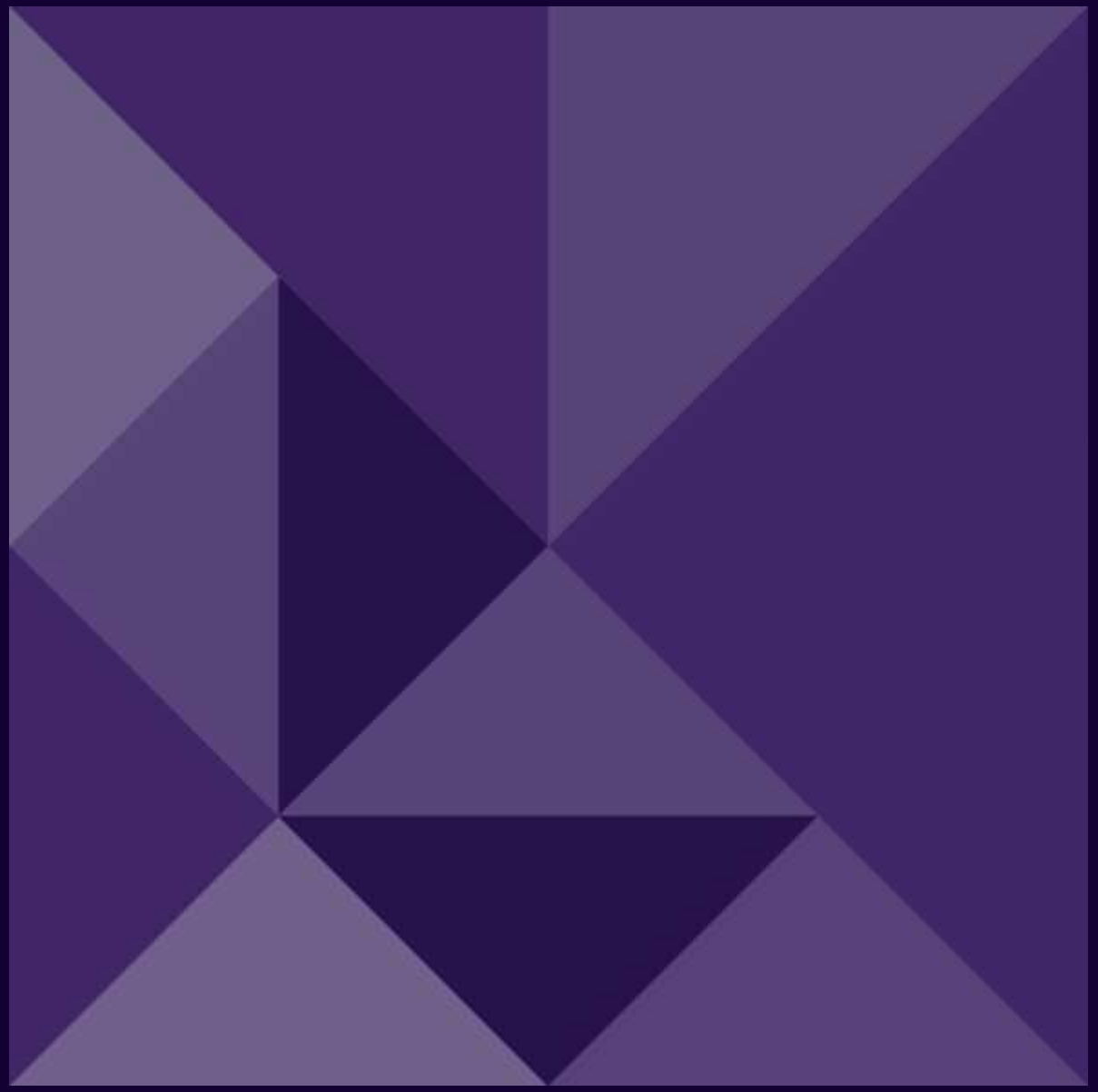
22 February 2024

Undertaking economic analysis of a Renewable Gas Target

APGA Renewable Gas Symposium



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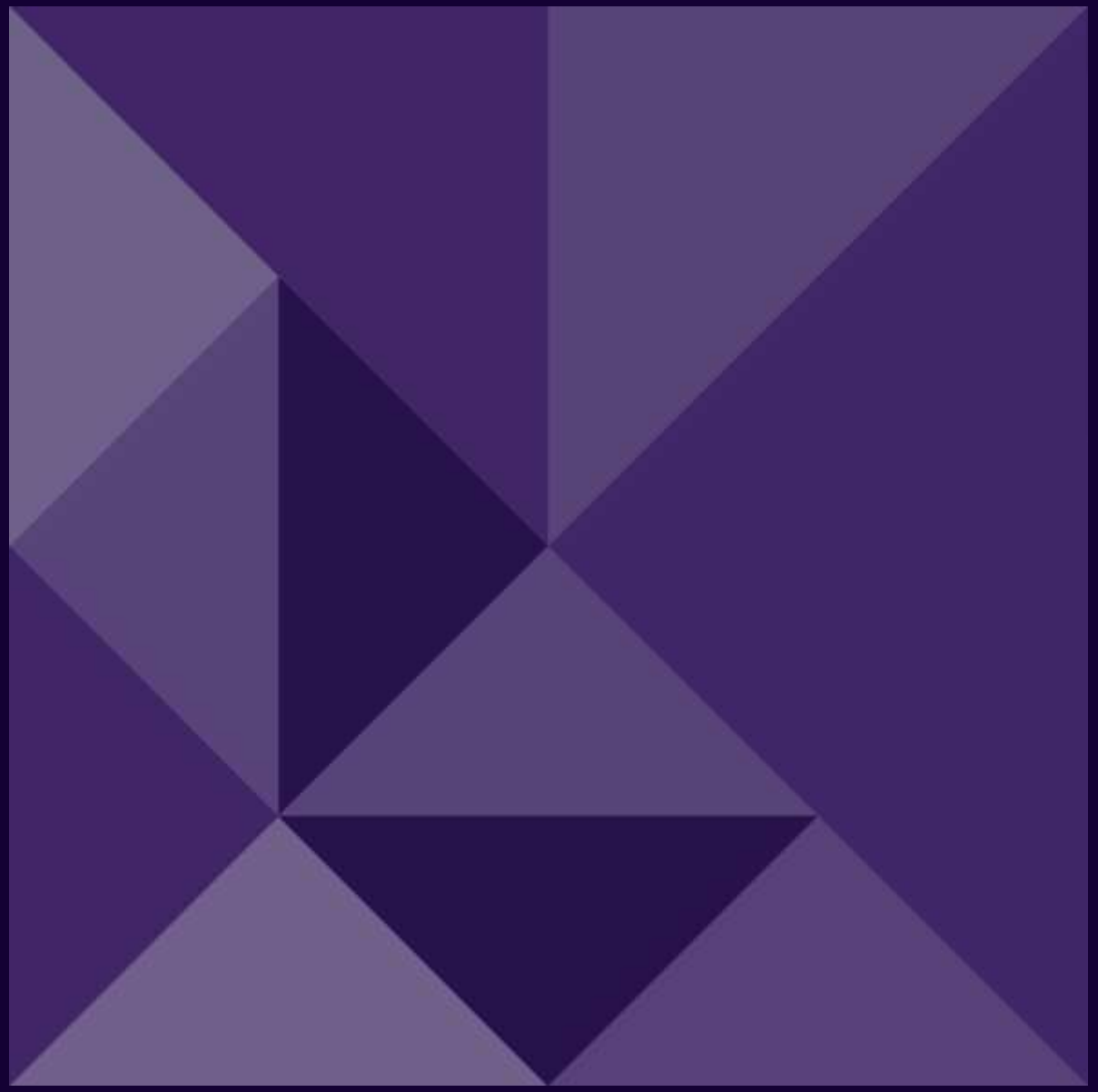
Agenda

1. Overview of engagement
2. Methodology and Transition model architecture
3. Some key assumptions
4. Theoretical Efficient Policy scenario
5. Key takeways



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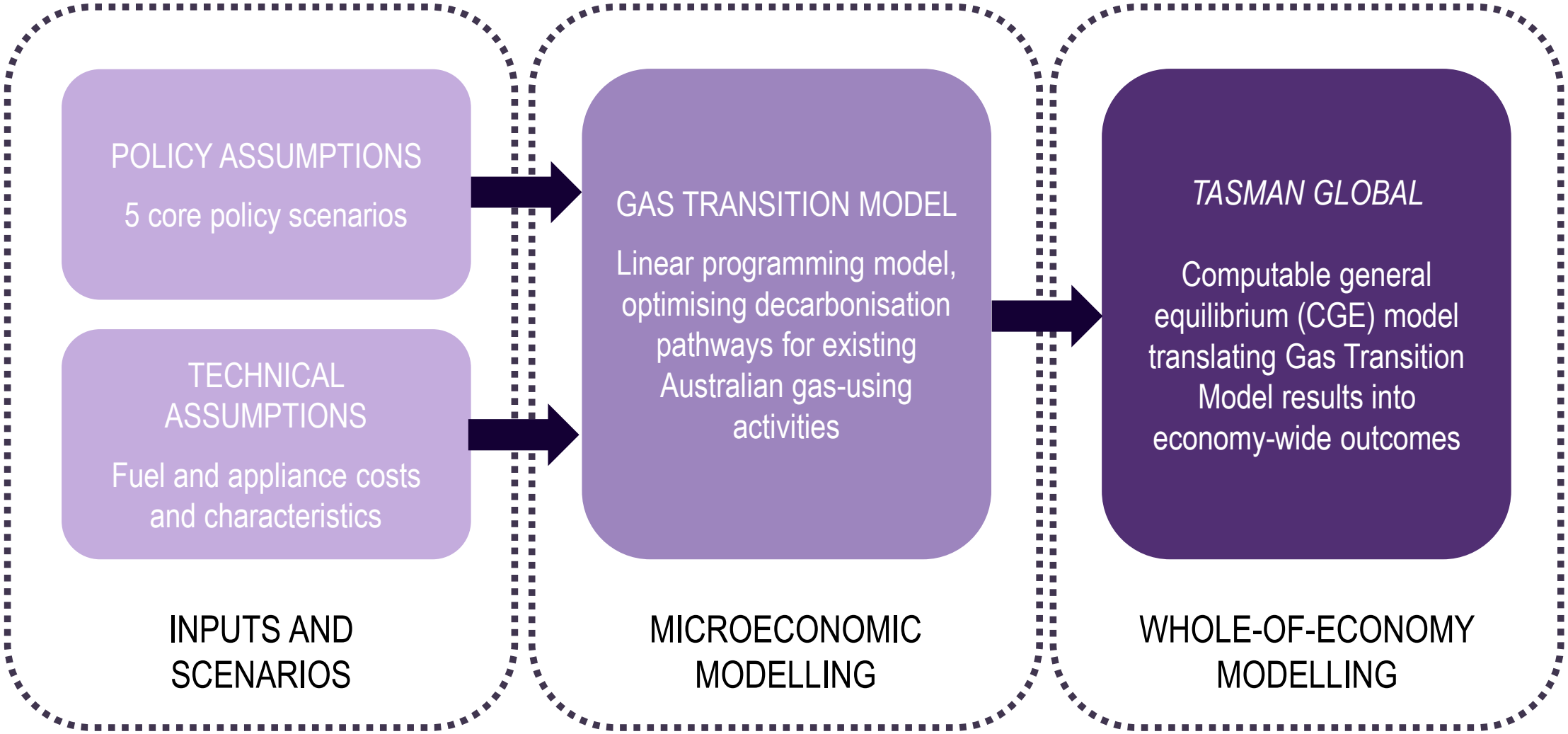
Modelling a renewable gas target

- ACIL Allen engaged by APGA in early 2023 to model the impacts of a National Renewable Gas Target
- Original project schedule was for a 21-week project, with wrap up in early September 2023
- Core part of the project was to leverage an existing gas transition model developed as part of the Victorian Gas Substitution Roadmap
  - Expanded to include all Australian jurisdictions and consumer categories
- The model only looks at existing domestic gas users (excl gas for power generation)
- Ability to incorporate sector policies and abatement targets
- Sector results taken through to economic impacts from our computable general equilibrium (CGE) modelling

Methodology overview



Gas transition model

- The GTM is formulated as a large-scale linear program (LP) for the sector with the objective function to minimise the present value of resource costs, subject to a range of constraints
- In developing the model structure, the following design principles were applied:
  - Both demand and supply side solutions are available to meet abatement targets
  - The model examines the least cost pathway from a system planning perspective. It is not a consumer choice model and does not implement Government policies to encourage take-up of certain technologies unless constrained to do so.
  - The model only considers economic costs (capital expenditure and operating costs)
  - Existing end-user appliances must be replaced at the assumed end of their life, but early replacement is allowed if an acceleration of appliance replacement transition is economic given any emissions or other constraints imposed.
  - Emissions considered include those from combustion of natural gas. It does not consider fugitive emissions. Where electrification occurs, any incremental emissions associated with additional electricity generation to serve the electrified load are accounted for within the gas sector's emissions constraints (but the baseline level of emissions from gas-fired generation is accounted for within the electricity sector, which is subject to its own emission budget).

Technical assumptions

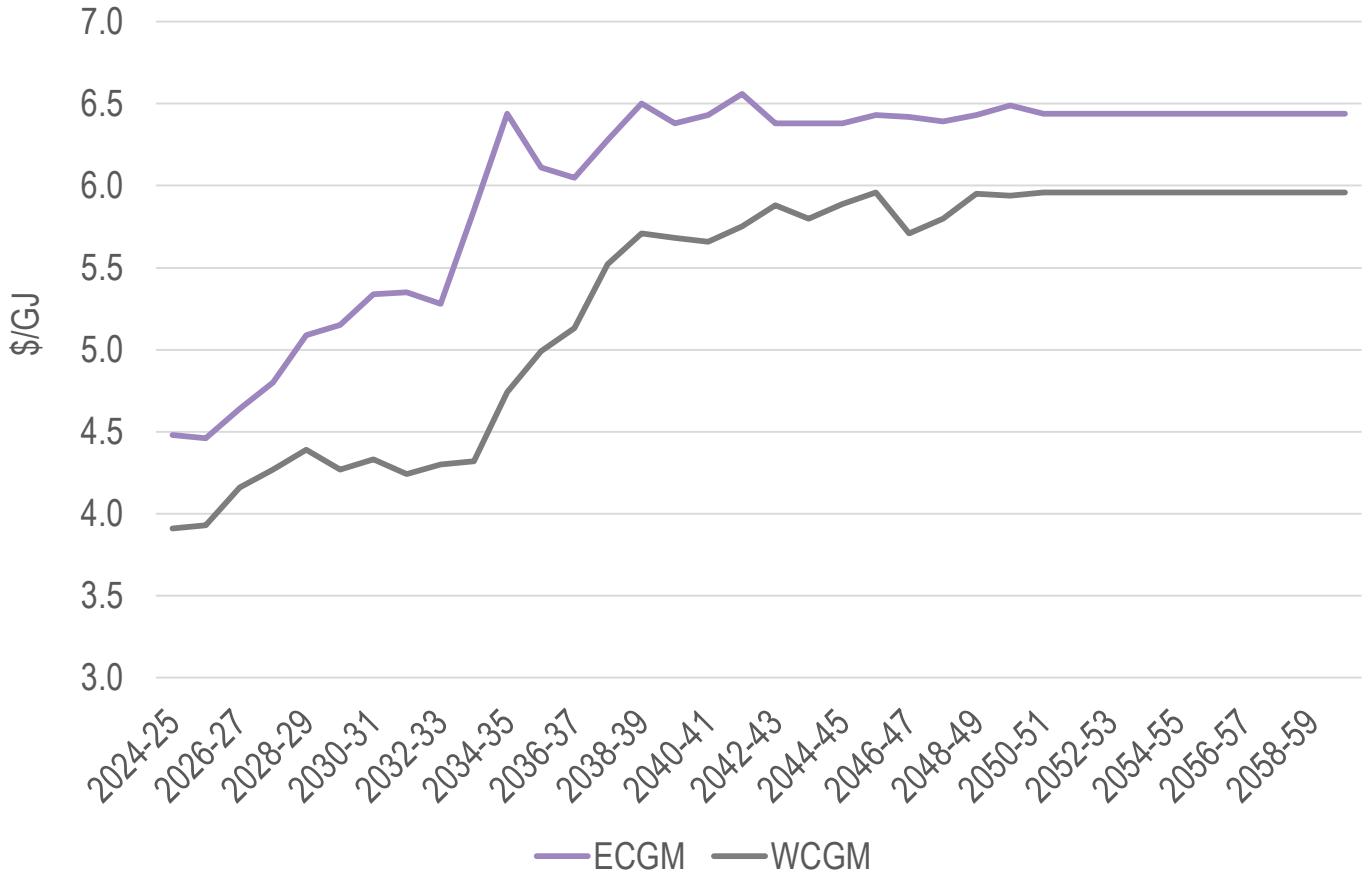
Assumption	Approach/key sources
Wholesale electricity price	ACIL Allen PLEXOS modelling based on ISP assumptions
Natural gas costs	ACIL Allen *GasMark* modelling
Hydrogen costs	ACIL Allen modelling based on ISP solar and wind traces, AEMO and CSIRO capex assumptions
Biomethane costs	Bioenergy Roadmap assumptions
Biomethane availability/volume	Bioenergy Roadmap assumptions
Carbon budget (2025-2030)	Calibrated based on pro-rated share of Safeguard Mechanism emissions budget for Safeguard entities, and emissions projections for non-Safeguard entities
Carbon budget (2031-2050)	Estimated based on a straight-line decline in emissions from 2030 to 2050, converted to a budget to allow inter-year flexibility
Use of offsets	No offsets allowed prior to 2050. Offsets volume limited to 4.2 Mt CO_2-e/year from 2050. Offset cost of \$321/tCO_2-e in 2050.

Activities and appliance efficiency

Activity	Sectors/ sub-sectors	Electrical appliance efficiency	Gaseous fuel appliance efficiency
Low temperature heat	Agriculture, food & beverage, other manufacturing, gas distribution	300%	85%
High temperature heat	Gas processing, food & beverage, pulp & paper, petroleum & coal products, other chemicals, iron and steel, other non-ferrous metals other manufacturing,	85%	65%
Compression	Gas processing, gas transmission, LNG	94%	30%
Ammonia synthesis	Ammonia and derivatives	N/A	N/A
Urea	Ammonia and derivatives	N/A	N/A
Glass making	Glass	85%	50%
Metal reheat	Fabricating, machinery and equipment, iron and steel	75%	65%
Calcining	Alumina	N/A	65%
Digestion	Alumina	330%	80%
LNG power generation	LNG	100%	36%
Cooking	Commercial, residential	85%	20%
Hot water	Commercial, residential	95-350%	85%
Space heating	Commercial, residential	300-400%	80%

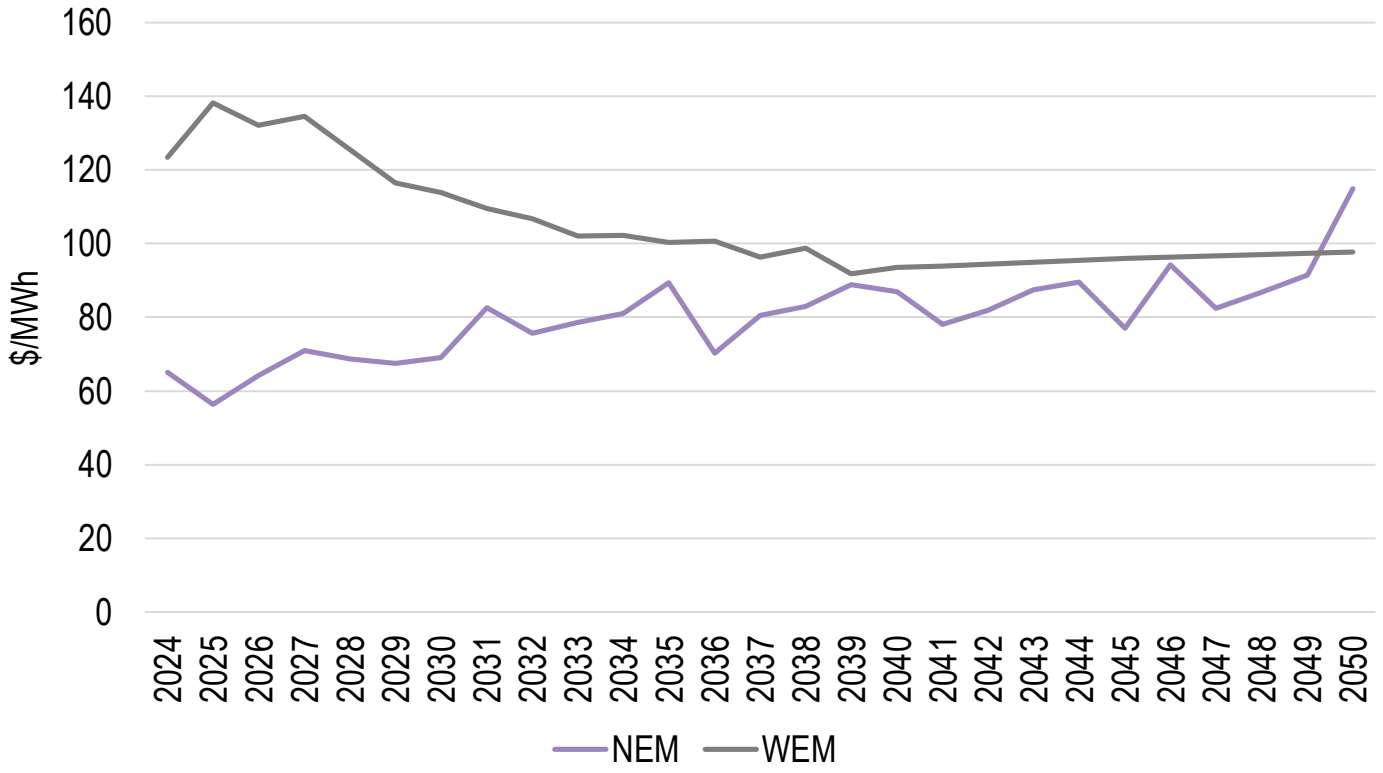
Wholesale natural gas costs

Source	ACIL Allen GasMark modelling
Notes	Costs reflect the change in resource costs due to a change in demand, not market prices ECGM = East coast gas market WCGM = West coast gas market



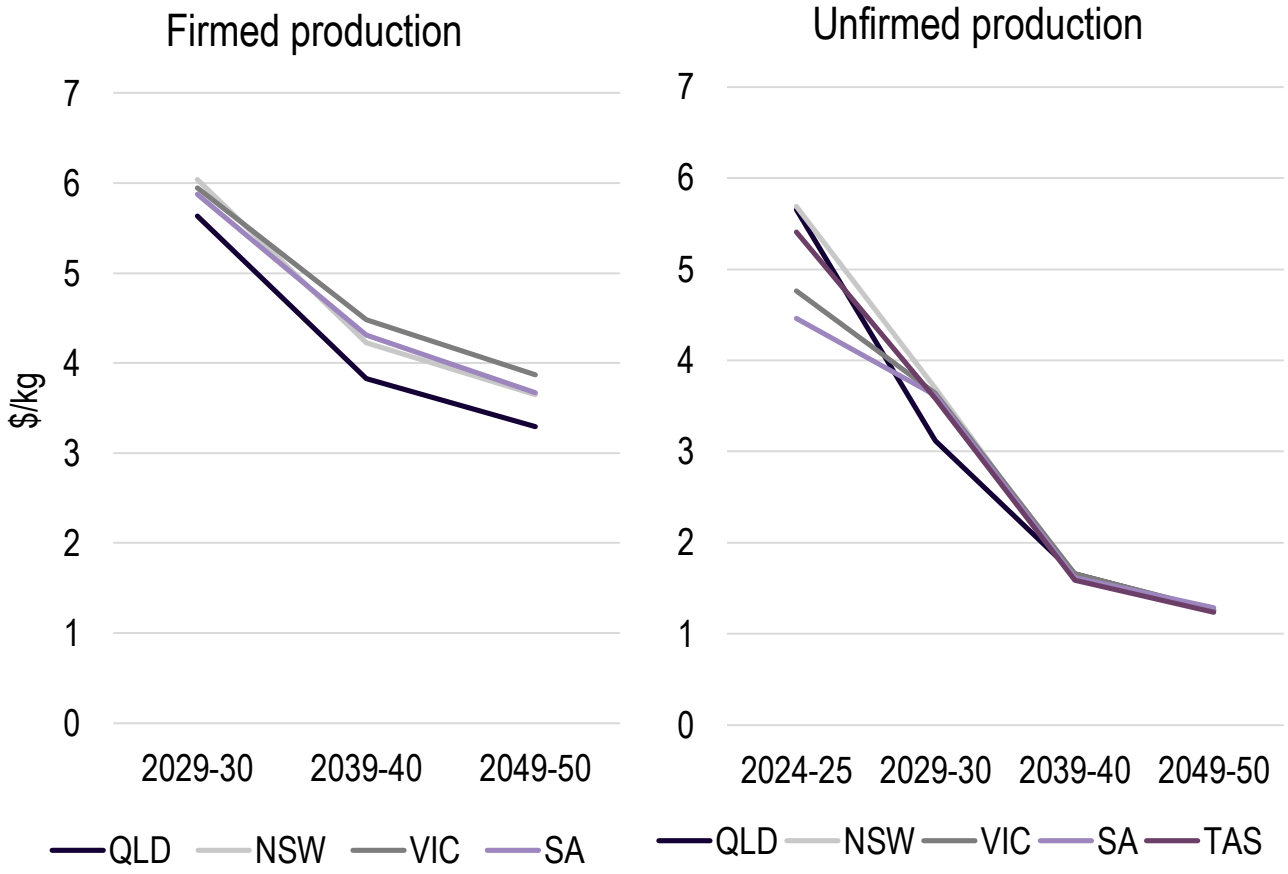
Wholesale electricity costs

Source	ACIL Allen PLEXOS modelling
Notes	Costs reflect the change in resource costs due to a change in demand, not market prices NEM = National Electricity Market WEM = Wholesale Electricity Market (WA)



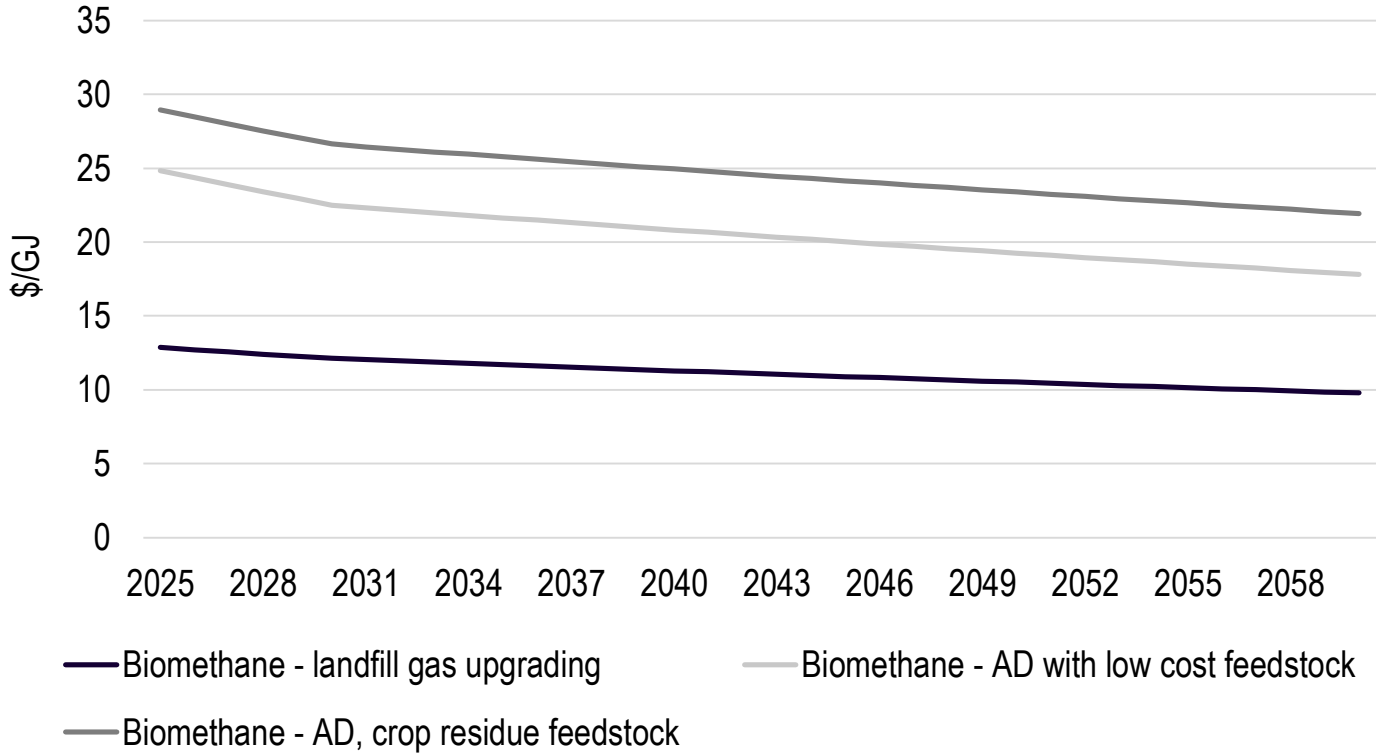
Wholesale hydrogen costs

Source	ACIL Allen modelling using various sources: - AEMO ISP - CSIRO GenGost - APGA pipeline costs - PowerMark modelling
Notes	Firmed costs include pipeline delivery to nearest demand centre Unfirmed hydrogen can only be used when blended into natural gas streams in limited quantities



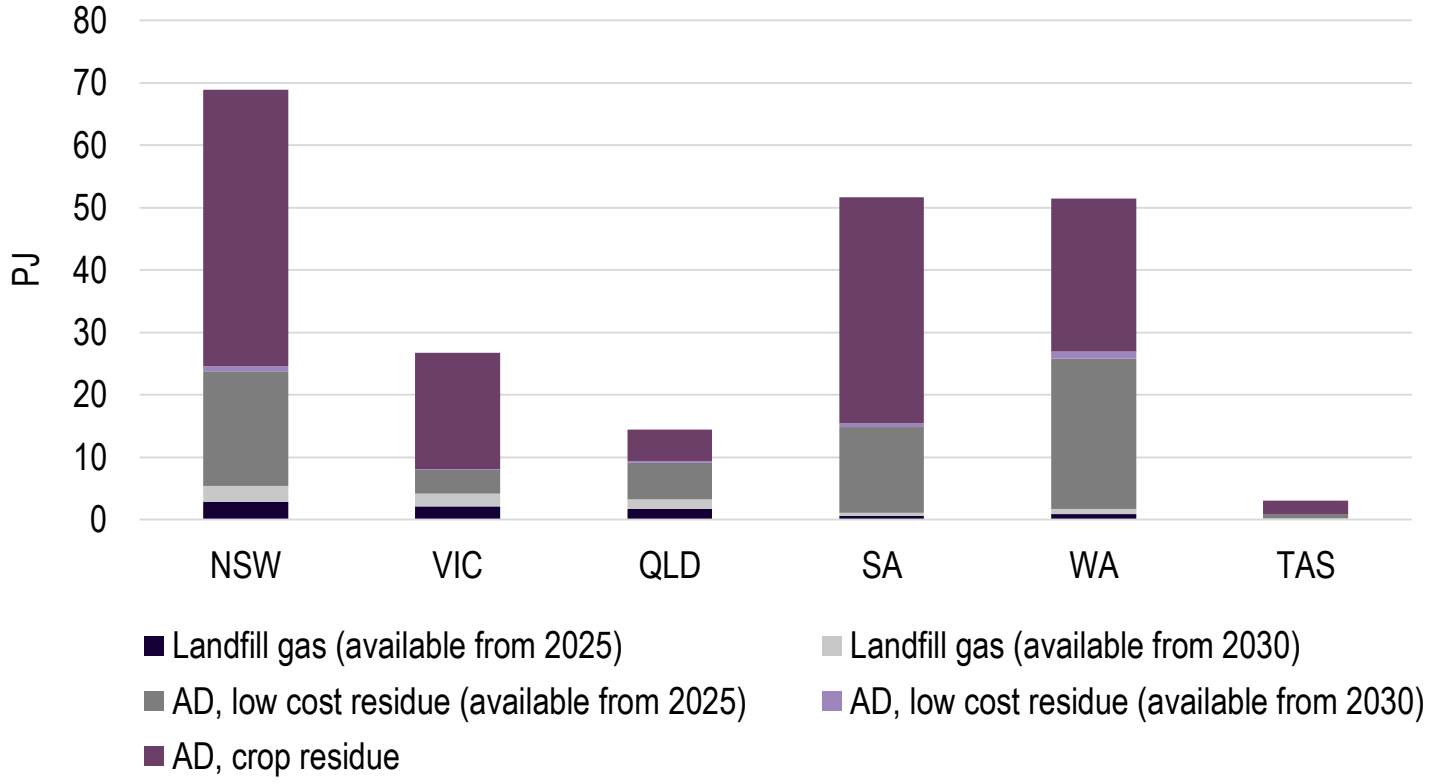
Biomethane costs

Source	Bioenergy Roadmap (Deloitte & Enea)
Notes	Low cost feedstock is available from concentrated waste streams such as wastewater or food processing. AD = anaerobic digestion



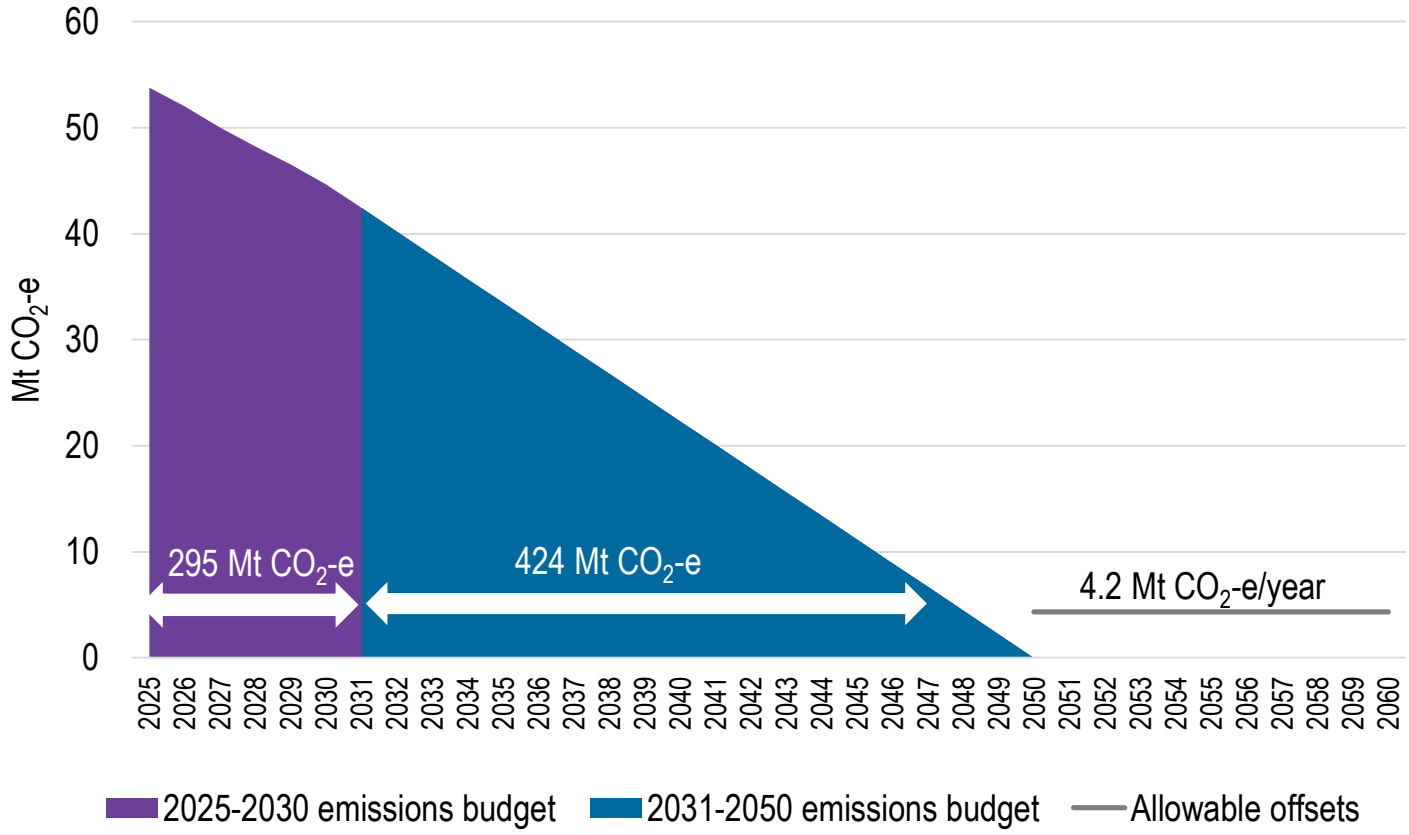
Biomethane volumes

Source	Bioenergy Roadmap (Deloitte & Enea)
Notes	Some sources are not made available to the model prior to 2030 due to assumed committed use under the Large-scale Renewable Energy Target (e.g. for electricity generation from biogas) AD = anaerobic digestion

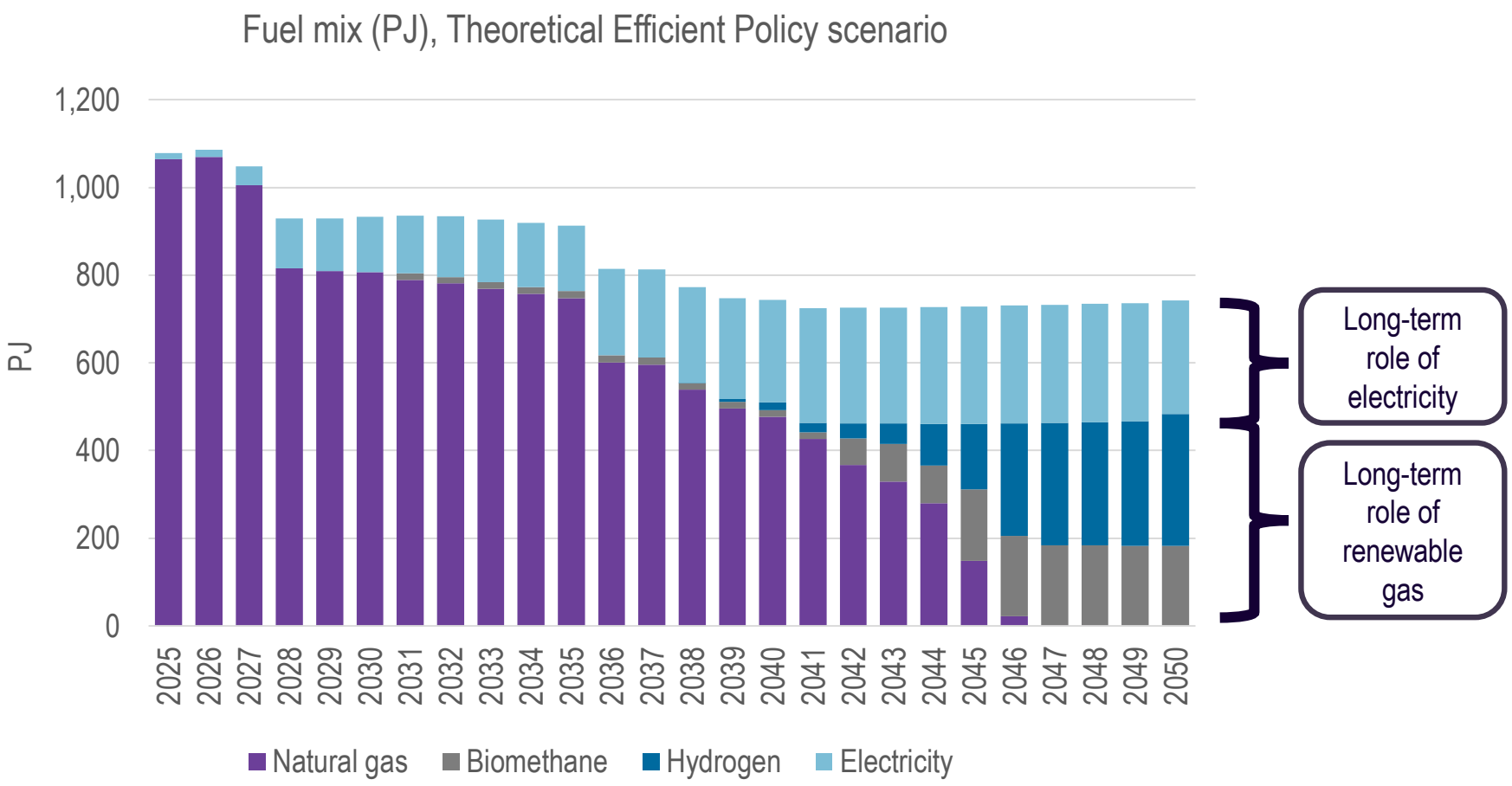


Carbon budget

Source	ACIL Allen assumptions based on Australian Government emissions projections and Safeguard Mechanism Statement of Reasons
Notes	Straight-line extrapolation from 2030 emissions levels to net zero in 2050



Theoretical Efficient Policy scenario

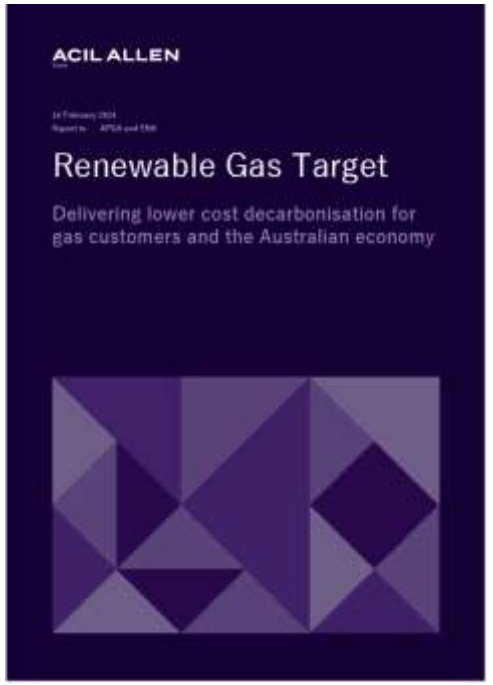


- Renewable gas provides about two-thirds of the long-term energy delivered to today's gas users, in our core scenario
- Electricity provides the remaining third
- Both hydrogen and biomethane play a role in this transition

POLICY INSIGHT
Renewable gas and electrification work together to decarbonise gas-using sectors

Key take aways

- The modelling shows a significant role for renewable gas in decarbonising today's gas-using sectors
  - This finding is robust to sensitivity analysis, though there is significant uncertainty over the timing and scale of renewable gas development
  - The modelled pathways also ignore real world factors such as the need to develop skills and build confidence in emerging industries such as renewable gas, and so delay development later than what is likely to be desirable
- At the sectoral level, the household sector has a range of plausible decarbonisation pathways, while the industrial sector has a number of hard-to-electrify activities and renewable gas is likely to be essential
- A more heavily electrification-focused approach will have higher overall costs, indicating the need for policy to strike a balance between electrification and renewable gas, and empower users to choose the decarbonisation option that best suits their needs
- A Renewable Gas Target is an efficient policy to develop renewable gas and decarbonise gas-using sectors



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