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Bundaberg Bioeconomy Conference 2023

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Can renewable gas take market share?

24 October 2023, Bundaberg

GAS & HYDROGEN

ELECTRICITY

WATER & WASTE WATER

REGULATORS AND GOVERNANCE BODIES

CONSUMERS

Energy Market Outlook - OMG….

- **Why this talk?**
  - Real changes occurring with emissions reduction legislation – a BIG R reform package – large users must decarbonise their natural gas use, while
  - We have (now extremely) tight energy supply, and
  - Trying to scale up renewable supplies with a high level of firming – as dispatchable coal generation looks to exit and domestic gas supply dwindles rapidly under policy pressures, and
  - Increasing energy prices and concerns about reliability – especially with sector coupling (GPG).
  - Businesses under intense ESG pressures (and greenwashing risk)
  - The trend is in full swing to decarbonisation – and the cracks are appearing….rapidly
- **It's an ugly mix and about to get even worse:**
  - Beset by social licence issues - for renewable energy infrastructure roll out – transmission, pumped hydro, etc., amid
  - Chaotic policy development – almost back to central planning days in some States – back to "picking winners" – and the rapid rise of "green" elephants – large scale pump storage (Snowy 2) and "full electrification"?
  - Why – because Governments seem to be losing confidence in markets – feel they must take control?
  - And - because Governments are reacting to community concerns regarding climate change, and affordability issues – key policy issues.

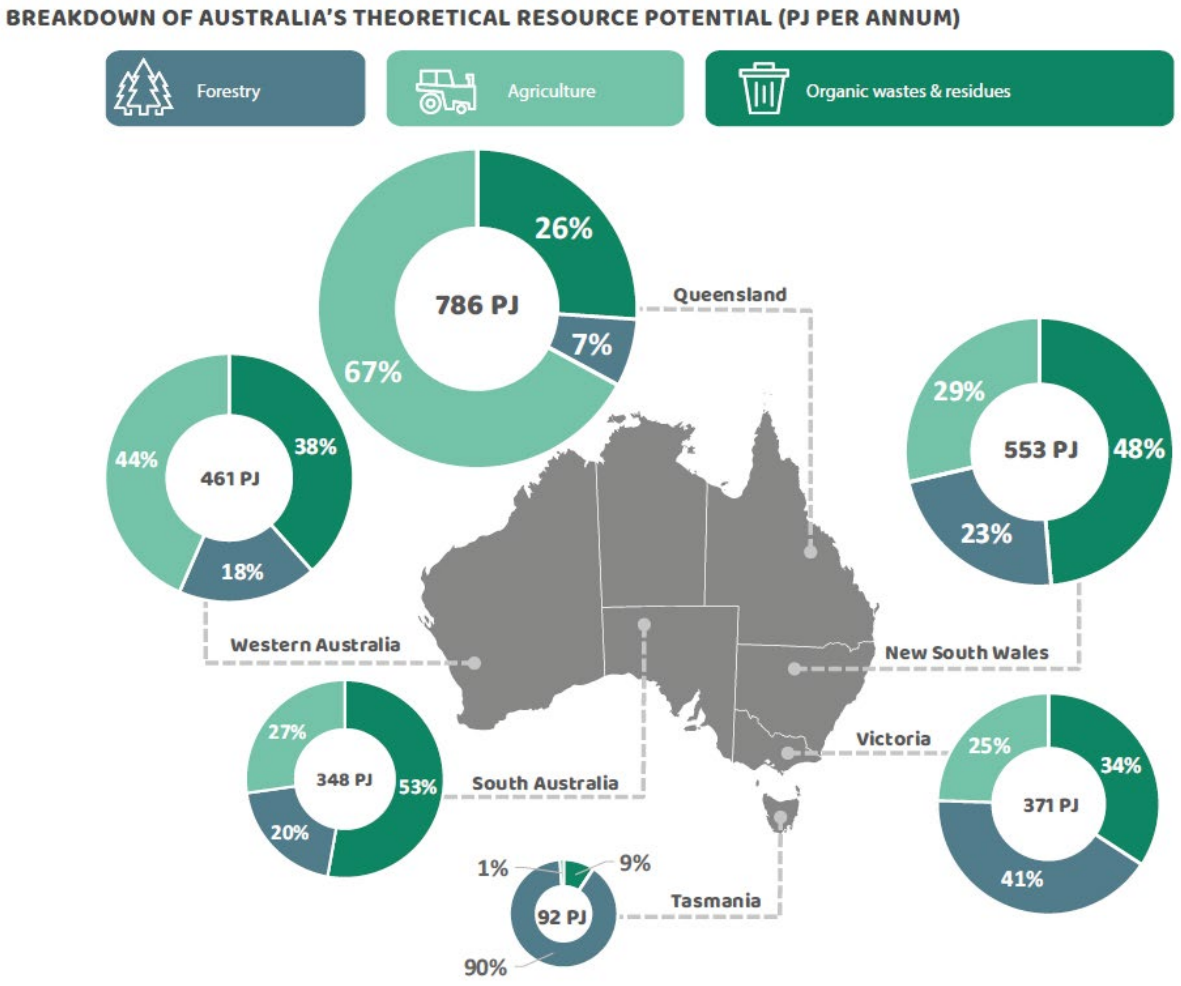
But let's stick to the messages for today….slides have a lot of detail for you to take home and digest but today I will stick to the key messages

Key messages for today….big resource, affordable for customers, can take large market share

The key themes in a short burst:

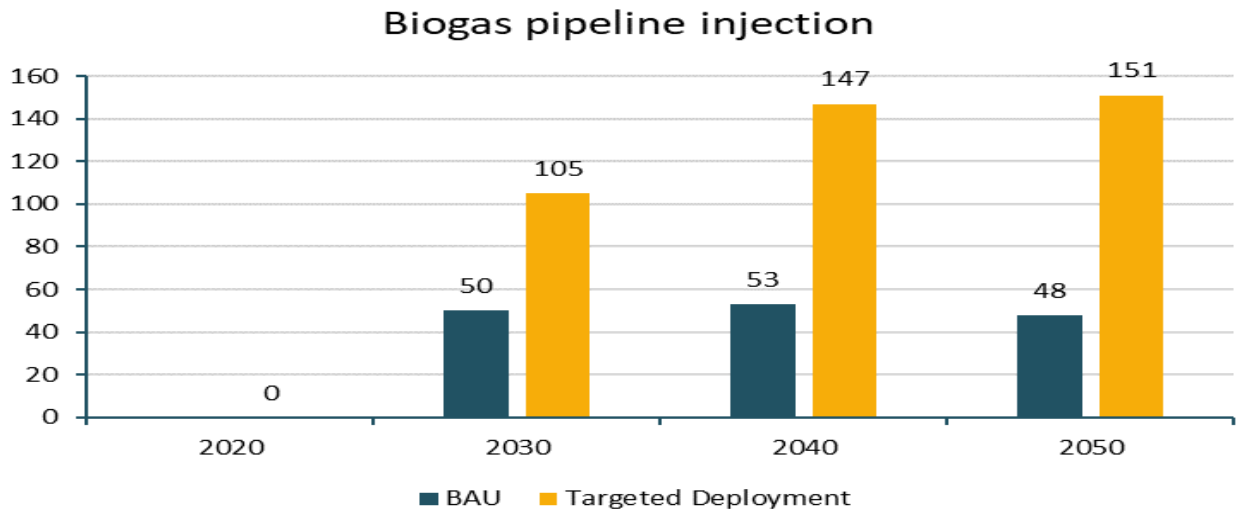
- The **size of the potential market** for renewable gas is huge – just taking a share of the natural gas market is enough – current domestic natural gas market is circa 650PJ/year and $8-10b/year
    - Pipeline quality biomethane and synthetic renewable methane (renewable gases or **RG**) can take a sizeable share based available resource analysis and associate costings – **has a major (affordable) role to play in the net zero transition – but must be scalable**
- There is a **gas system already in place that can easily be repurposed** with biomethane as it is pipeline quality and totally interchangeable with natural gas
    - This system **can haul as much energy as the NEM** – circa 200 TWh/year and currently supplies 175 TWh/year – all of which will need to be replaced if RG is not used e.g., Vic gas use = total Queensland electricity use…
    - It has some 200 PJ of storage already in place – this is 55 TWh - **equivalent to the energy storage of 150 Snowy 2.0** (or 75 Snowy 2.0 electricity output through a gas fired generation - and potential power output of some 200 x Pioneer-Burdekin).
    - Use of RG **can reduce the overbuild of renewables and electricity transmission forecast by AEMO by up to a staggering 50%** - it is a classic diminishing return issue – again good for customers and limiting low use asset builds.
- Customers can use it today for **NO CAPITAL COST** – difficult and expensive to abate industries, gas power stations, residential customers appliances and house supply systems, etc. – yes, no cost to decarbonise at their end
- There is a critical need for a **renewable gas certificate scheme** – the NSW GreenPower and international IREC (G) developments can play this role – totally mimics the electricity schemes (making investment more symmetric)

Carbon neutral methane – modelling – natural gas displacement with biomethane



Is the resource there – appears it is?

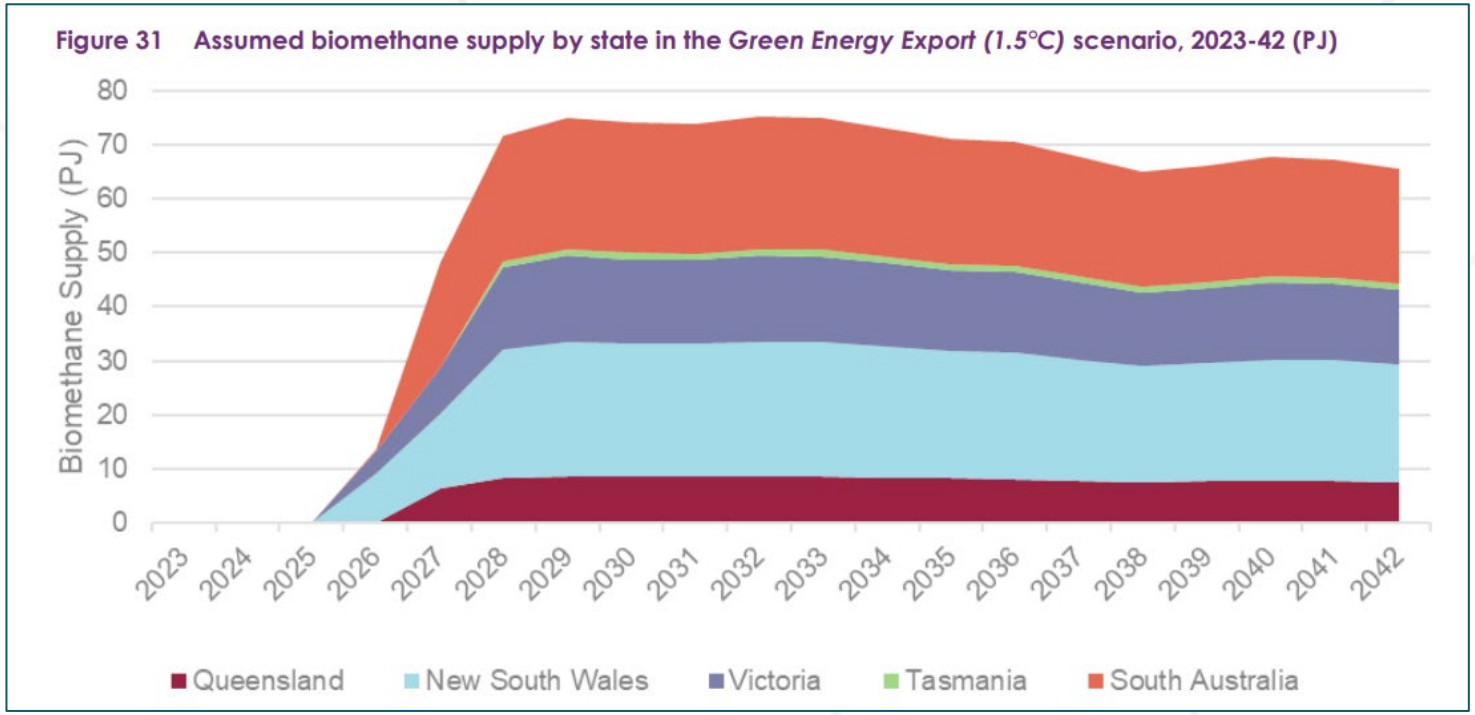
- According to ARENA/Deloitte/ENEA Biogas Roadmap (Nov 2021) the theoretical total is 2,150 PJ per annum (3 x NEM) - more conservative scenarios are still very high – and this does not add in methanation…
- Modelled cost of biomethane was $12.20 (2021) and $9.80/GJ (2030),
- Compared to forecast cost of gas of $8.60 (2021) and $11.50/GJ (2030) ARENA roadmap
- Current projects are examining > 350 PJ/year of biomethane production but 650 looks to be achievable
- Several investors undertaking similar studies/showing interest – and they *are all not currently in the gas industry* – the next "producers"?



AEMO now starting to take RG seriously – because the resource is there…

- Over the last 12-24 months the language has changed – carbon neutral methane gases were not seen as the least bit viable – rejected by policy makers and even the "gas" industry…H2 was the "answer" – technology would prevail?
- With a lot of effort, we are now moving from a focus purely on hydrogen to the broader category of renewable or alternative gases with a recognition that net zero/low emission methane is a viable, in fact an attractive, economic option for customers – and it is available relatively quickly (try building an electricity transmission project – even CopperString 2 will be earliest 2029…)
- For the first time we have seen this recognition in the 2023 GSOO - 80 PJ – this is $1 billion/year of gas – by 2028

2023 GSOO biomethane forecast



When we put alternative (non-H2) gases forward as a potential strong option in the transition it was "***nah – too small, too hard***" to now being "***essential to reach net zero - and action is needed now to develop them***" (Victoria)

Carbon neutral methane – taking renewable power generation market share

- **Overbuilding renewable electricity with very low utilisation versus using carbon neutral methane in power generation – this is a really interesting trade off and we do longitudinal modelling on this issue – AEMO heading down this track this year in the ISP (hopefully)**
  - This work was built upon our South Australian net zero transition case study modelling – which we have been doing since 2020 – when we started to think about the transition dynamic and how to make it economical reusing existing infrastructure and minimising new builds of assets (renewable power generation, transmission, batteries, pumped hydro)
  - Large overbuild can be offset by biomethane and the existing gas systems are perfect for this

SA is world class case study because:

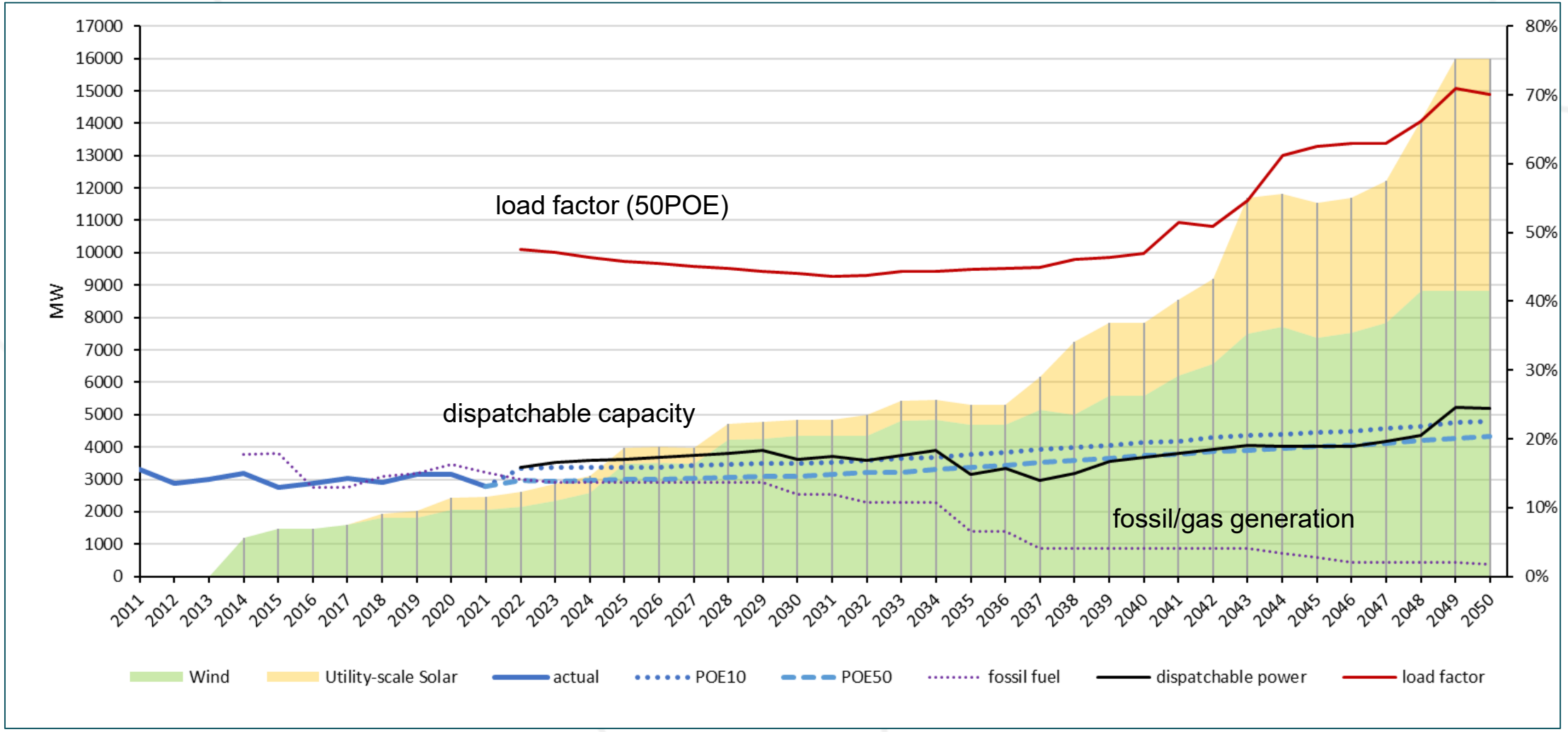
- Currently operating with 65% + renewables with gas mainly generating for firming
- There is no coal generation, and the interconnect does not add significant volumes to the energy balance (less then 10%)
- There is sufficient gas generation plant to meet the states peak demand, and there is a growing level of wind and solar generation in the grid (and behind the meter)
- SA had the first "big battery" in Australia, and
- There is excellent data over several years of this transitional mix – gas and renewables
- There is also been an active program by Government to assist the transitional arrangements and the wind resource is a large source of the supply which is not common anywhere else in Australia yet – Qld building up

South Australia GPG gas demand – additional modelling, but NEM based now

- OGW has undertaken **detailed wholesale market modelling** to further examine the GPG demand in SA into the future.
- The wholesale modelling by our modelling partner EndGame Economics used PLEXOS. This forecast of future generation investment in the NEM is based on AEMO's most recent (2022) ISP inputs assumptions (Step Change scenario*).
- The inputs selected from the ISP scenario have been used in the market modelling: Operational demand forecast including peak and energy targets; fuel prices including coal, gas and distillate; and plant technical and operational characteristics.
- The PLEXOS model used only these input assumptions of the Step Change Case but not the resultant, or the forecast of AEMO's modelled capacity investments.
  - This means that the forecast of new generation underpinning the outputs of our model is determined by the model.
- Our modelling partner has however made one key adjustment to AEMO's assumptions:
  - They have found that the investment path for AEMO's Step Change scenario leads to ***under investment in firm capacity, leading to material levels of Unserved Energy (USE) over the forecast horizon (particularly during periods of low VRE generation).***
  - To overcome this, they add a "***duration constraint***" to avoid any amount of USE in the 2019 reference year used.
  - ***This has the effect of leading to enough firming capacity being built (in many cases, OCGT) to ensure that during the day of highest residual demand in each region (demand less renewable generation) there is no unserved energy.***

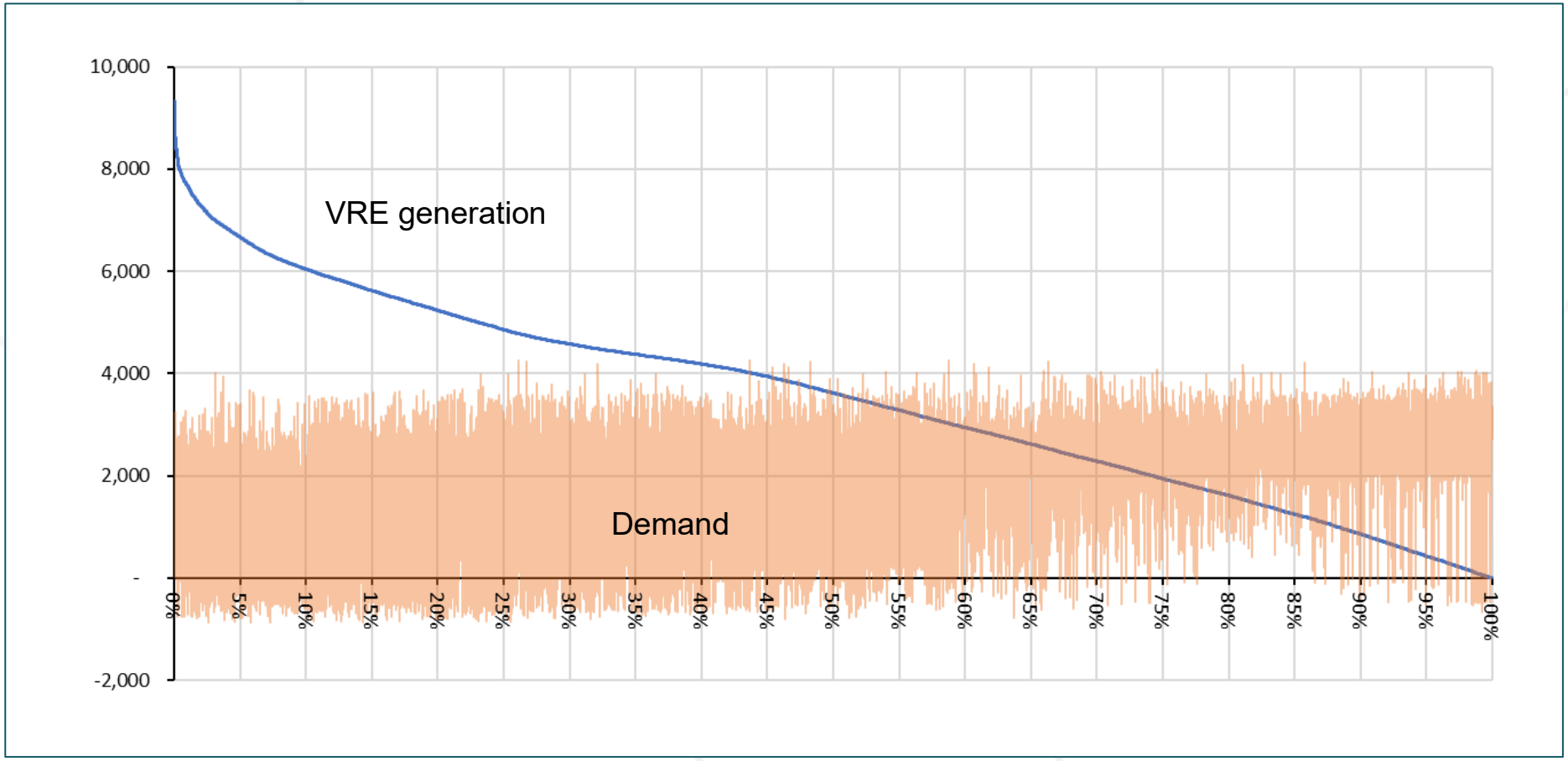
*AEMO models several different scenarios. During the development of the 2022 ISP, stakeholders expressed the view that the Step Change was the "most likely" scenario.

ISP 2022 Final Step Change Case – generation outlook – huge VRE overbuild to minimise the unserved energy – 3,000 to 16,000 MW…



Low overbuild utilisation – it has past some level of diminishing return…

- The AEMO Modelling relies on massive over build of renewables, BUT
- At year 2048 the utilisation of thousands of MW of VRE is negligible and this leads to huge “spills” of renewable energy

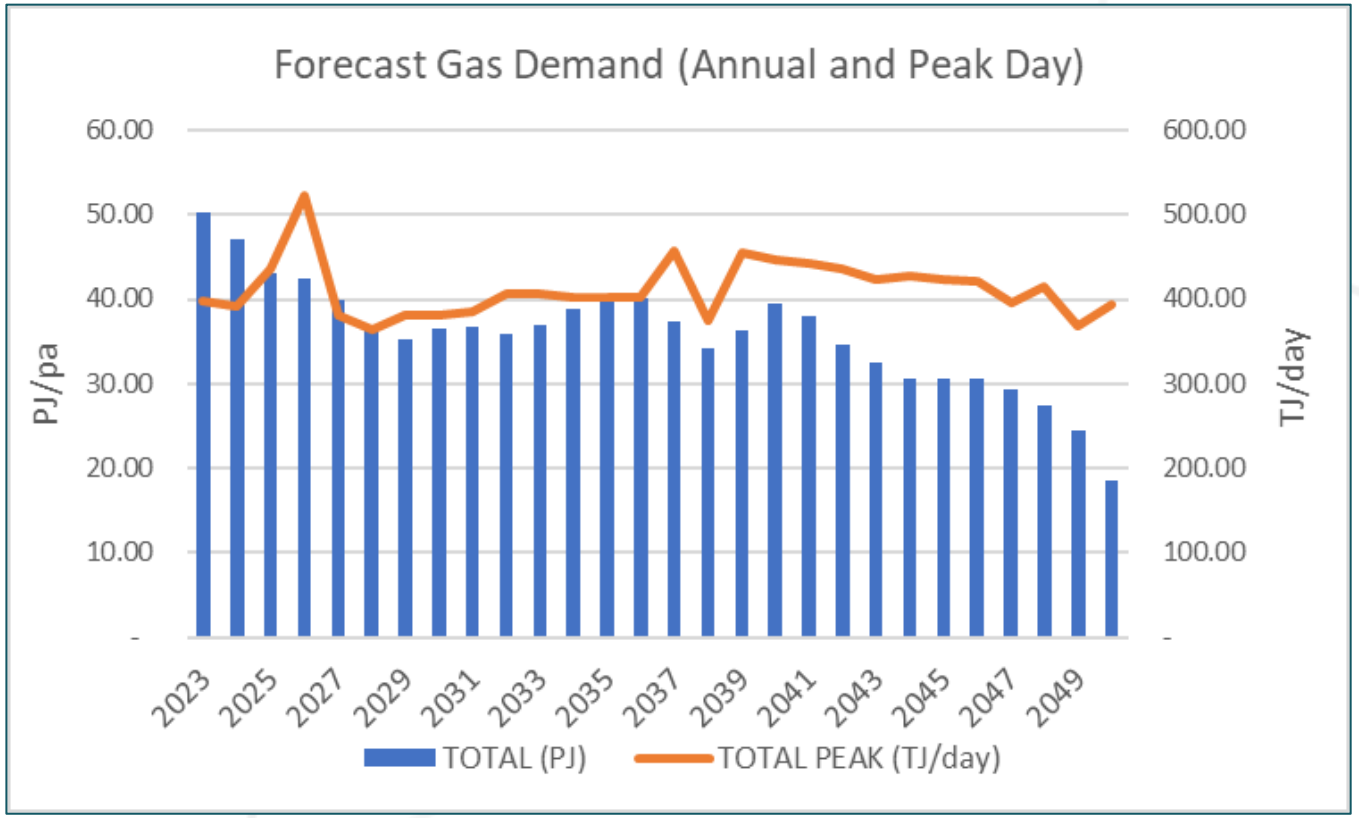


- Some 9,000 MW is used for less than 5% of the time…
- Utilisation of the last 8,000 MW is not discernable on the chart as the usage is so low….resource diversity issues
- Who would build that and who wants to pay for this virtually unused asset?

South Australia GPG gas demand – additional modelling, but NEM based now

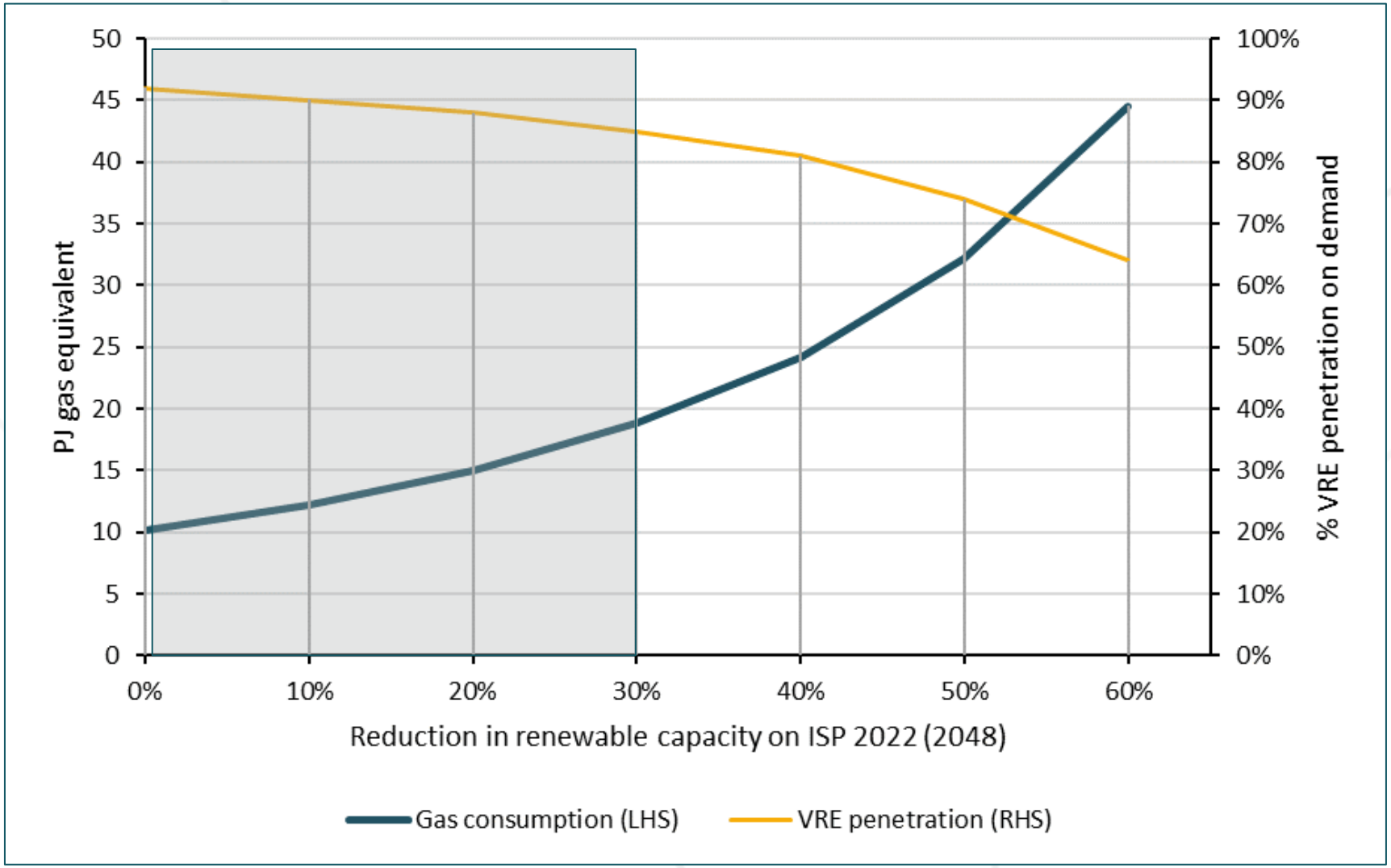
The OGW SA Case study we have run over the last 3 years is compelling and informative, and

- Originally run to examine wind drought issues – demonstrated the need for extended GPG support – well more than battery can provide, but
- We have started to run that now NEM wide at a more granular level as outlined – this shows other major opportunities for "*gas*" and *gas infrastructure*
- SA output still shows declining GPG annual load as VRE grows - but higher than current (2022) NEM modelling used in the March 2023 GSOO (see box in colour), but
- Peak demand remains very consistent – when you have to run you have to run……VRE droughts, driving a '*all-hands-on-deck*' use of GPG i.e., they are all required at certain times to support the system.
- Major implications for existing gas infrastructure as we have said consistently and an opportunity for renewable gases (which is growing as a form of renewable energy storage).



The higher SA GPG gas use relative to the AEMO forecast does relate to the no unserved energy constraint **BUT** also the gas GPG is effectively **taking more market share** from the assumed renewable overbuild and battery storage build – it does more than firming – it out-competes and becomes a "battery" – and the gas demand is well within alternative gas production capability…..

How much “gas” is needed in the future? SA Study



For the year 2048 – the impacts become obvious from the modelling.

The trade offs become apparent between overbuild and repurposing existing assets…

> **Up to 30% reductions (5,000 MW of VRE) requires about 20 PJ of “gas”**

So huge gains may well be possible from moderate levels of RG supply…

But it needs existing gas infrastructure to make it work…

Firming will set the cost of power to customers – not wind or solar…

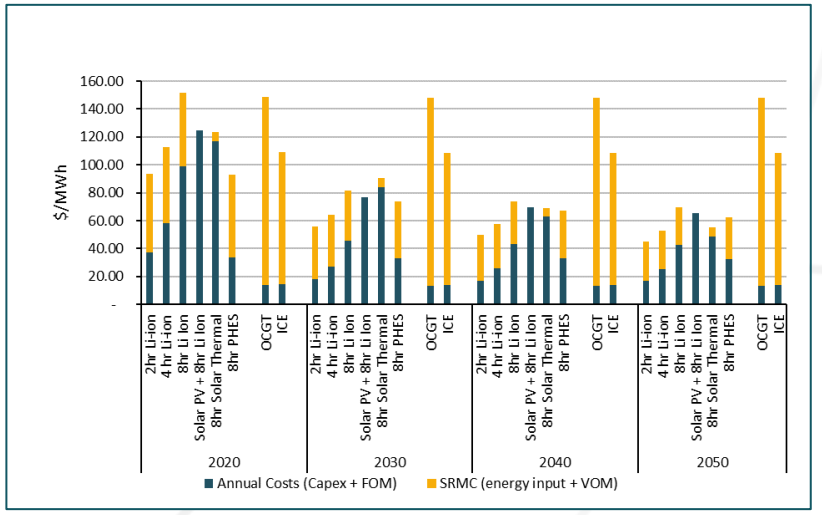
OGW has been working with EndGame Economic on forecasting power prices under various decarbonisation scenarios

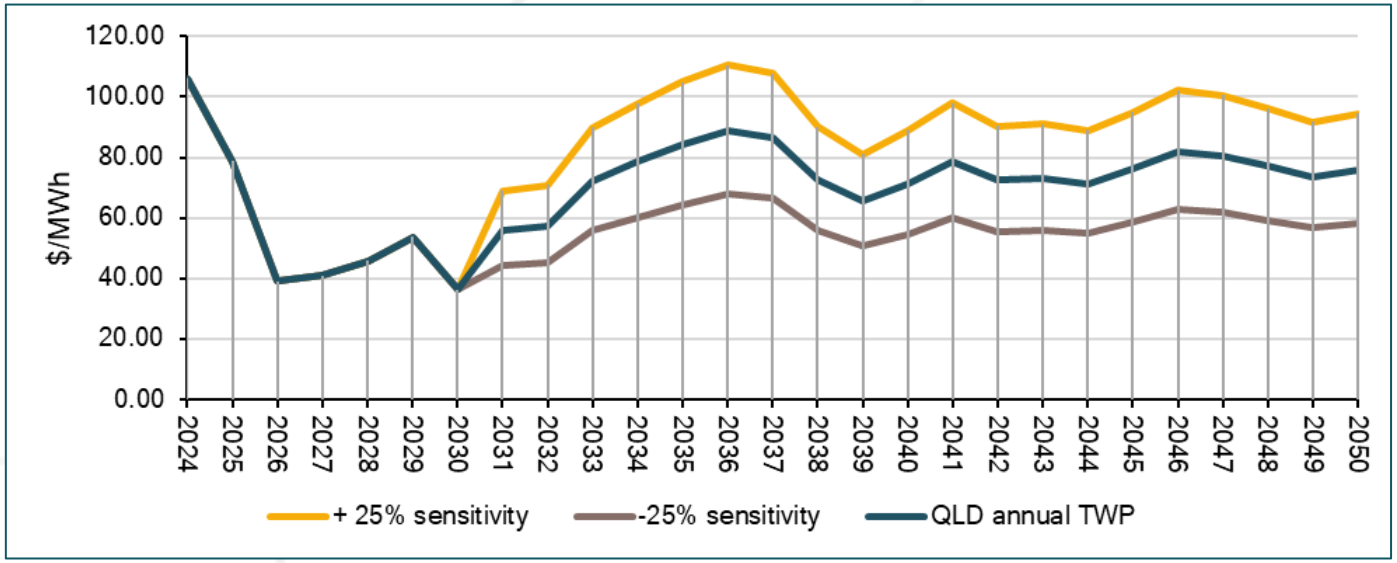
It becomes very clear that the wholesale cost of electricity is tied to the costs of firming – which is a very logical outcome as the marginal costs of wind and solar are very low – price takers not price makers.

The firming market is batteries, pumped hydro and (RG fired) power generation

The (RG fired) gas generation sets the price – as was found in the Low Emission Technology Roadmap work undertaken in 2020

- OGW led the storage section for the Commonwealth with main inputs from Dr Alan Finkel, CSIRO, Grant King and Drew Clarke.
- Long-term pricing for "storage" (firming) approaches $60 to $80/MWh.





Renewable Gas Certificate Schemes – NOW please

One critical policy issue is the need for a green gas certificate scheme that is recognised in NGERS (ACCUs) – it will enable:

- **Injection of gas anywhere on the interconnected grid** but the gas user can claim the green credits (in their transition to net zero)
- Which also allows the **most economically efficient sites to be exploited first** – lowest cost resources can be independent of customer location
- Should/could also allow some of the renewable methane to be injected into the distribution system at lower connection costs than into existing gas transmission pipelines – **could you for example inject in Queensland and claim it in South Australia (yes)** – can now with RE generation.
- Will also ensure the **most efficient trade-offs between renewable gas use and storage versus renewable electricity transmission and storage** (pumped hydro and battery) – the **"overbuild"** issue - and certainly will solve storage issues renewable electricity cannot yet economically – and gas storage is already there in huge quantities.
- It will **repurpose the existing gas infrastructure** – this currently supplies 175 TWh (NEM is 200 TWH).
- It will materially assist the **development of OEM suppliers and constructures, and early-stage investment in the sector**

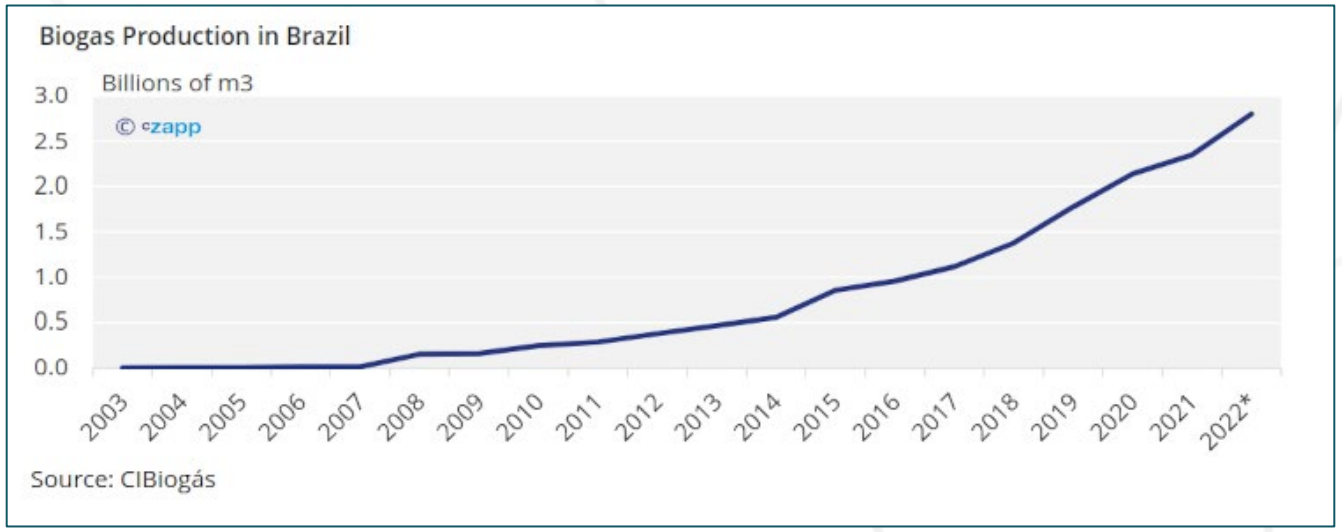
- How much is out there – BA currently think more than 350 PJ – my (and others) view is the full 650 PJ of domestic market demand is available.
  - Even up the playing field for customers and let them decide – **the green gas certificate scheme needs to be symmetric with those already in electricity – and some is already recognised for the production of ACCUs…**
  - **Give customers real and competitive/affordable options and choice – and then let the market develop….**

IREC (G) - IREC Gas

- IREC is an international certification scheme prominent in countries that don't have a comprehensive Government or regulatory based scheme.
- OGW is the Australian Issuer of I-REC(E) for RE that is unable to certify for LGCs (baseline issues)
- IREC has had a pilot scheme in place in Brazil which is seeing a rapid uptake of biogas
  - (~10mn m3/d currently) and expects to be producing 30mn m3/d by 2030 with a target of 120mn m3/d.
  - **10mn3/d = 139 PJ pa. assuming 100% CH4 – 400PJ/year target**
- Scheme is now operational and conducted its first issue late last year.
- **OGW is able to announce today we have signed an MOU with the I-REC Foundation to develop and issue Gas-RECs in Australia – great news for international investmenmt interest.**

THE INTERNATIONAL REC STANDARD

I-REC active regions



The key issue for the alternative gas industry is to get an effective carbon credit scheme established as there is an asymmetry with the power sector now e.g., it is worth more to use a biogas for power generation (and receive LGC's) than for biomethane.

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NSW GreenPower Renewable Gas Accreditation and Certification Scheme

- NSW GreenPower are running a Renewable Gas Certification Pilot based initially on the exports from the biomethane plant at Malabar – but also applies to green hydrogen and synthetic methane (from green hydrogen or similar sources).
  - Hydrogen accreditation is free though.
- The focus of this scheme is on commercial and industrial gas users – as a policy position residentials are excluded – they can only benefit from electricity certificate schemes.
- Certificates can be sold:
  - "**Coupled**" with renewable gas supply, so the customers effectively owns the value, or
  - "**Decoupled**" and traded by the producer (or Retailer that buys them coupled).
  - The electricity schemes started as largely coupled and moved more to decoupled over time.
- The IREC (G) will have no policy overlays – **available for all producers of renewable gases and all customers** of the certificates (as the IREC (E) is now), and
- Will **be internationally tradeable** – which is a benefit to many gas users who export product, are part of international groups and to traders in other countries looking for supply of internationally recognised (G) certificates.
- The BIG question for both IREC (G) and GreenPower is **acceptance into the safeguard mechanism…**

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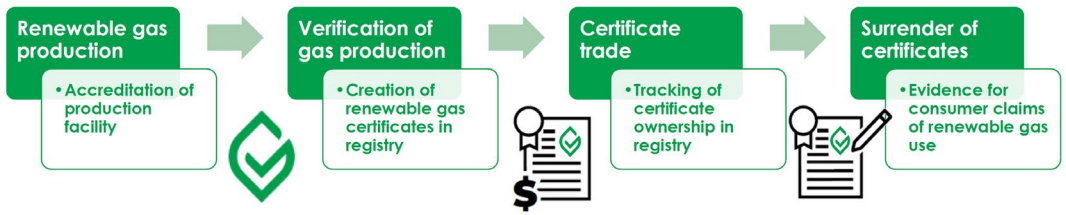

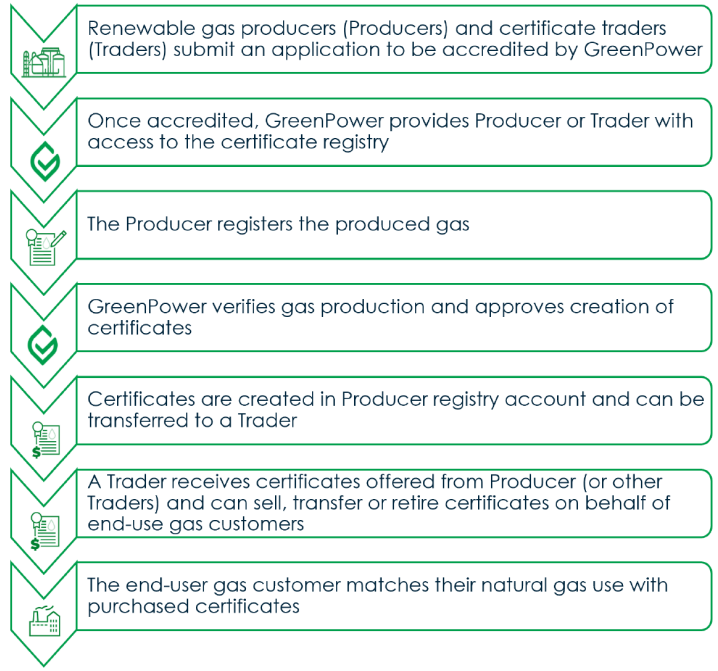

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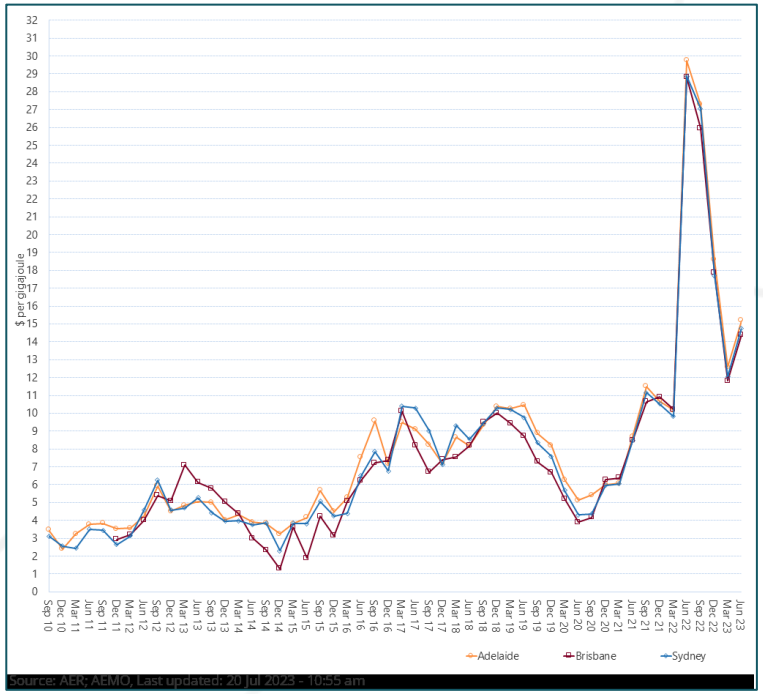
Renewable Gas Costs and value of Certificates?

OGW has undertaken extensive market studies for producers and investors

- The most lucrative market is **peaking gas fired generation** - well north of $20/GJ up to $35/GJ
- **Industrial consumers** are next accessible markets at some $15/GJ to $20/GJ – as they have to decarbonise – specifically Safeguard Mechanism customers
- **Commercial and residential custoemrs** tend to be more lucrative but supplied en-masse by Retailers – this groups can more easily absorb higher prices as the wholesale gas price is a much lower component of their actual tariff prices
- The certificate values are significant and can be shadow priced off ACCUs – this comes out in our analysis to be **some $3/GJ to $5/GJ**
    - Biomethane prices are **at parity with natural gas prices on this basis** – and shows why the certificate scheme is so valuable to providing real options for customers (as it did for solar and wind and remains so for those sources), remembering
    - The existing infrastructure can be reused – fully sunk network assets and vast storage, market designs and oversight and regulation, etc. – so no dislocation to the community for transporting and storing this energy (or additional costs of major infrastructure builds) , and
    - **Customers have zero conversion costs….let me finish on that line – yes, no conversion costs for customers at all….**

Quarterly STTM prices



ASX natural gas price futures

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OGW gas market and alternative gas experts

- **Jim Snow**, Executive Director, Adjunct Professor University of Queensland (Energy Initiative)
  - Started in the energy industry in 1979 with AGL, involved ever since here and internationally, in last 3 years major involvement as an Expert Witness in gas matters (Federal Court, Arbitrations and Public Inquiries) – also ESG matters: jsnow@oakleygreenwood.com.au
- **Angus Rich**, Executive Director
  - Technical specialist and market modeller, worked extensively in the last 3 years on policy issues, forecasts, power generation renewable integration and gas matters arich@oakleygreenwood.com.au
- **Rohan Harris, Executive Director**
  - Economist and expert in natural gas markets, renewable gas cost modelling and end use markets, deeply immersed in the transitional issues to net zero for the last 3 years rharris@oakleygreenwood.com.au
- **Bill Williams**, Principal Consultant
  - Gas industry specialist, worked extensively in last 2 years on decarbonisation, gas pricing, renewable gases, power generation, etc. bwilliams@oakleygreenwood.com.au
- **Matt Currie,** Principal Consultant
  - **Expert in remote energy requirements for mines and other major energy facilities (gas, electricity, generation, etc.) and expert modeller of NEM and gas matters and related transitional pathways** mcurrue@oakleygreenwood.com.au

Relevant recent work = very deep dives and legal challenges

- South Australian Energy Transition Case Study which we kicked off in 2020 – SA is world class case study in the transition to net zero and we have kept updating it each year.
- Undertaken detailed gas market studies for international investors looking to enter the renewable gas and energy markets – more focus on transitional issues and sector coupling – and some stranded asset buyers…
- Exert Witness (courts, arbitrations, public inquiries) – Viva LNG PI, storage litigation, WORM PI, Greenwashing – deceptive and misleading conduct, GPG enforcement issues and compensation cases, gas price arbitration (legally tested modelling of forecasts of gas prices - accepted OGW methodologies)
- ESG – large energy users (energy intense industries and mining firms), energy companies, gas infrastructure
- Alternative gas works – biomethane, renewable methane and H2 (various colours) – renewable gas cost modelling and cost of abatement – storing and delivering alternative gas analysis – market value of renewable gases and associated certificates
- Gas and electricity demand and supply forecasting - east coast, Vic and SA – APA VTS, gas infrastructure and GPG loads in NEM – shortfalls and critical drivers and solutions
- Granular modelling of GPG with no unserved energy and sensitivities on delays to major projects (with our partners Endgame Economics)
- Understanding what happens to pipeline revenues - forward haul and storage trade-offs if gas use declines and renewable gases increase
- Gas carbon credit scheme design for Governments and industry groups
- CopperString 2 detailed market analysis – GPG and renewable generation trade-offs
- Training on the gas market and pricing issues
- Redesign of NEM and associated matters
- Integration of gas, renewable, storage into major mine sites to minimise emissions – interesting analysis – reaching 75% penetration but changes the economics a lot

BACK UP SLIDES

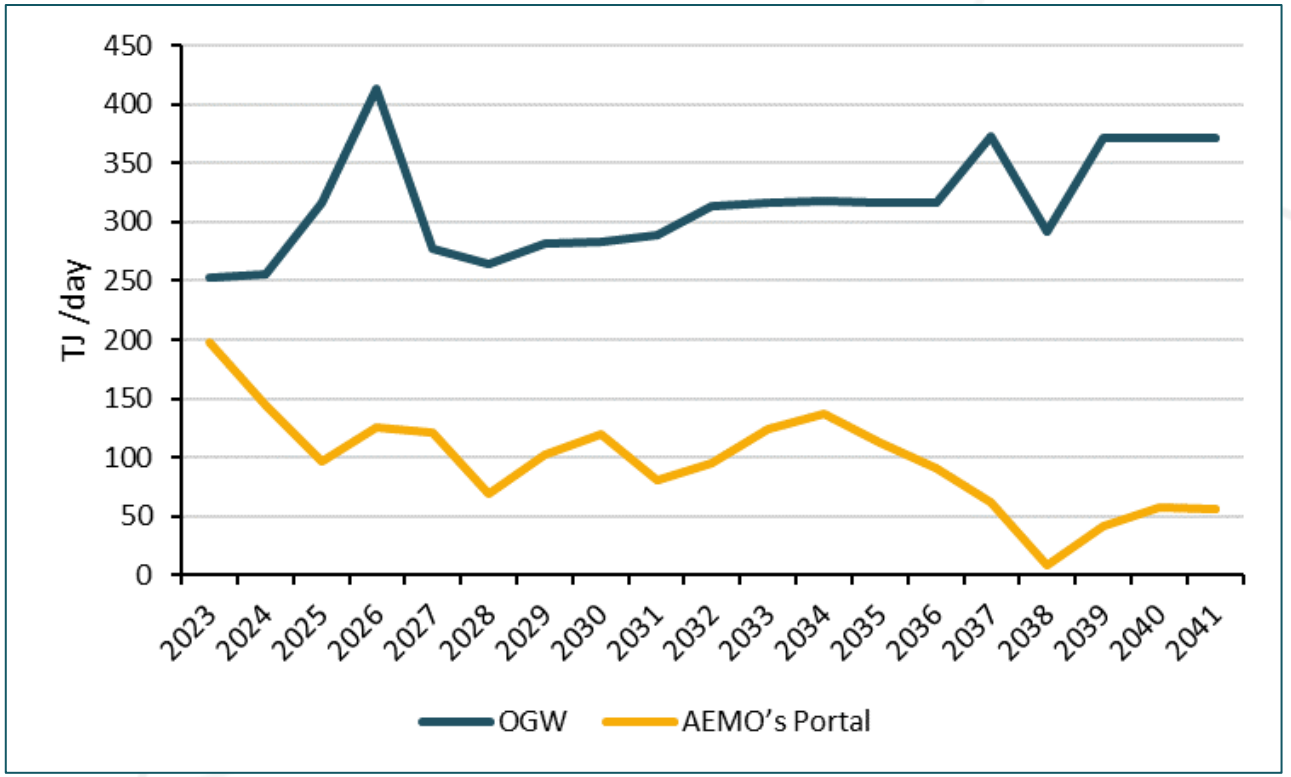
Differences between our forecasts of GPG demand and AEMO's forecast

- The modelling also demonstrates the difference between our undiversified forecast of GPG's peak demand and the AEMO forecast.
- "AEMO's Portal" forecasts are derived from AEMO's forecasting portal, assuming POE5 winter peaks
- They are:

  *"the levels of gas generation forecast for each region during the time of regional residential, commercial and industrial maximum demand (5 POE or 1 in 20)"**

*" *2022 GSOO – Gas generation daily maximum summary".xls (AEMO)*

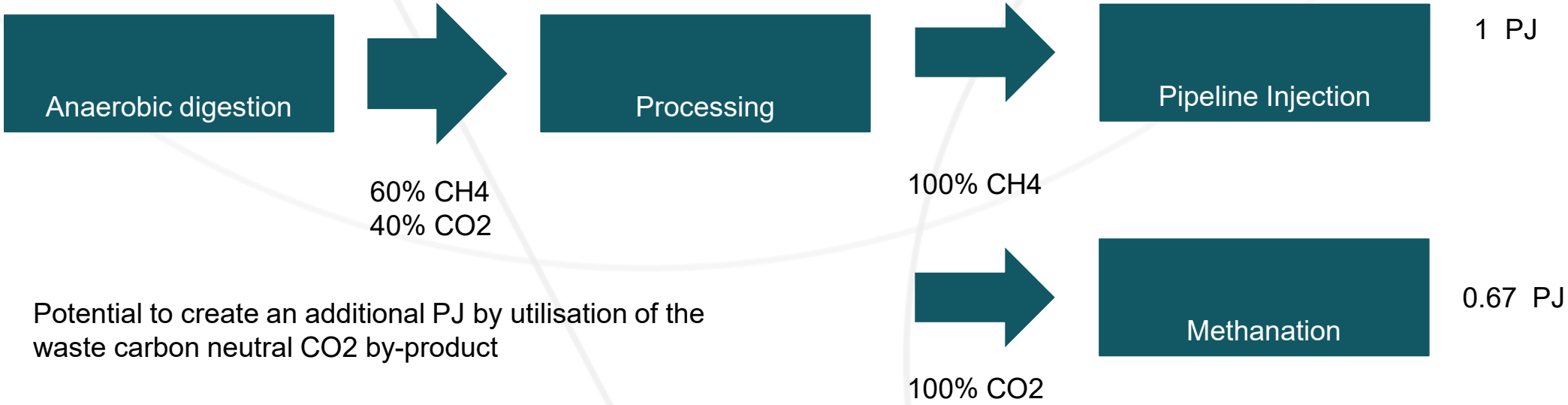
- <u>This is a fundamental issue for gas infrastructure – it maintains its peak demand profile and becomes an efficient and low-cost storage system – which is logical – carbon neutral methane in GPG stored in the existing gas infrastructure is very effective (and we do it now but with natural gas).</u>



Carbon neutral methane – modelling – biogenic CO2 methanation

- Biogas production through anaerobic digestion also produces CO2 which is removed
- The CO2 is a “waste” product and “carbon neutral”
- Coupling with the methanation process resolves one of the key inputs for a cheap/free carbon neutral CO2
- For each PJ of CH4 an additional 0.67 PJ can be created with methanation process (H2 plus CO2 - synthetic methane reaction – **100-year-old technology – off the shelf**).
- The process also returns heat (energy) and water.
- The marginal costs are very low for methanation itself – 5% -15% - driven more by H2 production costs – but way higher utilisation achievable (no new storage required)

Example:



Potential to create an additional PJ by utilisation of the waste carbon neutral CO2 by-product

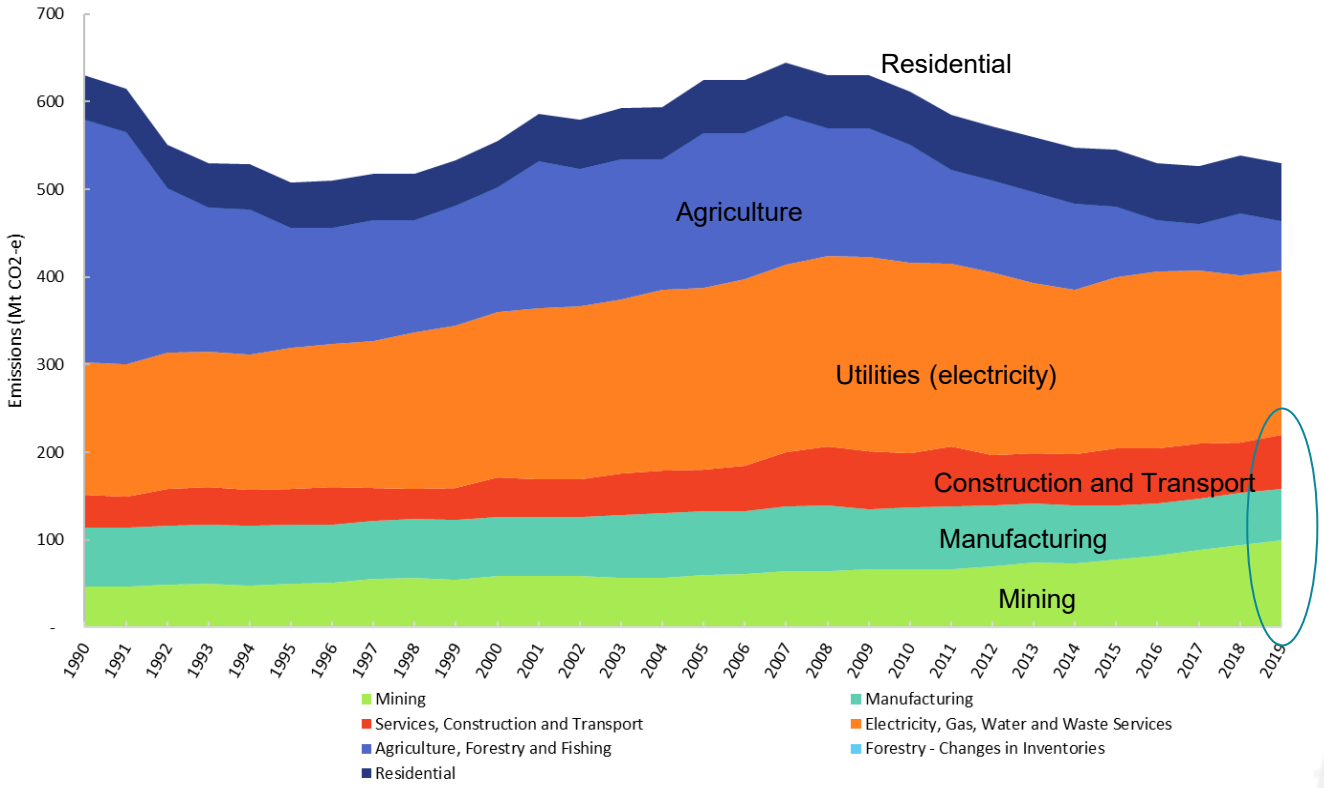
Key Messages – Big "R" emissions and hence economic reform is here – strap in..

- **Big "R" Reforming Government(s) – with enormous economic, investment and consumer cost consequences**
- **Reminds me of the Hawk/Keating era of microeconomic reform and the massive impact from removing tariff protections**
  - The Commonwealth Government is embarking in real time on decarbonising the industrial and commercial sectors via legislation that is truly reforming
  - Examples: the updated Safeguard Mechanism, the impending Gas Market Bill and current Gas Emergency Pricing Order ($12/GJ), Gas Market Code – a regulated cap that has turned into a floor price…
  - The States are also promulgating very ambitious targets for renewable penetration and emissions
  - It all raises serious question about what industries and manufacturers will be left by 2050 – and what will you be using in your home?

Qld – By 2030: renewables 50%, emissions by 30%, 70% renewables by 2032, 80% renewables by 2035, net-zero emissions by 2050.

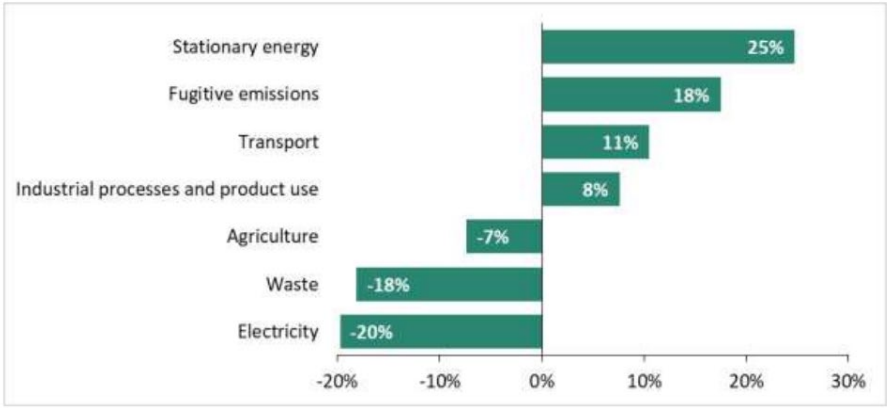
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
QLD	20%	23.3%	27.1%	30.8%	34.6%	38.3%	42.1%	45.8%	49.6%	50%	60%	70%	73%	76%	80%	81.3%	82.7%	84.0%	85.3%	86.7%	88.0%	89.3%	90.7%	92.0%	93.3%	94.7%	96.0%	97.3%	98.7%	100%
NSW	26%	28.7%	31.3%	34.0%	36.7%	39.3%	42.0%	44.7%	47.3%	50%	54.0%	58.0%	62.0%	66.0%	70%	71.3%	72.7%	74.0%	75.3%	76.7%	78.0%	79.3%	80.7%	82.0%	83.3%	84.7%	86.0%	87.3%	88.7%	100%
VIC	33%	34.8%	36.5%	38.3%	40%	51.0%	62.0%	73.0%	84.0%	95%	95.3%	95.7%	96.0%	96.3%	96.7%	97.0%	97.3%	97.7%	98.0%	98.3%	98.7%	99.0%	99.3%	99.7%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
SA	66%	69.8%	73.6%	77.3%	81.1%	84.9%	88.7%	92.4%	96.2%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Safeguard – 5% per annum reductions by large emitters – carve outs occurring..



Sectors covered by safeguard mechanism.

Figure 2.1: Change in Australia's emissions between 2005 and 2022 by sector



Make no mistake – this scheme is a blunt instrument – which raises many questions: Questions around - is it too quick, is it too complex, can we live with the costs and/or potential loss of industries and jobs from the energy intense sectors, are there security of supply issues around manufacturing capacity that what we need - and associated sovereign security issues, can we even achieve it, will we simply export emissions and jobs, will we need a CBAM, etc?

Key Messages – scale up – the numbers are mind boggling – is it even doable?

Let's look at some numbers :

- Electrification just for households - 7 million gas customers (NG and LPG) – to electrify estimates are $6,700 to $41,430 per customer - $47b to $290b – $150b is likely -1,000/day full conversion for 27 years…
- The existing gas assets deliver nearly 90% of the NEM energy (175TWh / 200TWh).
- The gas demand in Victoria is the same as the total electricity demand in Queensland… and the network augmentation will be very expensive (mostly low voltage system).
- The east coast of Australia has some 150 PJ of natural gas storage for market use (>200 PJ in total) – mostly underground – yes, it is existing. This is more than 55,000 GWh of electricity storage equivalent (25,000 GWh from a CCGT) = 75 x Snowy 2 output of electricity which is 336 GWh for comparison.
- There are also some 35,000 km of natural gas transmission mains in Australia – these can not be readily repurposed with hydrogen to haul the same level of energy – technical issues, reduced energy throughputs at much reduced pressures, certification issues and expensive to replicate – and yes, all (literally) sunk assets…they need to be repurposed.
- Estimates to develop, operate and maintain the generation, storage and future network investments of the NEM to 2050 if electrified are $320b (AEMO)….