The Australian Renewable Energy Agency (ARENA) and Clean Energy Finance Corporation (CEFC) are two of the key stakeholders for all new entrants to the Australian market in terms of understanding key risks and opportunities. A brief overview of the market and key stakeholders is shown below.

Figure 5: Market and key stakeholders for Australian renewable energy sector



Last updated: Oct 2017

Source: Bloomberg New Energy Finance.

Roadblocks and Challenges

The Australian market has seen a significant increase in uptake of utility scale wind and solar projects over the last five years, particularly with an increasing interest in utility scale battery projects. This is despite a challenging policy environment and limited access to long-term revenue contracts. The below list of roadblocks and challenges is not exhaustive, and likely to change over time, but should be seen as the current issues facing those investing in wind, solar and battery assets.

Issue	Risk	Mitigant	Value Impact
Approval for foreign investors	Cost, time and compliance with FIRB requirements	Early engagement on prospective investments	Low
Grid access	Changing national electricity rules making access challenging	Time and cost contingency for approvals	Medium
Energy losses	Market losses in the form of curtailment, transmission losses vest with generators	Diversity of location and technology	High
Access to offtake	Long term offtake arrangements limited; average tenor 10 years	Analysis and understanding of downside risk	High
EPC contractors	Limited number of EPC contractors due to historical underperformance	Clear engagement and tendering	Medium
Labour costs	High labour costs and limited access to skilled personnel	Selection of locations in less remote areas / good access	Medium
Market conditions	Transitionary arrangements still under defined	Careful understanding of potential changes / impact	Medium
Market structure	Market is one of the few global “energy only” markets	Diversity of technology and contract protections	Low

Potential Entry Strategies

Entering the Australian market offers several entry options, each with a varying risk reward. Whilst each entity will have to consider its own capabilities, there are generally two key options for consideration:

1. the entry stage: which stage of the development cycle investment is sought - risk

2. the entry form: what form of investment should be considered - return.

Entry strategy risk levels – asset/project acquisition

Brownfield
Operating and grid connected

Greenfield (Construction)
Equity + Debt plus revenue contract

Greenfield (Approved)
DA Approved, Grid Connection

Development
Land agreements and consents progressing

Figure 6: Risk ratings for assets in various stages of development

Entry Form	Recent Example in Australia	Attributes
Organic	FRV; Neoen; Acciona	High Risk and Rewards; Long lead time; Local expertise/ relationships
Greenfield project acquisition	Nebras: Stockyard Hill Wind Farm	Most common mode of entry in the Australian market
Brownfield project acquisition	OTP & Partners Group: Ararat Wind Farm	Limited volume of projects available
Acquisition project interests	First Sentier: John Laing Portfolio	Limited volume of projects available
Acquisition platform operating business	Shell: 50% Esco Pacific Iberdrola: Acquisition of Infigen	Emerging new area with several organically built selling
Partnership & consortium	DIF / ENEL: Bungala Solar Farm Federation Asset Management / Squadron: Windlab	Each partner may contribute a unique skill to the partnership in addition to capital, e.g., asset management etc.

Australia's Waste to Energy Opportunities

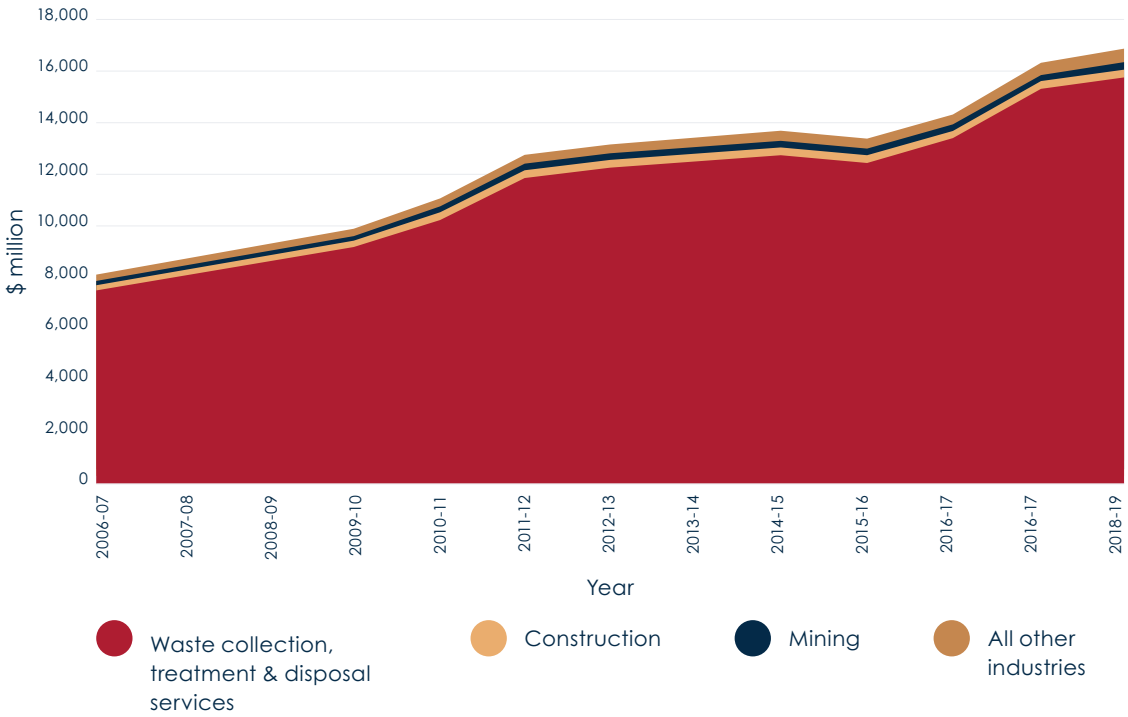
Market setup

The Australian waste market is estimated at A$17 billion (US$12.2 billion) per year in 2019 and is concentrated in the four major urban state capital cities of Sydney (New South Wales), Melbourne (Victoria), Brisbane (Queensland) and Perth (Western Australia).

Municipal Solid Waste (MSW), Commercial & Industrial Waste (C&I) and Construction & Demolition (C&D) Waste to Energy (WtE) in Australia is a nascent market with no domestic/ commercial waste incineration plants currently operating in Australia. Two plants are under construction in Perth, Western Australia and are scheduled for completion in 2022. Several other projects are in early stages of development in Victoria and New South Wales. Australia does have a biomass and biogas industry which utilises existing waste streams such a bagasse from sugar can but most applications are on a small industrial scale.

Historically, Australia has low population density and large areas of land available for disposal of waste into landfill. However, this is changing with over 80% of Australia's 26 million population concentrated in the five major cities and strong population growth. The subsequent pressure on land availability in these growing cities has forced governments to introduce new policies to deter landfill as the cheapest disposal option. In 2018-19 in Australia there were about 61.5 Mt of 'core waste' (those wastes managed by the waste and resource recovery sector) generated, or 2.44 t per capita. This is up from 57.3 Mt in 201617.

Figure 7: Australian Waste Market Growth 2006-2019 (Source ABS) AUD

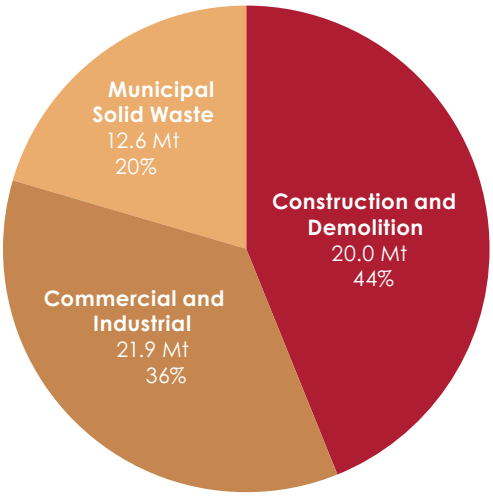


Waste flows in Australia are divided into three broad categories:

1. MSW municipal solid waste (waste from households)
2. Commercial and industrial waste (C&I) waste from industry and government
3. Construction and demolition waste (C&D) wastes from construction/demolition sites.

In 2018-19 Australian waste production was comprised of:

Figure 8: Australian waste production segments



Recycling infrastructure exists in Australia with varying success. At source separation-systems are the main process with MSW and C&I waste producers employing three bin systems: residual waste bin, recyclables bin (which takes plastic, cardboard, glass and metal) and an organic waste bin which currently takes garden organics waste but with Governments offering incentives to include food waste.

Recycling rates have stagnated over the last few years with few local government or commercial entities achieving Government set recycling rate targets. Recycling rates for C&D are higher due to the nature of the waste (bricks, concrete, steel etc). Current recycling rates by waste type in Australia are:

Recycling Rates by Waste type	% recycling achieved 2018–19
Municipal Solid Waste (MSW)	41%
Commercial & Industrial Waste (C&I)	57%
Construction & Demolition waste (C&D)	76%

Current market practice is to dispose of non-recyclable or residual municipal and commercial wastes in landfills.

Waste volumes that are currently going to landfill for final disposal and are potential feedstock for waste to energy plants are as follows:[4]

State	Million tonnes
NSW	3.2
Victoria	2.8
Queensland	2.7
Western Australia	1.4

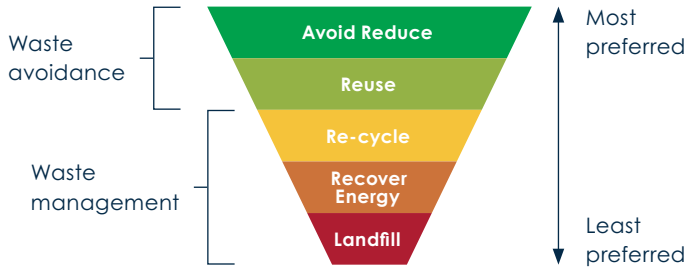
[4] National Waste Report 2020, Blue Environment

Government Policies

State Government

State Government policies are the main legislative levers used to regulate the waste industry in Australia and in particular waste to energy developments. There are similarities between the different state's laws but also significant differences.

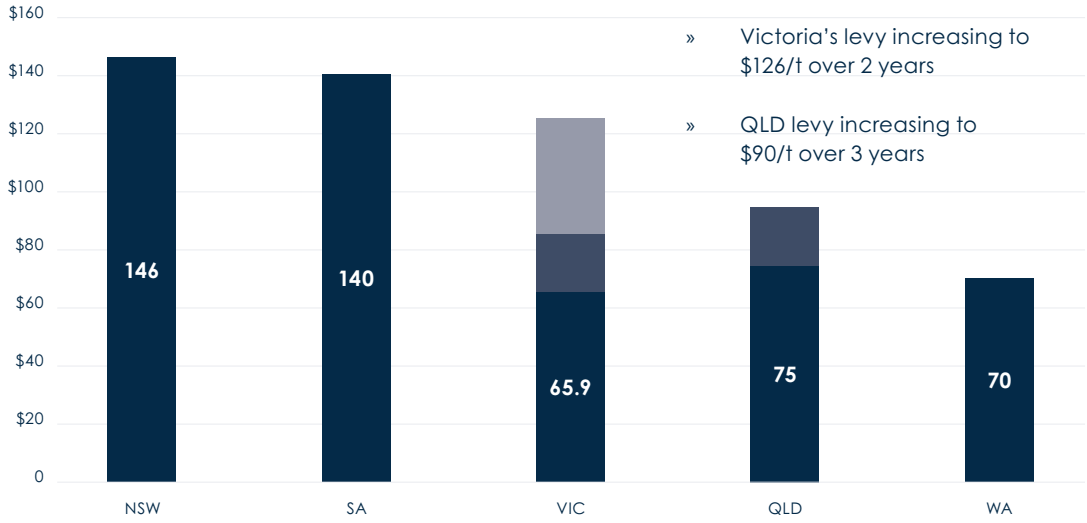
Figure 9: Australian Waste Hierarchy



State Government policies are moving towards implementing circular economy principles and encouraging recycling and diversion from landfill. All states have adopted a form of the waste hierarchy shown below and have realised that landfill diversion targets are virtually impossible to achieve without energy recovery facilities.

The key mechanism used by State Governments and adopted by all major states is the landfill levy. The levy differs by state and in recent years, has been significantly increased as a deterrent to landfill disposal. Current landfill levy rates by major states in Australia are below.

Figure 10: Landfill levies by State



All major states have introduced (or have promulgated and are finalising) Waste to Energy policies that outline various requirements for WtE plants including air emission standards, feedstock supply restrictions, community consultation procedures, plant efficiency requirements.

Federal Government

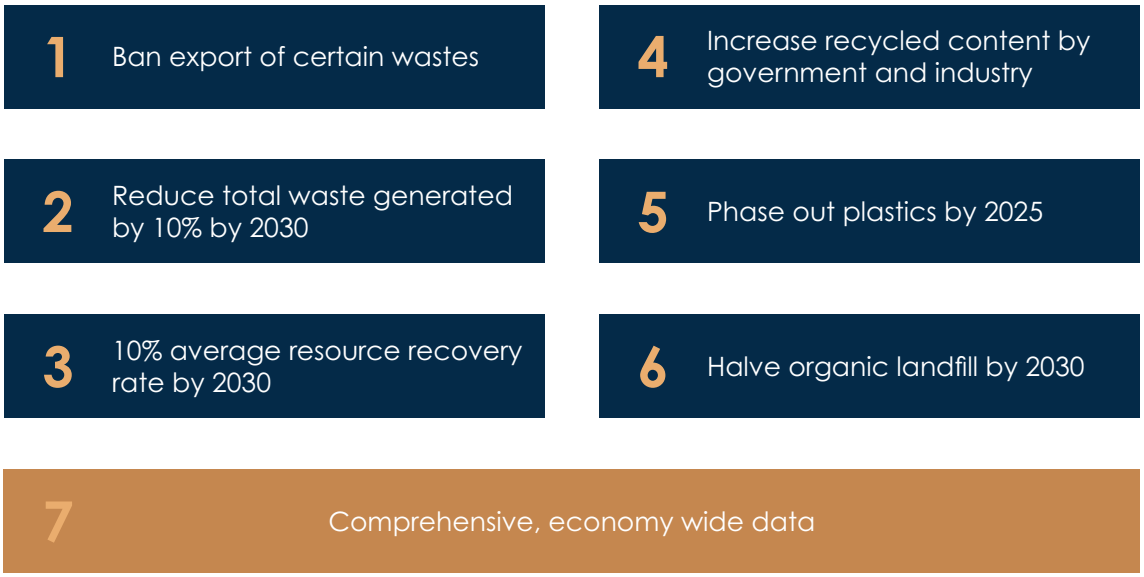
The Federal Government has been increasingly active in waste policy with the release of its 2019 National Waste Policy. Australia's attitudes about waste and resources management have shifted. The value of resources and embodied energy in waste is now recognised. There is an economic opportunity and growing desire to see our resources recaptured and recirculated within our economy.

The 2018 National Waste Policy provides a framework for collective action by businesses, governments, individuals and communities until 2030, and provides a framework for businesses to embrace innovation and develop technologies that create new opportunities.

Differences in policy and regulation of waste management resource recovery across Australia are hindering effective action. Many businesses operate in national markets and must meet different requirements in every state, territory or council area.

The below is a summary of the 2019 National Waste Policy key action points:

Figure 11: 2019 National Waste Policy Action Points



Risk and return profile

The first two waste to energy projects currently under construction have been privately developed with financial support provided from ARENA and CEFC. Plants are being developed using non-recourse project finance which requires wrapped lumpsum turnkey construction solutions, as well as maximised contracted revenue on waste supply and energy offtake. This adds complexity and cost to project development, creating additional barriers to entry to the sector in Australia.

State Governments have generally left the development of waste to energy plants to the private sector in Australia with support in the form of grant assistance from the Australian Renewable Energy Agency (ARENA) and some debt financing through the Clean Energy Finance Corporation (CEFC). As a result, developers of waste to energy projects assume a variety of risks including waste supply contracts, power offtake agreements, regulatory approvals, EPC, operation of the plant and financing.

2020-2030 Trends

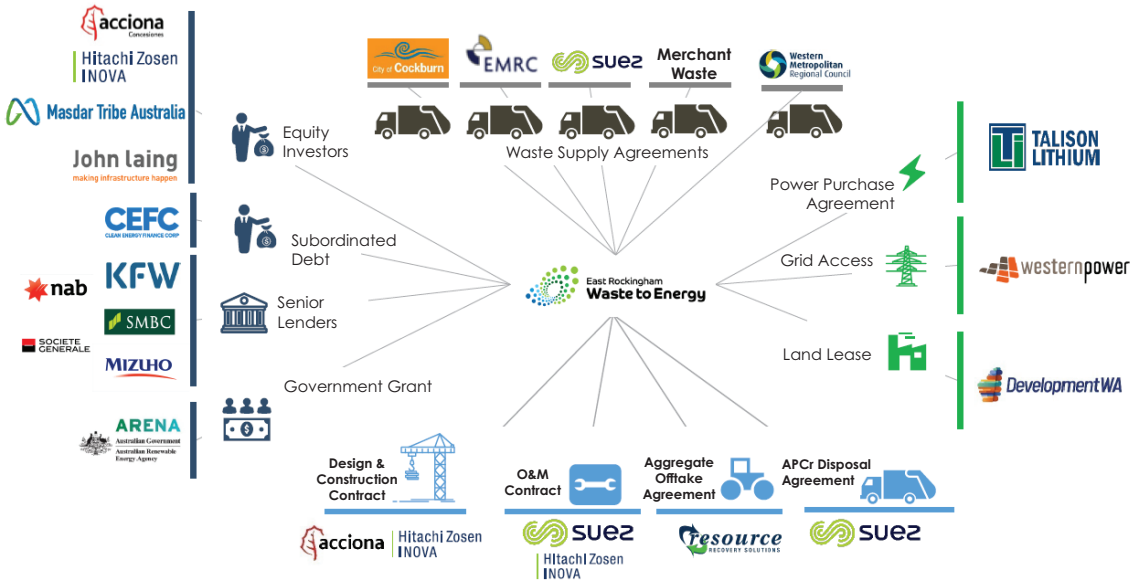
With the increasing landfill levies and State governments adopting regulations and policies to encourage the introduction of waste to energy there is an increasing trend in the development of WtE plants in the major cities. There are currently four to five projects under development in Melbourne, five to six in Sydney and one in Brisbane. Not all of these projects will succeed however there are opportunities in the current market size for 10 to 15 facilities on the east coast states of New South Wales, Victoria and Queensland representing an investment in the order of A$6-9 billion (US$4.3-6.4 billion).

Key stakeholders

Stakeholders include State Governments, Local Government, commercial waste operators, adjacent communities, construction and operation companies, electricity market operators, electricity off takers.

As an example, the Masdar-Tribe East Rockingham project in Perth included the following stakeholders in the development of the project that is now under construction and scheduled to commence commissioning in Q4, 2022.

Figure 12: East Rockingham WTE project structure



Development and investment roadblocks

Waste to Energy projects in Australia are seen in some sense as a new technology and there is a general lack of understanding among communities and Governments as to the benefits and risks associated with such projects. This is rapidly changing with the announcements in the last two to three years of numerous projects, forcing Australian regulators and the general public to move rapidly up the waste to energy "learning curve".

As a result, WtE projects in Australia have experienced long development phases and incur numerous challenges before reaching FID status.
The more significant challenges include:

- Sourcing of waste feedstock from a variety of local Government and commercial sources
- Navigating differing State Government approval pathways
- Achieving community and Government support, or a "social licence" for the projects
- Availability in Australia of experienced EPC contractors who can provide construction and commissioning services
- Availability of experienced operation and maintenance companies

Potential entry strategies

Entry strategies exist for WtE projects depending on the risk appetite of the entrant and the desired stage of entry into the project. With long development timelines (in the range of 3-8 years) there are opportunities for equity and debt providers to align themselves with existing projects. Current projects have shown typical capital costs in the order of $5-700M AUD and significant equity and debt financing is required.

Entry into early-stage development of WtE projects is possible but requires a higher appetite for risk with delayed timelines common and sharing of early development costs which can be significant.

Significant opportunities exist for EPC construction companies and waste to energy technology providers who wish to expand into Australia. With the potential for [10-15] plants to be built in the next 10-20 years in the Australian market represents an EPC pipeline of $6-9 Billion AUD.

UAE OPPORTUNITIES FOR AUSTRALIAN INVESTORS

UAE Green Hydrogen Investment Landscape

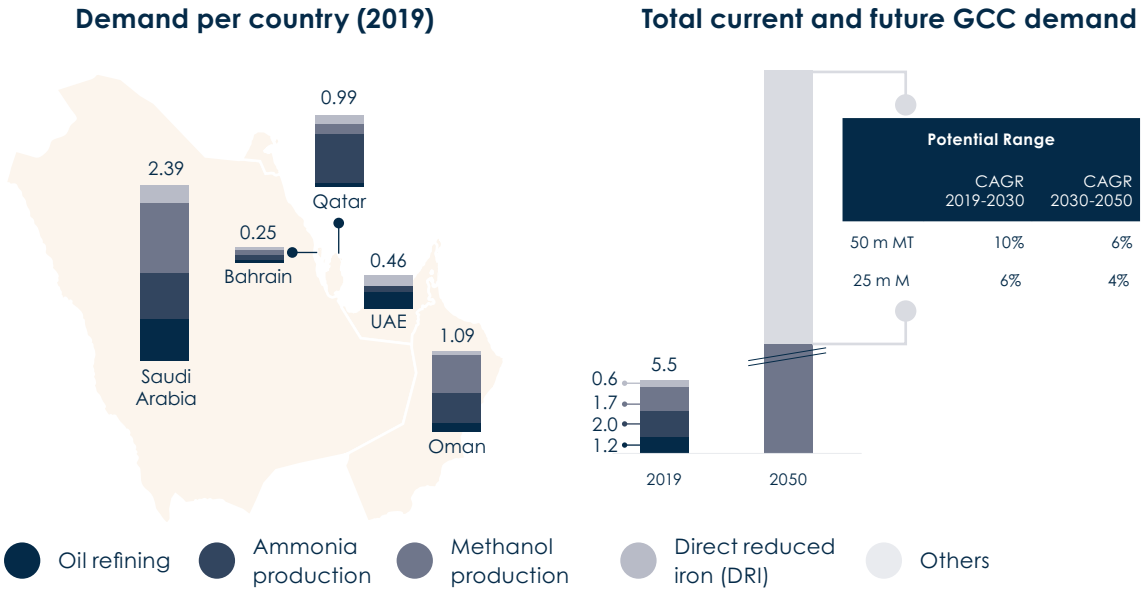
UAE hydrogen opportunities

The GCC countries' annual hydrogen demand in 2019 was estimated at around 5.5 million Mt and in the UAE, demand amounted to 0.46 million Mt, driven by oil refining, ammonia production, and direct reduced iron in steelmaking industry.

In an optimistic scenario, the regional demand could reach 50 million Mt by 2050, supported by local industries, aviation and energy activities. According to the International Energy Agency, the GCC demand represents approximately 6-7% of the global demand of hydrogen (75-85 Mt annually in 2018[5]).

As with the current hydrocarbon market, the GCC is expected to play an important role in the future hydrogen export market. The GCC region can capture this new market thanks to the ability to produce inexpensive low carbon hydrogen and capitalizing on its well-established export infrastructure for oil and gas products and its strategic location between the European Union (EU) and East Asia. This could enable the GCC to become a key enabler in the global decarbonization agenda. According to a recent report from Dii and Roland Berger, hydrogen imports into the EU from the GCC could reach 100 million Mt of hydrogen annually in 2050. Meanwhile, East Asia (mainly Japan) is projected to import 85 million Mt of ammonia annually by 2050.[6]

Figure 13: GCC current and future hydrogen demand by application [Dii & Roland Berger 2021][7]



[5] IEA, "The Future of Hydrogen", June (2019)

[6] Vision Port of Rotterdam, Germany's National Hydrogen Strategy, EU Hydrogen Strategy, METI, Hydrogen Korea Team, Dii Desert Energy / Roland Berger

[7] Dii Desert Energy & Roland Berger, https://mcusercontent.com/3cb7aa0bdf946096e07e98867/files/39f8d2b3-367d-3f5e-2c03-fd1598a9a919/The_potential_for_green_hydrogen_in_the_GCC_region.pdf

UAE policy for green hydrogen and fuels

The UAE has highlighted its commitment to pursuing renewable and alternative energy by ratifying a series of commitments.

The UAE is signatory of the Paris agreement, which came into force on 4 November 2016, and submitted in December 2020 its second Nationally Determined Contributions (NDC) with the following major commitments:

1. reduction of Greenhouse Gas (GHG) emissions by 23.5% for the year 2030 compared to business as usual (emission reduction of 73 million tons)
2. increase installed clean power capacity by 14 GW in 2030 from currently 2.4 GW in 2020,
3. plant 30 million mangrove seedlings by 2030, and
4. strengthen climate resilience of priority sectors.[8]

In 2017, the UAE launched the "UAE National Energy Plan 2050", which is considered the first unified energy strategy in the country that is based on supply and demand. The energy strategy has three major objectives:

1. Increase the contribution of clean energy in the total energy mix to 50% measured on a capacity basis by 2050
2. Reduce the carbon footprint of power generation by 70% by 2050 compared to the level in 2013
3. Increase consumption efficiency of individuals and corporates by 40% by 2050 versus business-as-usual.

The strategy targets an energy mix that combines renewable and nuclear to meet the UAE's economy requirements and environmental goals. The capacity breakdown, targeted by 2050, is given as 6% from nuclear; 12% from clean coal; 38% from natural gas and 44% from clean energy[9].

In 2021, the UAE launched the "Operation 300bn", which is the largest and most comprehensive plan for developing the UAE's industrial sector and enhancing its role in stimulating the national economy. The strategy was named Operation 300bn because of its ultimate goal of raising the industrial sector's contribution to the GDP from AED 133 billion to AED 300 billion by 2031. The strategy is aligned with national goals and international commitments relating to advancing sustainable economic growth, deploying clean energy solutions, driving industrial innovation and promoting responsible consumption and production[10].

To continue the UAE's decarbonisation strategy, the development of hydrogen production is key for energy and industry sectors, internationally and domestically. The UAE does not yet have a dedicated hydrogen strategy because the hydrogen development is merely one solution out of the basket of measures to help achieve the Paris agreement and the goals of the UAE National Energy Plan 2050.

In its NDC the UAE identifies hydrogen as "a fuel of the future". The country has a fast-growing economy, a strong

[8] UNFCCC, https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/United%20Arab%20Emirates%20Second/UAE%20Second%20NDC%20-%20UNFCCC%20Submission%20-%20English%20-%20FINAL.pdf

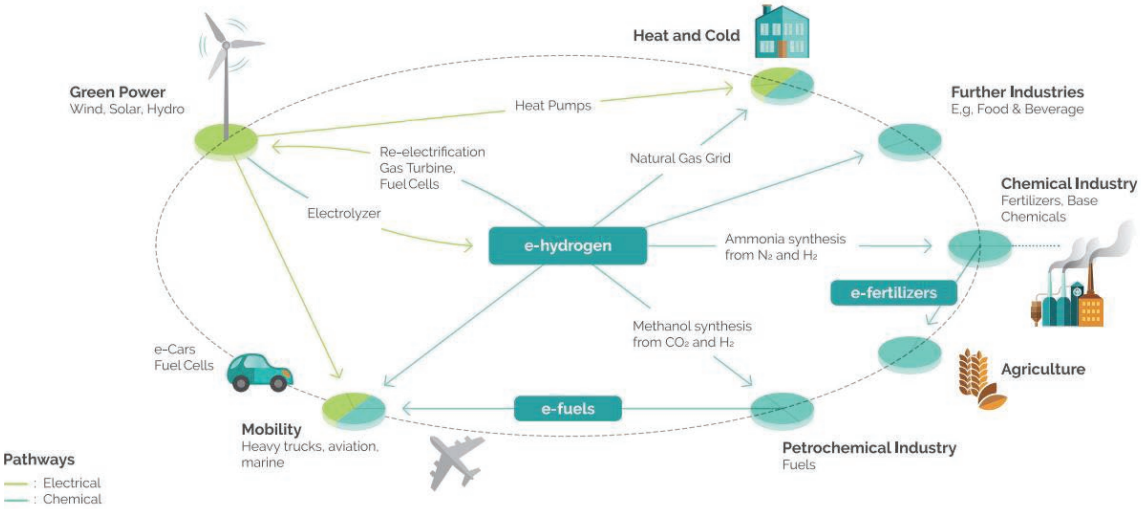
[9] The United Arab Emirates' Government portal, https://u.ae/en/about-the-uae/strategies-initiatives-and-awards/federal-governments-strategies-and-plans/uae-energy-strategy-2050

[10] The United Arab Emirates' Government portal, https://u.ae/en/about-the-uae/strategies-initiatives-and-awards/federal-governments-strategies-and-plans/the-uae-industrial-strategy

experience and expertise in the oil and gas as well as renewable energy industries, which places the UAE within the top countries to develop hydrogen at large scale. There are several initiatives created by local companies to respond to the possible increase in hydrogen demand in the near future with the country also looking to diversify its energy mix through the addition of solar energy

To fight climate change and commit to the UAE decarbonisation strategies, the aim is to produce hydrogen from renewable sources - "green" - or from natural gas with carbon capture and potential utilisation - "blue". As clean fuels, green and blue hydrogen could be used in a broad range of applications; mainly industrial, commercial, and transportation [Figure 14].

Figure 14: The role of hydrogen in sector coupling [Siemens 2019]



Market segment

The transportation sector is typically considered one of the hardest sectors to decarbonise due to its heavy dependence on fossil fuels. The UAE is a global aviation hub and one of the world's largest producers of aviation fuel. This is not surprising as it homes Emirates, the forth largest airline in terms of Revenue-Passenger-Kilometres (RPK) and the world's third busiest airport - Dubai Airport[11]. The country is an active member of the International Civil Aviation Organization (ICAO), and is signatory to the organisation's Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) which explores reduction and offsetting measures through operational efficiencies, offsets and most importantly sustainable aviation fuels. Hydrogen and derived fuels such as Sustainable Aviation Fuel (SAF) are low carbon fuels and could be a key component for the aviation's energy transition. The Abu Dhabi-based carrier Etihad Airways has made a commitment to a 20% reduction in emissions intensity by 2025, a 50% reduction in net emissions by 2035, and net zero carbon emissions by 2050[12].

[11] Flight Global 2019, https://www.flightglobal.com/download?ac=65723

[12] Etihad,https://www.etihad.com/en-ae/news/etihad-targets-zero-net-carbon-emissions-by-2050-in-expanded-commitment-to-environmental-sustainability

2020-2030 Trends

The GCC and more specifically the UAE have some competitive advantages to achieve their ambition and play an important role in the development of local and global clean hydrogen and SAF markets. Their main advantages are:

- abundance of renewable energy resources and low-cost renewable power production (e.g., in 2020 Emirates Water and Electricity Company awarded the 2 GW Al Dhafra PV plant to one of the lowest bids of 1.35 c$/kWh[13])
- abundance of space,
- existing infrastructure for the in-country use and export,
- qualified workforce in the oil and gas and renewable energy sectors, and
- availability of attractive project financing.

The position of the UAE in the hydrogen market compared to the other GCC countries will depend on the quantity and the price of the hydrogen and the sustainable fuels that they can supply.

Key stakeholders

There is an opportunity for the UAE over the next years to develop blue and green hydrogen, and sustainable fuels for domestic use and export. Some relevant local companies already initiated ambitious projects to demonstrate their commitment to blue and green hydrogen and sustainable aviation fuel production.

In February 2018, DEWA (Dubai Electricity & Water Authority), Siemens Energy and Expo 2020 at Dubai launched a solar-based hydrogen electrolysis facility at the Mohammed bin Rashid Al Maktoum (MBR) Solar Park in Dubai[14]. With this first success, DEWA has confirmed their intention to develop a hydrogen roadmap in Dubai.

In the Emirate of Abu Dhabi, Abu Dhabi Future Energy Company - Masdar has partnered with Siemens Energy, TotalEnergies and Marubeni to demonstrate the production of sustainable aviation fuel in Abu Dhabi using green hydrogen powered by solar energy and recycled carbon dioxide as main feedstock. Decarbonized fuels for the maritime sector will also be explored as part of the project. The project is undertaken in collaboration with the Abu Dhabi Department of Energy, Etihad Airways, Lufthansa and Abu Dhabi based Khalifa University and aims to build a pilot plant in Masdar City, which will produce up to 5,000 litres of sustainable aviation fuel per day. The technology to convert the green hydrogen to sustainable aviation fuel forms the core innovation of the pilot plant which will be operated over a couple of years, after which the plant will be up-scaled to a utility size commercial production facility[15].

ADNOC (Abu Dhabi National Oil Company), ADQ Holding and Mubadala have launched the Abu Dhabi Hydrogen Alliance[16]. The Abu Dhabi Hydrogen Alliance aims to establish Abu Dhabi's position as a reliable exporter of blue and green hydrogen to international markets, in addition to joining efforts to build a solid hydrogen economy in UAE. The alliance will also develop a roadmap to accelerate the use of hydrogen

in major state sectors. In addition, Mubadala signed a Memorandum of Understanding with Siemens Energy and other players to accelerate green hydrogen capabilities in the UAE[17]. Besides, TAQA (Abu Dhabi National Energy Company), majority owned by ADQ, has recently announced partnerships with Emirates Steel in Abu Dhabi to develop a large-scale green hydrogen project enabling the first green steel produced in the MENA region[18] and with Abu Dhabi Ports to develop an industrial scale green hydrogen to ammonia export project in Abu Dhabi[19].

Development and Investment roadblocks

International efforts to address climate change and hydrogen support schemes recently introduced by various governments constitute the most important drivers for the development of clean hydrogen and sustainable fuel industries. However, significant challenges still need to be addressed.

In the UAE, the main roadblocks are:

1. Absence of a clear domestic market in the near future
2. Market entry difficulties, due to current high cost of hydrogen and derived fuels
3. Significant size of required infrastructure projects and consequently need of major financial commitments and bank financing
4. Domestic policies, regulations and standards for clean hydrogen are still being developed

Potential entry strategies

A co-operation between Australia and the UAE in the hydrogen and sustainable fuel value chain will be of benefit to both countries which should work together to establish key enablers, such as policies, support schemes, regulations, joint studies, technological exchange.

In the short-term, the co-operation needs to:

» Set up R&D partnerships to accelerate the development of the hydrogen ecosystem

» Visit of existing production sites in Australia and in the UAE to allow an exchange of experiences and know-how

» Establish a joint hydrogen hub to develop studies and workshops

» Implement first commercial projects for in-country use

In the medium and long-term, the co-operation needs to:

» Implement joint projects on hydrogen and sustainable fuels in Australia and in the UAE

» Implement commercial projects for the export market of hydrogen and its derivatives

» Collaborate on hydrogen trade and transport to establish a hydrogen export market.

UAE Renewables and Battery Storage

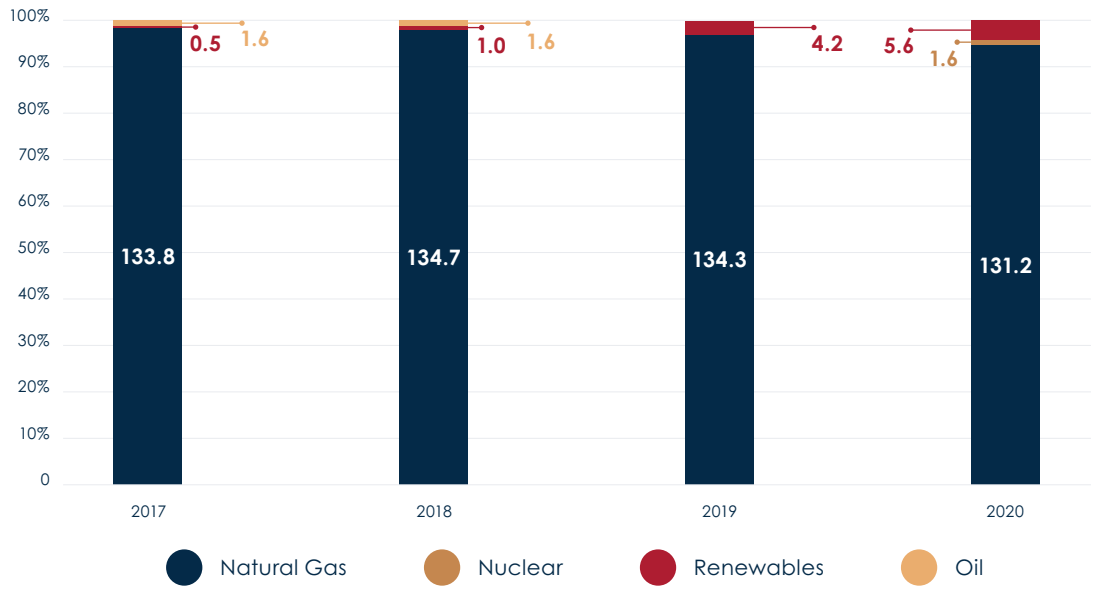
Market Overview

The electricity market in the UAE is centrally planned and operated, with four State-owned electricity and water authorities having ownership of the generation, transmission, and distribution components of the electricity supply chain. These State-owned businesses are [design with map]:

- Abu Dhabi Department of Energy (Abu Dhabi)
- Dubai Electricity and Water Authority (Dubai)
- Sharjah Electricity and Water Authority (Sharjah)
- Federal Electricity and Water Authority (Ajman, Umm al Quwain, Fujairah, and Ras al Khaimah)

As of 2020, the UAE's electricity demand was approximately 138TWh, or roughly 50% of Australia's. Electricity in the UAE is predominantly generated by natural gas-fired power stations. However, under the 'Energy Strategy 2050' launched in 2017, the UAE has started to diversify its electricity supply to a range of sources including nuclear and renewables.

Figure 1: Electricity Generation by Fuel Type



Source: BP Statistical Review of World Energy (2019, 2020, 2021)

[13] Emirates News Agency, https://wam.ae/en/details/1395302897117

[14] Emirates News Agency, https://wam.ae/en/details/1395302935980

[15] Emirates News Agency, https://wam.ae/en/details/1395302902336

[16] Emirates News Agency, https://wam.ae/en/details/1395302902000

[17] Emirates News Agency, https://wam.ae/en/details/1395302902061

[18] Emirates News Agency, https://wam.ae/en/details/1395302957591

[19] Emirates News Agency, https://wam.ae/en/details/1395302950849

Under the current framework, new generation and transmission assets are developed under competitive processes with international and local developers competing to build, own and operate (and depending on the situation, transfer) these assets over the contract or concession period.

In addition to investing in lower carbon-emitting generation technologies, the UAE is working to improve energy efficiency and implement demand side management policies. According to the UAE Ministry of Energy & Industry, from 2012 to 2017, energy demand grew at a compounded annual growth rate of 4.0%. At this growth rate, the UAE's total demand by 2050 would be in excess of 100GW.

Another aspect of the UAE's current energy consumption is the historic investment in power generation alongside desalination plants. Responsible for supplying 80% of the UAE's non-agricultural water requirements, there are 25 energy-intensive desalination plants across the UAE with the first of these commissioned in the 1970s.

A separate strategy, the UAE Water Security Strategy 2036, seeks to decouple power generation from water generation through pursuing alternative potable water generation technologies to improve energy and water efficiency and assist in meeting other energy and water security targets.

2020-2030 Trends

Over the next decade, the UAE's electricity sector will be transformed as greater diversity is brought into the generation mix, and demand side management policies start to be implemented.

In addition to federal policies and targets, Abu Dhabi and Dubai have also implemented their own targets for decarbonisation and energy efficiency. These initiatives focus on both building out the investment in clean energy sources, as well as reducing electricity consumption per capita. For instance, Dubai is committing AED 100bn to invest in renewable projects, and R&D for the clean energy sector. Through the Shams Initiative, Dubai is also promoting investment in rooftop solar at the residential, commercial, and industrial levels to reduce grid demand. In addition to similar programs as Dubai, Abu Dhabi also runs an education program, Tarsheed, aimed at bringing awareness of high per capita electricity consumption, and ways to reduce this.

Managing the demand side will be an important piece of the puzzle as the UAE's population continues to grow over the next ten years, and load is increased through expansion of industry and the greater penetration of electric vehicles.

Yet regardless of demand side management, forecasted peak demand in the UAE is set to reach 26.3GW in 2030 -- a nearly 50% increase from 2020 levels of 18.3GW. This substantial increase in peak demand is driven by development of onshore hydrocarbon projects, expansion of the industrial sector, and new residential and commercial developments.

Key Stakeholders

There are several key stakeholders who undertake a variety of roles within the UAE's electricity sector. These roles may be grouped as follows: Regulator, Asset owner/ operator, and Developer.

Emirates	Regulator	Asset owner / operator	Developer
Abu Dhabi	State-owned Abu Dhabi Department of Energy	High Risk and Rewards; Long lead time; Local expertise/ relationships	In Abu Dhabi, foreign companies may own up to 40% of an electricity project company. The remaining 60% is apportioned between the Department of Energy (c. 6%) and TAQA (c. 54%).
Dubai	Dubai Supreme Council of Energy	Most common mode of entry in the Australian market	DEWA may own project companies outright, or in collaboration with other parties. Where DEWA's ownership in a project company is in conjunction with other investors, DEWA may not own any less than 51% of the shares in the project company.
Sharjah	Sharjah Electricity and Water Authority encompasses all roles within the Sharjah electricity supply sector, including the setting of electricity tariffs and connection fees, subject to approval by the Ruler of Sharjah		
Ajman, Ras al Khaimah, Fujairah, and Umm al Quwain	Etihad Water and Electricity (formerly the Federal Electricity and Water Authority).		

Other key stakeholders in the sector include major international and regional power development and EPC companies such as Acciona, EDF, Engie, JinkoPower, ACWA Power, and Masdar.

Foreign Investment in the UAE Electricity Sector

With the electricity generation sector structured as it currently is in the UAE, foreign companies are able to take a substantially de-risked position investing in a project alongside a State-owned corporation, and with revenue contracted over a long-term (typically up to 25 years) with a State-owned corporation.

Some aspects which may act as deterrents to attracting foreign investment include the minority project company ownership required of foreign companies, and the potential lack of appropriate security attached to the PPA through a parent company guarantee. However, one of the largest deterrents may be in the project returns with tariffs for new solar projects in the UAE consistently breaking records as the world's lowest tariff.

For foreign businesses looking to invest in the UAE, they will find that it is a relatively easy place to do business, with a highly international workforce bringing a range of experiences and perspectives to project development and operations.

For new entrants to the UAE, finding an investment or development partner will be important in order to ensure that processes are followed correctly, and all facets of a project's development have been considered in the context of the UAE. Absent finding a development or investment partner, securing key staff in the UAE with relevant experience and expertise in the region and sector will ensure the greatest chance of success.

INVESTABILITY POSITIONING

In Australia there is an estimated 27GW of fossil fuelled capacity that will require economic replacement by 2030.

In the UAE approximately ~24GW of utility power generation could be replaced by alternative clean energy sources.

The pipeline of proposed replacement green projects according to AEMO total ~93GW in Renewables and 23GW in Battery. Only 5.8GW is committed currently.

Below are the highlights from AEMO and pipeline summary.

There are many investment groups, developers and projects that are not cited in AEMO or not fully included in AEMO.

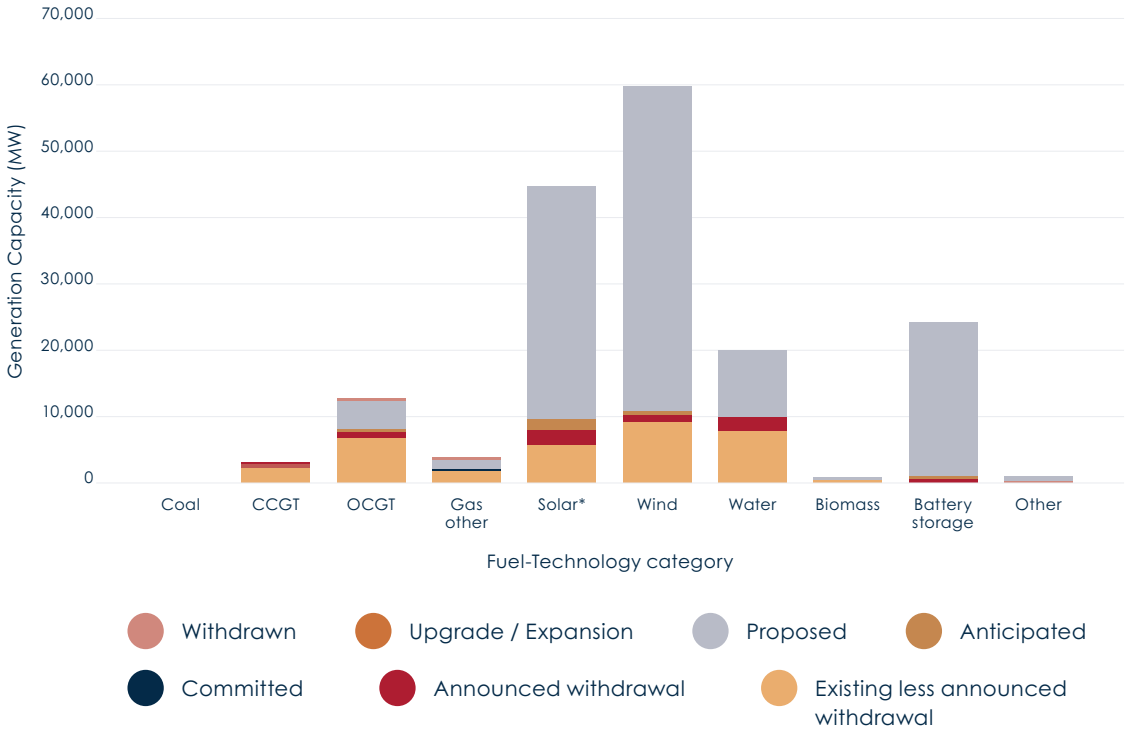
Observations:
Within the AEMO database, there are – in the NEM:

- Over 5,800MW of committed renewable generation projects (solar, wind, hydro), nearly 500MWhr of battery storage currently
- About 94,000MW of proposed renewable energy projects (solar, wind, hydro, biomass), and around 23,000MWhr of battery storage
- Of the proposed renewable projects, offshore wind represents around 23,000MW
- Of the proposed hydro projects, some 8000MW is pumped hydro for energy storage

Some funds and operators in this pipeline that were a part of this Working Group that prepared this paper and have active projects that are not included in the AEMO data are summarised below.

Name	Description	Technologies flagged	Number of projects	Size in total of projects	IRR Range 5 year	Fund or Developer	Stage range of projects
Federation	Multi fund asset manager	Green Hydrogen, Blue Hydrogen, Battery, Utility Solar, BTM Solar, Wind	9 (Australia)	25t per day, 9,085MW	10-20%	Fund	Pre-IPO, Pre-Construction, Construction Development, Operating
Masdar Tribe	Infrastructure development company	Waste to energy	3 (Australia)	1,350 ktpa	18-25%	Developer	Pre-Construction, Construction, Development
QIC							

Summary Chart: MEM Scheduled, Semi-sechuled & Non-scheduled Generation (MW) - Existing and New Cevelopemtns by Fuel-Technology Category



Summary Table: MEM Scheduled, Semi-sechuled & Non-scheduled Generation (MW) - Existing and New Cevelopemtns by Fuel-Technology Category

	Fuel - Technology Category										
Summary Status	**Coal**	**CCGT**	**OCGT**	**Gas Other**	**Solar**	**Wind**	**Water**	**Biomass**	**Battery Storage**	**Other**	**Total**
Existing	0	2,985	7,013	2,050	5,789	9,342	7,992	617	261	202	36,251
Announced Withdrawal	0	388	0	120	0	0	0	0	0	0	508
Existing less Announced Withdrawal	0	2,597	7,013	1,930	5,789	9,342	7,992	617	261	202	35,743
Upgrade / Expansion	0	0	15	0	0	0	0	0	0	0	15
Committed	0	0	904	0	2,362	1,157	2,290	0	489	24	7,226
Anticipated	0	0	316	0	1,656	368	0	0	268	0	2608
Proposed	0	207	4,433	1,607	35,039	49,056	9,870	41	23,418	887	124,558
Withdrawn	0	0	34	120	0	0	0	0	0	0	154

HOW TO GET INVOLVED

Strengthening global alternative and renewable energy pathways will require collaboration and support across vertical and horizontal pillars of global civil society – from government support ranging from tax incentives and subsidies and supportive policies, through to business investment and development underpinning the evolution of new energy systems, and finally, to the contribution from academia which is creating the technology and research underpinning this unprecedented energy transition.

The Australia UAE Business Council is proud to offer this report as another signal from our respective countries for a commitment to achieving this long-term and vital sustainable energy transition.

Over the coming months, we will continue engaging with all our stakeholders to continue mapping the renewable and alternative energy opportunities and in doing so, deepen bilateral trade and investment opportunities for Australian and Emirati businesses to ultimately strengthen the ties between our two great nations.

We invite you to contact us to find out how you can contribute.

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- Sally Torgoman – KPMG
- Stephen Panizza – Federation Asset Management

Green H2 and fuels:

- Rowan Logie – New Energy Technology
- Ajayan Vinu – University of Newcastle
- Bob Baldwin – Varley Group

Waste to Energy:

- Andrew Smith – Tribe Infrastructure Group

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Investability Positioning

- Ellecia Saffron – Maysaffron
- Stephen Panizza - Federation Asset Management

Working Group Secretariat:

- Sara Bradford – QIC
- Fatimah Husin – Masdar

AUSTRALIA UNITED ARAB EMIRATES BUSINESS COUNCIL
Level 23, 91 King William Street,
Adelaide, South Australia 5000
Australia

enquiries@ausuaebc.com
+61 (08) 7123 2537

AUSUAE
BUSINESS COUNCIL