2030 Emission Reduction Opportunities for Gas Networks

Final report

Prepared for: Energy Networks Australia

enea CONSULTING

2030 Emission Reduction Opportunities for Gas Networks

Gas infrastructure emissions

Australia's gas infrastructure delivers **~1,100 PJ** of gas for domestic use and accounts for ~**61.5 MT CO_2-e p.a.** of the country's total emissions:

- The emissions within direct control of gas infrastructure businesses are the Scope 1 and 2 emissions that include operational and fugitive emissions. This accounts for 4 per cent of the total emissions.
- Emissions from end-use applications[1] (Scope 3) make up 96 per cent of emissions from domestic gas use. These are areas where gas infrastructure businesses can enable emission reductions. Examples of this include gas use for heating, power generation and industry.

Transition to Net Zero

Australia has committed to net zero emissions by 2050, which requires the decarbonisation of domestic gas use in Australia. This can be supported through the uptake of renewable gases and the reduction of operational and fugitive emissions.

2030 emission reduction opportunities

Emissions across the domestic gas industry can be **reduced by between 16% to 50% by 2030** depending on the level of policy support, across all emissions types:

- While gas infrastructure owners have direct control over their Scope 1 and 2 emissions, they can only enable scope 3 emissions reductions as these are dependent on gas producers and customers choosing to transition to renewable gases.
- Depending on the speed and impact of policy support, emissions from domestic gas use could be reduced by **16% to 50% by 2030**.
- Gas infrastructure owners are ready to support gas use decarbonisation by reducing their **Scope 1 and 2 emissions by 30% to 50% by 2030** where supportive policy levers are provided.

The domestic gas industry is a driving force for decarbonising Australia. Infrastructure operators are ready to cut their own Scope 1 & 2 emissions drastically and many are technically ready to accommodate renewable gases. With the right government initiatives and the involvement of the full gas value chain, greater emissions reductions can be enabled whilst sustaining domestic gas demand – which remains a critical resource for sectors and use cases that cannot be easily electrified.

Notes: [1] For completeness, domestic-use-related emissions of gas production are estimated to a be further 12.3 MTCO2-e p.a. This report focuses on gas infrastructure emissions and emissions linked to the downstream use of gas.

Sources: [1] Gas infrastructure stakeholder interviews, [2] IEEFA "*European Gas Pipeline Companies Emissions Hiding in Plain Sight*" (December 2020) and Enea analysis.

2030 Emission Reduction Opportunities for Gas Networks

Combining various levers to reduce emissions

To decarbonise the use of gas, the domestic gas industry must **combine a range of emissions reduction levers**:

- Reducing fugitive and operational emissions is the main avenue for the industry to reduce its Scope 1 and 2 emissions.
- Decarbonisation levers impacting Scope 3 emissions include enabling renewable gases use (i.e. biomethane, blended hydrogen, pure hydrogen and renewable methane), as well as increasing end-use energy efficiency.
- Relevant external factors impacting decarbonisation efforts include the availability of renewable gas production and the economic and regulatory environments in which gas companies operate.
- Scope 3 emissions reduction levers also reduce operational and fugitive emissions in turn.

Policy support from governments

To unlock the decarbonisation potential of the gas industry, **public policies can leverage multiple avenues:**

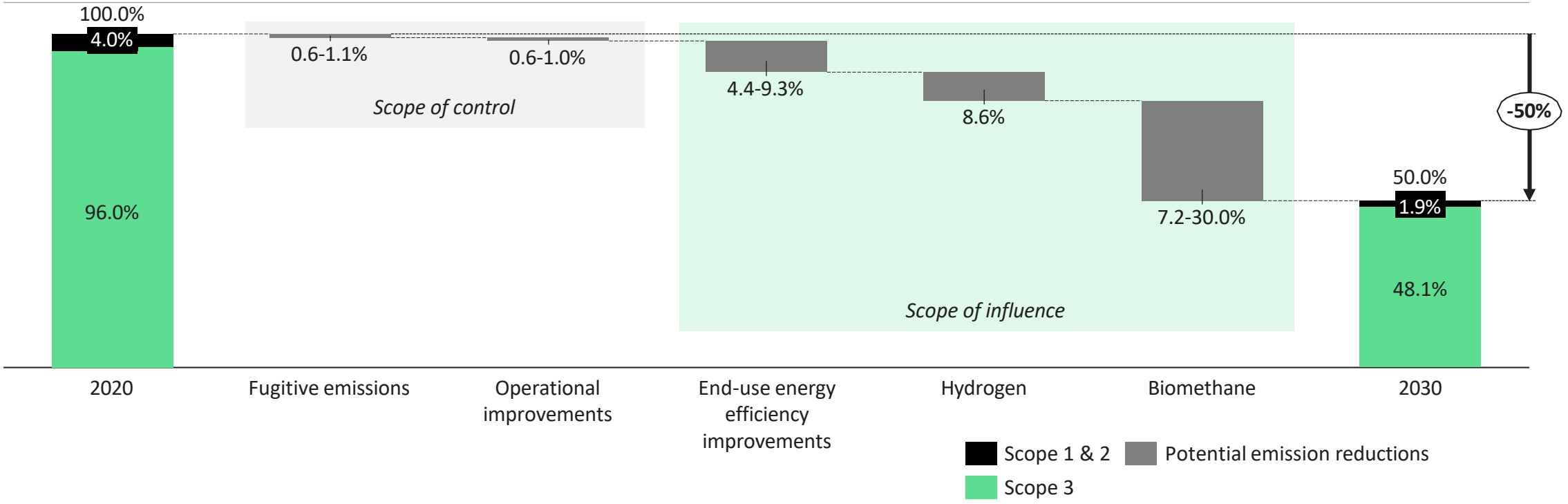
- Establishing **renewable gas targets** would drive the development of renewable gases, as has been the case with renewable electricity through the Renewable Energy Target.
- To reduce the size of the gas use decarbonisation challenge, policies supporting the uptake of more efficient electric appliances should also be adapted to support the uptake of more efficient, renewable gas ready appliances.
- Creating the right investment signals to incentivise operational and fugitive emission reduction for gas infrastructure, including the removal of regulatory barriers that currently inhibit fugitive emissions reduction activities in some regulated gas infrastructure.
- Public authorities need to enhance public awareness on the role of gas in Australia's energy transition.

Sources: Enea analysis

Moderate supportive policies can achieve a 16 to 30% reduction in emissions while stronger settings may achieve up to 50% reduction

Contribution to 2030 emission reduction opportunity[1] for each key lever for emission reduction[2]

Units: % of total emissions



Notes: [1] Baseline year standardised at 2020; despite some being reported for 2021 [2] Assumes no expansion in natural gas demand over the next decade

Sources: Stakeholder interviews and Enea analysis.

Contents

1

Context

Why identify 2030 emission reduction opportunities now?

Background

- National and state levels have set decarbonisation objectives for domestic energy supply, including ambitious 2030 emissions reduction targets
- Multiple roadmaps have been published to guide the development and integration of renewable gases to help the gas industry attain net zero objectives
- Examples include Gas Vision 2050, National Bioenergy Roadmap, National Hydrogen Strategy, and the Technology Investment Roadmap
- Considering the longer-term decarbonisation requirements, Energy Networks Australia and its members are eager to contribute to the design of the gas industry's decarbonisation pathway in the shorter-term to move Australia closer to a more economic decarbonisation pathway drawing on existing gas infrastructure[1]

Key objectives of the present document

- Taking stock of existing gas infrastructure emissions with focus on domestic gas use
- Identifying actions and levers applicable for Scope 1 & 2 and Scope 3 emissions to support domestic gas use decarbonisation
- Identifying emissions reduction opportunities for 2030
- Providing recommendations for government policy to help deliver emission reduction activities

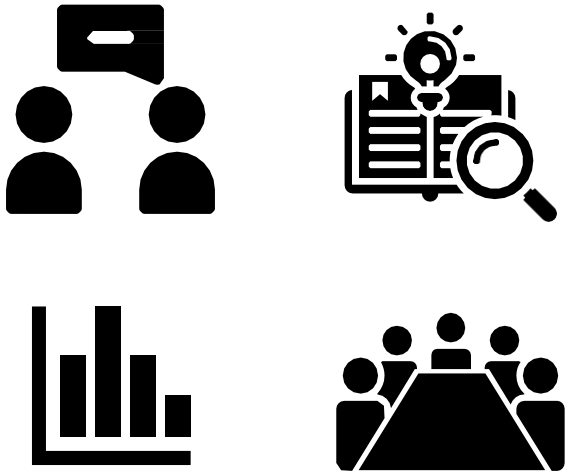
Note: [1] Based on Frontier Economics modelling in 2020, achieving net-zero in 2050 can be more cost-effective if leveraging renewable gas pathways, rather than through purely greater electrification.

High-level methodology overview of the project that led to this report

Ten gas network companies and one peak industry body

Energy Networks Australia

Stakeholder interviews, data collection, literature review and collaborative workshop



Identified opportunities

Strong policy settings

Technically and economically feasible for gas infrastructure, with strong political and regulatory support[1]

Moderate policy settings

Baseline reductions with moderate political and regulatory support[1]

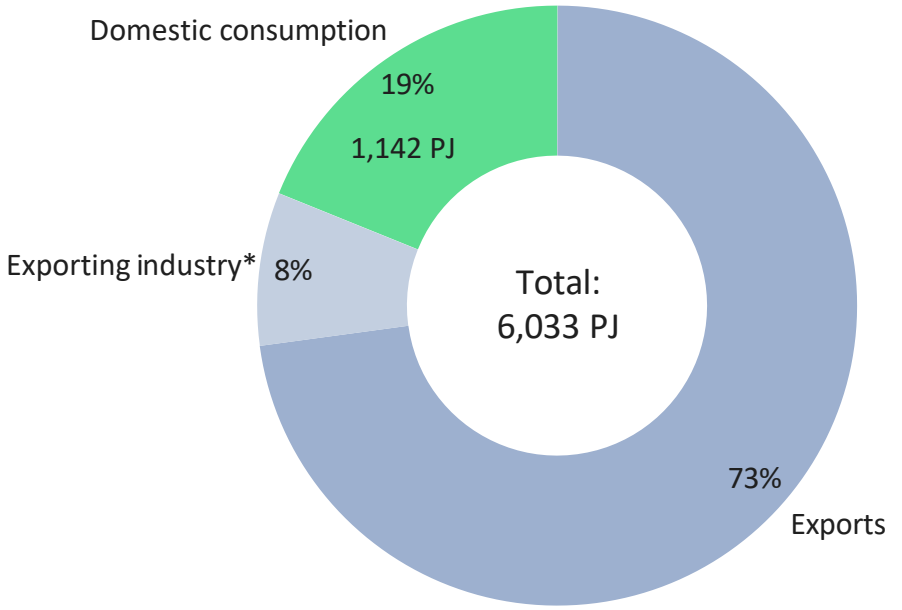
This project was completed with 10 stakeholders interviewed, data collected from 10 gas network companies, 30+ external reports reviewed, and 1 industry stakeholder workshop. Further work will be undertaken to delve into these estimates on emission reductions outlined in this study.

Note: [1] Key recommendations for political and regulatory support are given further in this document. Further work will be n eeded to quantify the impact of each of these policies on the reduction opportunities.

This report focuses on the reduction of emissions associated with domestic gas demand

Australian natural gas flows (2019 – 2020)

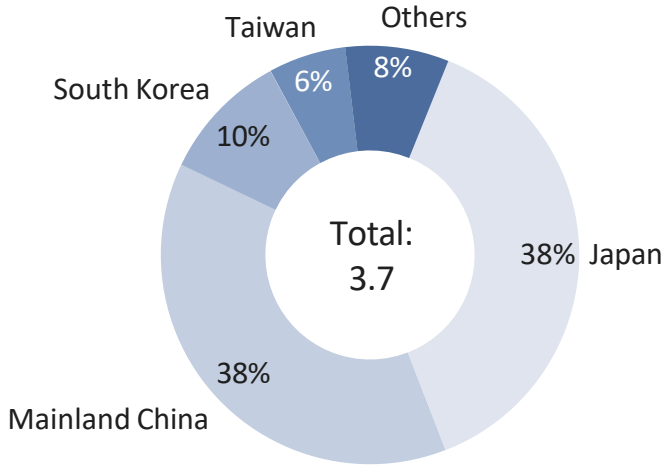
Units: PJ



- The report focuses on **decarbonisation of the domestic gas use (19% of Australia's natural gas flows)**
- However, nearly three quarters of natural gas flows from Australia are used for exports, some of which flow to geographies that can displace higher emitting options (e.g. coal-to-gas switch in Mainland China).
- And 8% of the natural gas is consumed by the exporting industry to allow for the gas exports

Australian LNG exports by destination (2020)

Units: Trillion Cubic Feet



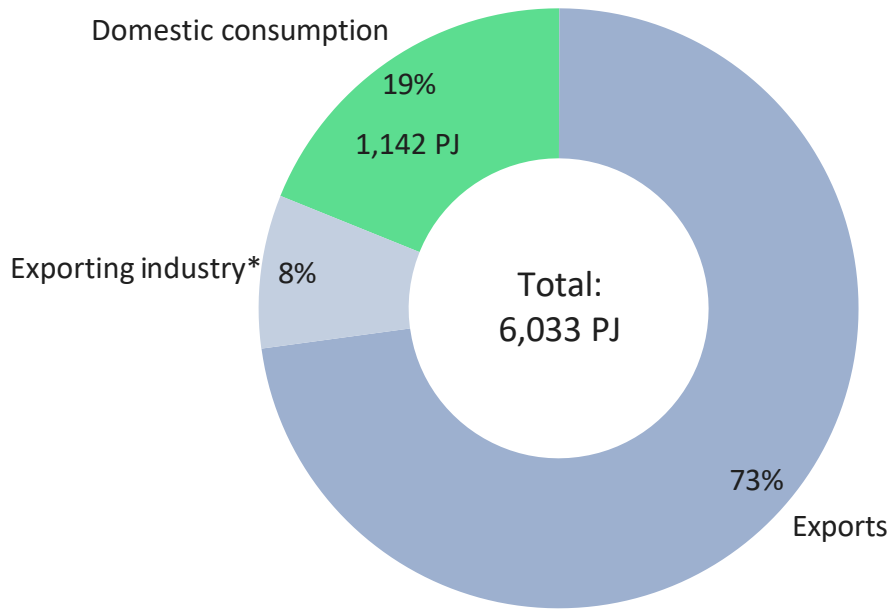
Sources: Department of Industry, Science, and Resources (2021) *Australian Energy Statistics, EIA* and Enea analysis.

Notes: [*] Exporting industry gas use refers to the natural gas used by the LNG plant operations including liquefaction process

Why does the study focus only on domestic gas use?

Australian natural gas flows (2019 – 2020)

Units: PJ



Focusing on domestic gas use

- This study focuses on emissions from domestic gas use, and as such excludes the natural gas use associated with the exporting industry as well as exports.
- The exporting industry (involving LNG plants) **would be on its own decarbonisation journey**
- The exporting industry emission reductions would support **international decarbonisation** efforts of the end-markets

Decarbonisation starting with constant gas demand

- Conceptually, this study focuses on the evolution of the emissions intensity of gas – as such, it starts from a position of a constant gas demand. Gas demand in reality is likely to evolve, with several forces pulling in opposite directions, such as:
  - Electrification reducing the demand for gas
  - Coal or diesel to gas switch increasing the demand for gas, e.g. in the context of the Safeguard Mechanism
- Even if some levers discussed in this study may result in gas volume variation (energy efficiency, fugitive emissions, etc.), the focus here is on the relative reduction of emissions they can bring compared to 2020 emissions.

Safeguard Mechanism

This mechanism applies to facilities emitting more than 100,000 tonnes of carbon dioxide equivalent per year. The responsible emitter who has operational control of the facility must ensure the facility's net emissions do not exceed the baseline determined by the Regulator.

Further insights:
Natural gas remains key to reducing emissions today

Natural gas is still a reliable, affordable, scalable and significantly less emissive fuel replacement for coal and diesel

- Natural gas is a reliable, less emissive alternative for baseload power generation substituting coal or diesel. In the US, natural gas was responsible for 61% of cumulative power-sector CO_2 emissions reductions through changes in the fuel mix, particularly through displacing coal-fired generation[1]. The same is true in many developed countries.
- Coal emits at least 1.95 times more CO_2 while Diesel emits at least 1.4 times more CO_2 than natural gas[2] for the equivalent amount of heat generated. For a significant number of thermal energy applications and requirements, natural gas is a widely available alternative fuel to produce heat in-situ for industries.

By ensuring sufficient controllable power, natural gas enables greater integration of variable renewable energy (VRE) such as solar and wind.

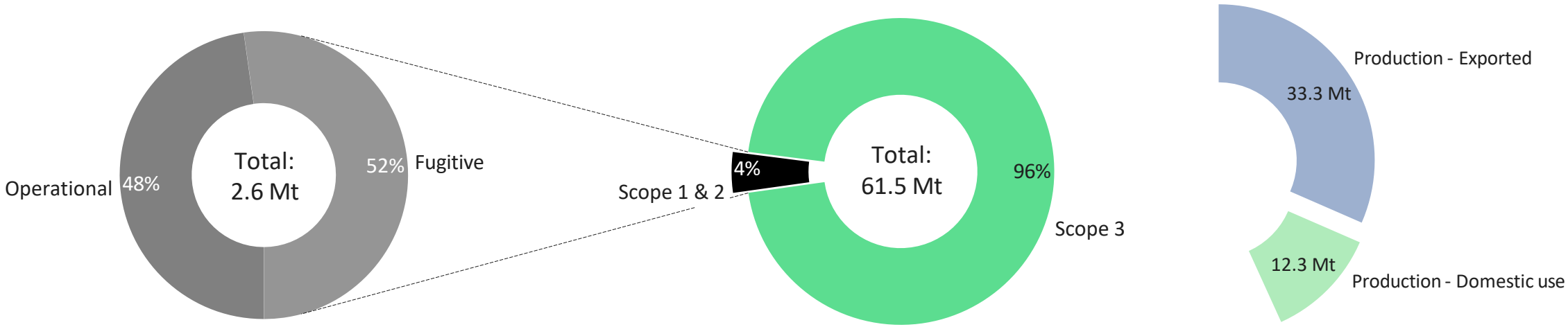
- Combined-cycle gas turbine and other gas peaker plants help maintain the reliability and robustness of the electrical system as the uptake of intermittent source of power increases.
- This is especially critical during periods of low solar and wind output (renewable resource droughts). Typically, VRE will have to be oversized and combined with energy storage to overcome such droughts.
- Previous modelling[3] suggests the presence of gas power generation (GPG) significantly reduces the investment required to enable high VRE penetration. The results suggest that the optimal system cost is achieved with 7% GPG to 93% VRE.

[1] API (2021): Eight Points – Natural Gas, Reducing Emissions and Environment [2] EIA (2021) Carbon Emission Coefficients [3] Frontier Economics (2021): Potential for Gas-Powered Generation to support renewables

~96% of Australia's gas infrastructure emissions are primarily driven by downstream scope 3 (end-gas use)

Australian domestic gas industry emissions

Units: Mt CO_2e (2020)[4]



Scope 1 and 2 emissions of gas infrastructure[1] are comprised of operational (venting, flaring, compressor use and heating) as well as fugitive emissions.

Scope 3 emissions[2] are primarily driven by the end use of gas in Australia. Examples of end use applications include power generation and industrial heating.

Scope 1 & 2 emissions of production are the responsibility of gas producers hence are not addressed in this report, which focuses on the decarbonisation of domestic gas use.

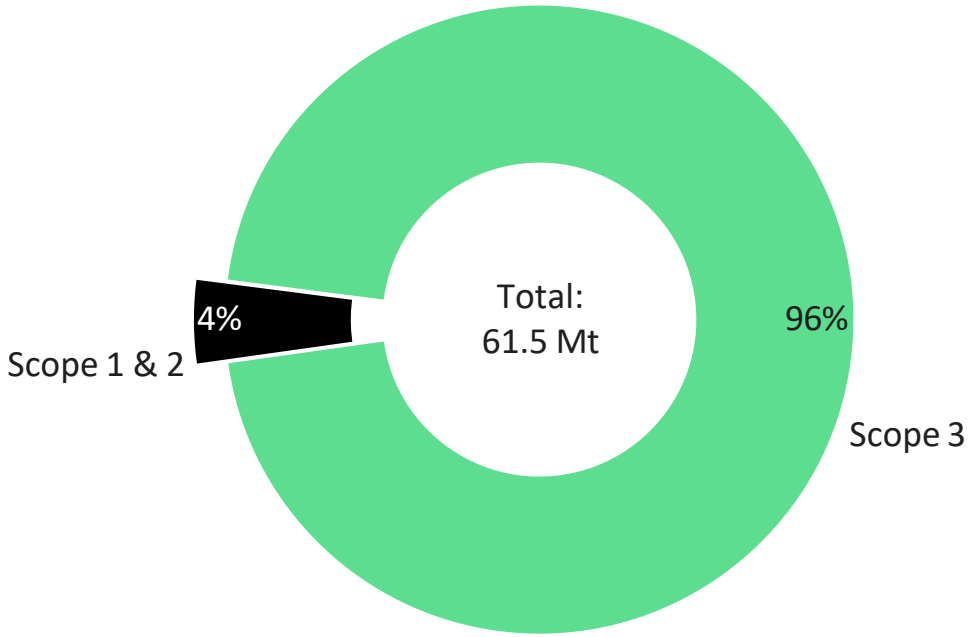
Notes: [1] Adjustments made for some stakeholders' scope 1 & 2 emission distribution amongst fugitive emissions and operational emissions (based on distribution for stakeholders that have provided data) [2] Scope 3 emissions for end gas use (sometimes called "extended scope 3" for network businesses) estimated based on total gas use in Australia without LNG facilities (1142 PJ p.a.) and applying an emission factor (51.56 kg/GJ) = 58.9 Mt CO_2e [3] Scope 3 emissions related to upstream not considered [4] 4 stakeholders reported their data for 2021 rather than 2020; their emissions were assumed to be for 2020 instead without adjustments

Sources: Stakeholder interviews, IEEFA "*European Gas Pipeline Companies Emissions Hiding in Plain Sight*" (December 2020) and Enea analysis.

Domestic gas use decarbonisation involves both the gas industry and domestic end-users

Australian domestic gas industry emissions

Units: Mt CO_2e (2020)



Reducing emissions from gas infrastructure (Scope 1 & 2 for the gas industry)

- These emissions are within the industry's scope of control, hence direct actions can be taken by the industry to reduce these emissions.
- Gas infrastructure owners have identified levers to reduce these emissions, both fugitive and operational emissions
- Support from policy measures will accelerate and further enable the uptake of these actions.
- Scope 1 & 2 emissions reduction is explored further in Section 2

Decarbonising domestic end-use of gas (Scope 3 for the gas industry)

- Consumption of gas does not have to be emissions-intensive. Indeed, there are opportunities to reduce emissions via energy efficiency efforts and through the uptake of renewable gas such as hydrogen or biogas.
- Further policy settings are needed to activate these opportunities.
- Scope 3 emissions reduction is explored further in Section 3.

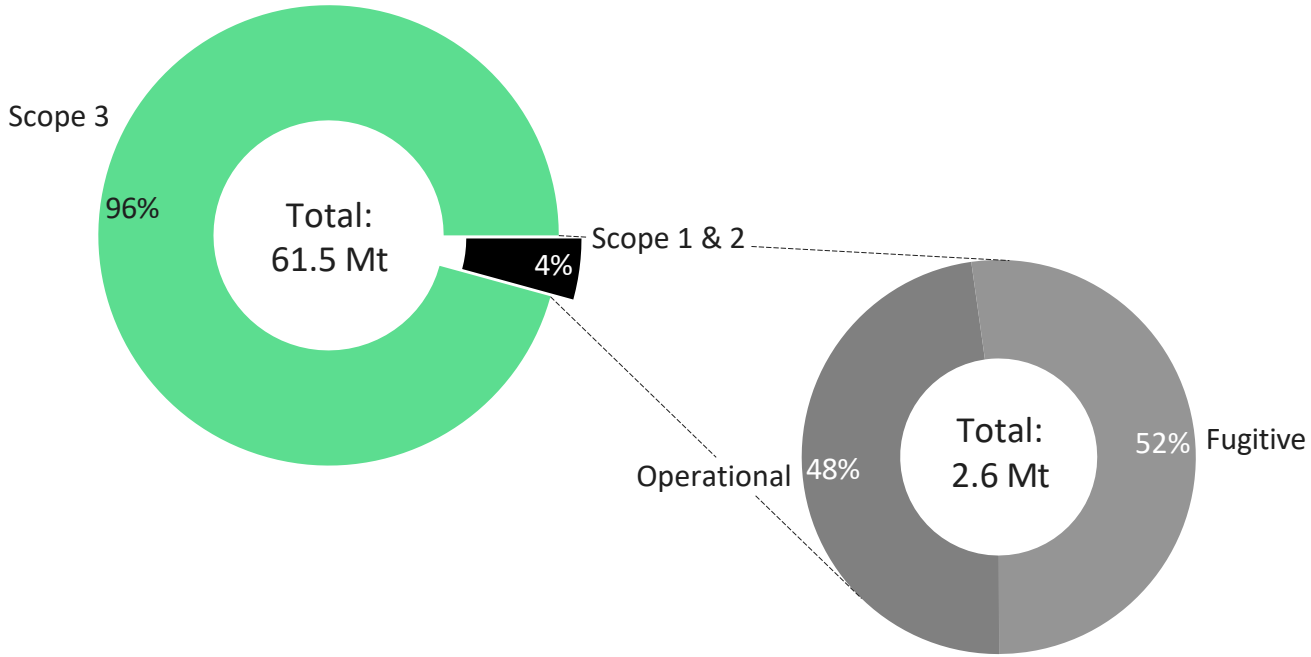
2

Reducing emissions from gas infrastructure

Emissions from gas infrastructure can be managed through direct action levers by the industry

Australian domestic gas infrastructure emissions

Units: Mt CO_2e (2020)



For the gas infrastructure industry, Scope 1 and 2 emissions of 2.6 Mt CO_2e are comprised of:

***Operational emissions**: Typically, emissions from venting, flaring, combustion for energy, heat and energy used to perform other infrastructure functions*

***Fugitive emissions**: Emissions resulting from leakages and other irregular releases of gases or vapors*

Reducing fugitive emissions requires greater alignment of network operators' incentives with decarbonisation objectives

Emission reduction levers		Policy priority of industry stakeholders[3]	Impact
Understanding fugitive emissions across assets	• Improving UAFG[1] accounting by replacing estimated factors data from UAFG studies and/or in-depth asset metering (e.g., pressure compensated meters) to enable targeted actions of certain regions and assets • Completing and monitoring inventories of pneumatics using natural gas • Improving data quality on losses to allow better targeted replacement programmes through global best practice fugitive measurement (e.g. OGMP 2.0[2])	• Allowing regulated gas infrastructure to recover costs of fugitive emission reduction initiatives (currently prevented) • Providing regulatory incentives for gas infrastructure operators to minimise gas leakages and reduce fugitive emissions • Expand Emissions Reduction Fund methodologies to include venting or fugitive emissions avoidance (currently only flaring of vented gas is covered)	Fugitive emissions can be reduced by 29–50%, translating to reduction of **15–26% in Scope 1 & 2 emissions** depending on level of policy support
Preventing fugitive emissions across assets	• Routine preventative maintenance and repair programs (including fugitive emission reduction benefits) • Implementation of best practice compressor seal gas recovery systems and electric or instrument air / nitrogen operated valve actuators • Work closely with other (non-gas) utilities (e.g. preventing high pressure jets from water delivery pipes causing damage to natural gas pipes) • Use of vent-avoidance technologies such as mobile flares or reinjection equipment • Implementing mains replacement program		
Responding to fugitive emissions	• Targeted leak detection field surveys accompanied by repair programs • Use of advanced detection capability including drones and satellite imagery • Use of metering data to swiftly identify and repair leaks		

Notes: [1] UAFG - Unaccounted for gas [2] OGMP 2.0 - Oil and Gas Methane Partnership (OGMP) 2.0 Framework [3] A comprehensive list of policy recommendations collected in stakeholder interviews is available in section 4 of this report

Sources: Stakeholder interviews and Enea analysis.

Reducing operational emissions involves energy efficiency improvements in operations

Emission reduction levers		Policy priority of industry stakeholders[1]	Impact
Reducing direct emissions from gas pipeline infrastructure	• Uptake of renewable energy use in generators, compressors, heaters, and other forms of fossil energy use, including the conversion of equipment to use renewable gas or electricity. • Reducing venting through plant upgrades allowing flaring or gas capture • Reducing flaring through plant upgrades and operational changes (e.g. safety changes) • Using low grade heat sources to heat up gas during transmission and distribution • Fine tuning heater operations (let-down heaters)	• Allowing regulated gas infrastructure to recover costs of operational emission reduction initiatives • Safeguard Mechanism amendment to recognise zero Scope 1 emissions from renewable gas use • Transition to zero carbon fleet vehicles requires Government support for broader model availability and refueling/recharging infrastructure	Operational emissions can be reduced by 32–50%, translating to reduction of **15–24% in Scope 1 & 2 emissions** depending on level of policy support
Reducing other operational emissions	• Purchase of renewable gas for fuel gas applications • Purchase of renewable electricity to power equipment (Scope 2) • Converting to a low carbon transportation fleet (e.g. hydrogen or electric)		

Note: [1]] A comprehensive list of policy recommendations collected in stakeholder interviews is available in section 4 of this report

Sources: Stakeholder interviews and Enea analysis.

Through supportive policies and identified actions, Scope 1 & 2 emissions can be reduced by 30 to 50%

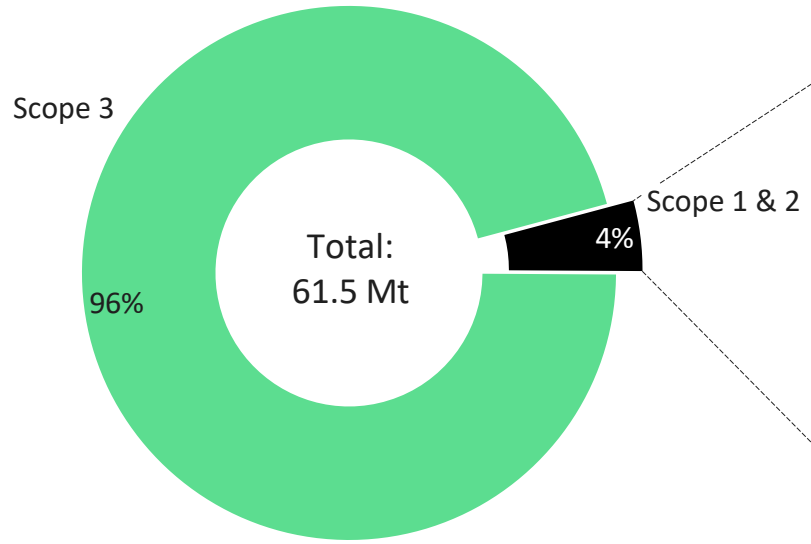
Decarbonisation lever	Emission reduction opportunities with moderate supportive policies		Emission reduction opportunities with strong supportive policies	
	Overall reduction (Scope 1 & 2)	*By lever*	*Overall reduction (Scope 1 & 2)*	*By lever*
Fugitive emission reductions	**30 – 40%**	15 – 20%	**45 – 50%**	23 – 26%
Operational emission reductions		15 – 20%		21 – 24%

Notes: Reductions compared to 2020 baseline. Due to rounding, sums may differ by +/-1%.
Source: (1) Stakeholder interviews, (2) Enea analysis

Strong supportive policies and actions can enable a 50% reduction in Scope 1 & 2 emissions

Australian domestic gas industry emissions

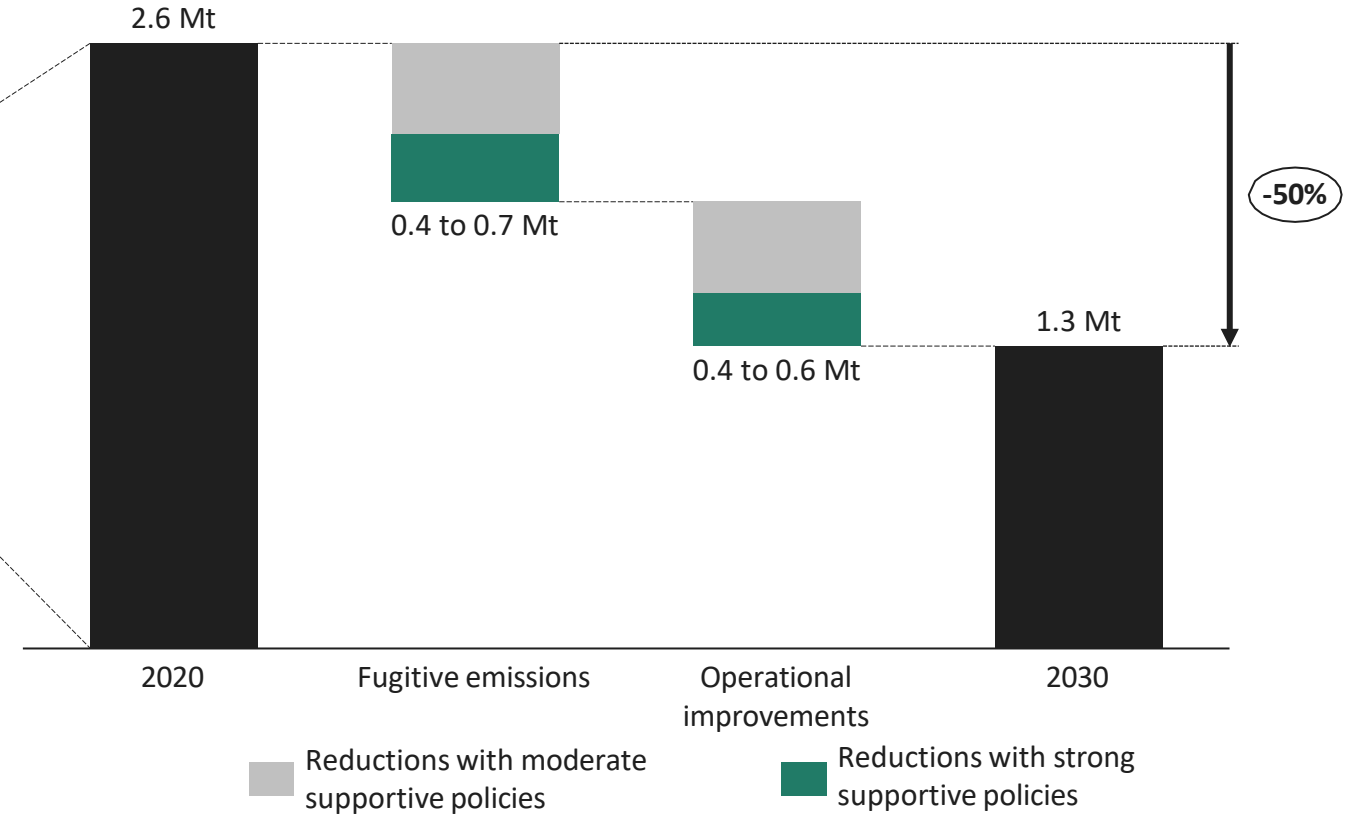
Units: Mt CO_2e (2020)



Scope 1 & 2 emissions for gas infrastructure are directly in the control of the infrastructure owners

Contribution to 2030 emission reduction opportunity (scope 1 & 2 – T&D)

Units: Mt CO_2e (2020)



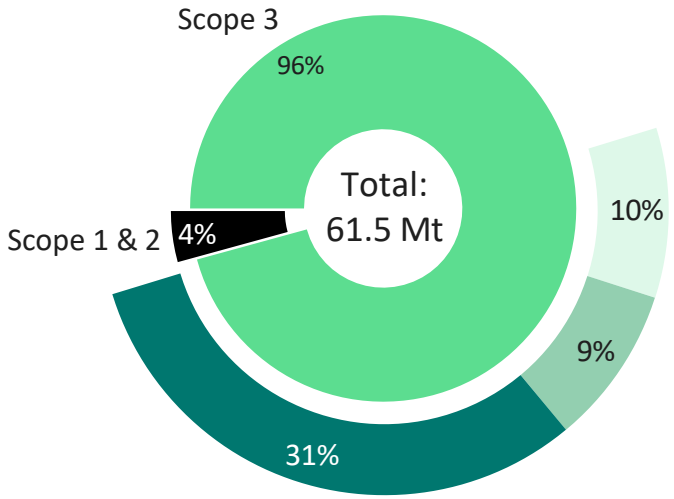
3

Decarbonising domestic end-use of gas

Decarbonising domestic end-use of gas

Australian domestic gas infrastructure emissions and reduction opportunities

Units: Mt CO_2e (2020)



Scope 3 emission-reduction levers and potential reductions with strong supportive policies

Energy efficiency improvements | Hydrogen | Bio- & Syn- Methane

Pathways to decarbonise domestic gas use

- Efficiency improvements for gas appliances
  - Improving efficiency of end-use equipment can result in 5–10% emission reductions
  - 5% is deemed achievable with wider adoption of technologies already available for decades
  - Raising this to 10% will require **more aggressive adoption of the technologies via stronger policy settings**
- Hydrogen
  - The use of hydrogen into pipelines can lead to a 3–9% reduction in emissions
  - It is assumed that a 3% reduction would be based on a widespread blend of hydrogen of 10% by volume, which is a commonly accepted limit for existing infrastructure and end-use equipment
  - Raising this to 9% emission reduction would require a **combination of further blending (up to 20% by volume, as is the reference in other geographies) and use of pure hydrogen**
- Biomethane and synthetic methane uptake
  - Replacing natural gas with biomethane can result in 8–31% reduction in emissions
  - 8% reduction would represent a fraction (~98 PJ) of the available biomethane potential (~500PJ of potential), consistent with the estimate for pipeline gas from the Targeted Deployment scenario of Australia's Bioenergy Roadmap (~105 PJ).
  - Raising this to 31% (~408 PJ) would require a **significantly greater uptake of biomethane across Australia via stronger policy settings**

Notes: Details on the emission reductions in the coming slides

Source: (1) Stakeholder interviews and (2) Enea Analysis

Increasing energy efficiency of end-use applications can provide up to 9% emission reductions

Emission reduction levers		Policy priority of industry stakeholders[2]	Impact
Participating in industry development to boost the uptake of new appliances and end use energy efficiency	• Raising minimum gas appliance efficiency to 6-Star efficiency rating could reduce total domestic gas use emissions by 2%-5% by 2030 based on typical appliance end of life replacement rates alone • Incentivising higher appliance replacement rates through implementation of cashback offers, much the same as higher efficiency electrical appliances are incentivised today • Engaging in industry development studies, panels and groups (e.g. Future Fuels CRC) • Collaborating with domestic appliance and industrial equipment manufacturers to accelerate the transition towards next generation hydrogen / high efficiency appliances and industrial equipment • Collaborations within manufacturing industry to improve equipment maintenance, enhance operational optimisation, smart process redesign and replace old equipment with more efficient versions	• Minimum gas appliance efficiency limits should be raised to 6-Star gas appliance minimum • Rebates and loans should be made available to households to enable the uptake of more highly efficient hydrogen compatible gas appliances at every decision point (construction, replacement, end of life) • Provide incentives to support improvements to building insulation (thereby reducing heating/cooling needs)	Increasing energy efficiency of end-use applications can contribution to the gas industry's overall Scope 3 emissions reduction by **5–10%**[1] depending on level of policy support

Notes: [1] According to stakeholder workshop, a shift from 3 star to 6 star appliance can improve energy efficiency by 15-17%. Based on AGA's gas appliance star ratings, a 6-star water heater is 24% more efficient than 3-star, we have used the more conservative benchmark of 15-17% efficiency improvement in our modelling. This aspirational opportunity takes into account this unit improvement in gas consumption when upgrading equipment. [2] A comprehensive list of policy recommendations collected in stakeholder interviews is available in section 5 of this report

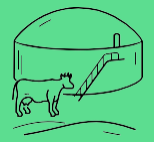
Sources: Stakeholder interviews and Enea analysis.

Enabling pure hydrogen and hydrogen blending will drive up to 9% emission reductions in Scope 3

Emission reduction levers		Policy priority of industry stakeholders[2]	Impact
Actively developing hydrogen projects	• Developing both hydrogen blending and injection projects / actively engaging with hydrogen project proponents • Developing hydrogen refuelling infrastructure projects (active downstream involvement)	• A blending target for hydrogen (by volume) in gas networks can help increase demand and further decarbonisation efforts. • Support the development of hydrogen infrastructure to address cost barriers associated with injecting hydrogen in gas networks. • Support co-optimisation between gas and electricity infrastructure to deliver lowest cost energy products to consumers.	Enabling pure hydrogen and hydrogen blending can contribute to the gas industry's overall Scope 3 emissions reduction by **3–9%**[1] depending on level of policy support
Understanding and upgrading infrastructure capabilities	• Studying maximum limits of hydrogen on current assets to ensure safe operation is maintained with hydrogen introduction • Upgrading assets to increase hydrogen compatibility through replacement (e.g. cast iron to plastic) where required • Exploring and building 100% hydrogen networks in certain areas		
Active industry development and participation	• Bolstering public opinion on hydrogen in the community (e.g. hydrogen homes) • Industry development by engaging in studies to explore higher hydrogen blends at all uses of the value chain (e.g. Future Fuels CRC membership)		

Notes: : [1] The upper end opportunity of 9.7% is broken down into 6.7% hydrogen blending by energy or 20% hydrogen blending by volume. The remainder of 9.7% hydrogen opportunity is made up of 3% of pure hydrogen networks (by energy) across the industry. [2] A comprehensive list of policy recommendations collected in stakeholder interviews is available in section 5 of this report
Sources: Stakeholder interviews and Enea analysis.

Enabling biomethane and renewable methane production can provide up to 31% emission reductions

Emission reduction levers		Policy priority of industry stakeholders[1]	Impact
 **Developing biomethane projects and customers**	• Actively developing biomethane projects and/or being a partner for biomethane projects. Some members are focusing on projects where long term feedstock supply can be guaranteed (e.g. WWTP or landfills) • Engaging with project proponents and entering into trials • Developing customers to generate biomethane demand • Gas infrastructure operators enabling biomethane connections through the development of industry guidelines and addressing existing barriers	• Introduction of Renewable Gas Targets inclusive of Bio- and Renewable Methane • Support industry in sourcing more biomethane & renewable methane supply sources to help with scale-up • Enact biomethane feed-in tariff or certification system • ERF methodology for biomethane in feedstock and anaerobic digestion should be expanded	Enabling biomethane and renewable methane production can contribute to the gas industry's overall Scope 3 emissions reduction of **8–31%** depending on level of policy support
 **Renewable methane actions taken by industry are currently limited**	• Further investigation into technoeconomic of renewable synthetic methane compared to customers transitions to 100% hydrogen • Actively developing renewable methane projects and/or being a partner for renewable methane projects.		

Notes: [1] A comprehensive list of policy recommendations collected in stakeholder interviews is available in section 5 of this report

Sources: Stakeholder interviews and Enea analysis.

Through supportive policies and identified actions, Scope 3 emissions can be reduced by 15 to 50%

Decarbonisation lever	Emission reduction opportunities with moderate supportive policies		Emission reduction opportunities with strong supportive policies	
	Overall reduction (Scope 3)	*By lever*	*Overall reduction (Scope 3)*	*By lever*
Increased end-use energy efficiency	**15 – 30%**	5 – 6%	**40 – 50%**	7 – 10%[3]
Hydrogen		3 – 6%		7 – 9%[1]
Biomethane (+synthetic methane)		8 – 18%		25 – 31%[2]

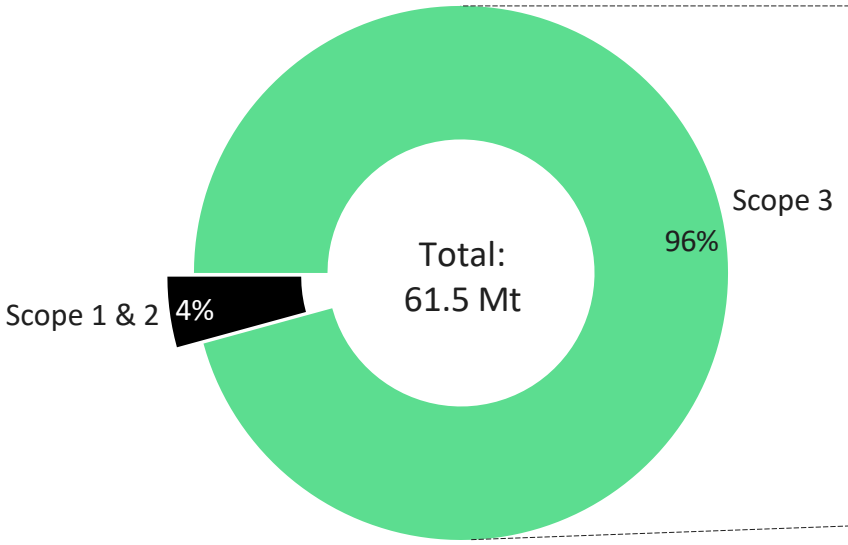
Notes: Reductions compared to 2020 baseline. Due to rounding, sums may differ by +/-1%. [1] This opportunity is broken down into 6.7% blending by energy or 20% blending by volume. The remainder of 9% hydrogen opportunity is made up of 3% of pure hydrogen networks (by energy) across the industry beyond a 20% hydrogen blending (by volume). [2] Australia's current biomethane potential of ~500PJ; this reduction would require close to 80% of the current potential [3] Based on AGA's gas appliance star ratings, a 6-star water heater is 24% more efficient than 3-star, we have used the more conservative benchmark of 15% efficiency improvement in our modelling. Assuming normal replacement cycle and up to 150% faster replacement, we expect reduction of 10–25% for residential sector over 2022–2030 (15% of total gas use). Manufacturing Gas Efficiency guide by CEFC expects at least 25% gas-use reductions from 2018 levels through equipment replacement, better maintenance and efficient process designs; we model a 10-20% efficiency improvement for manufacturing industry (29% of total gas use) over the same period.

Source: (1) Stakeholder interviews, (2) Enea analysis

Strong supportive policies and actions can enable Scope 3 emissions reductions of up to 50%

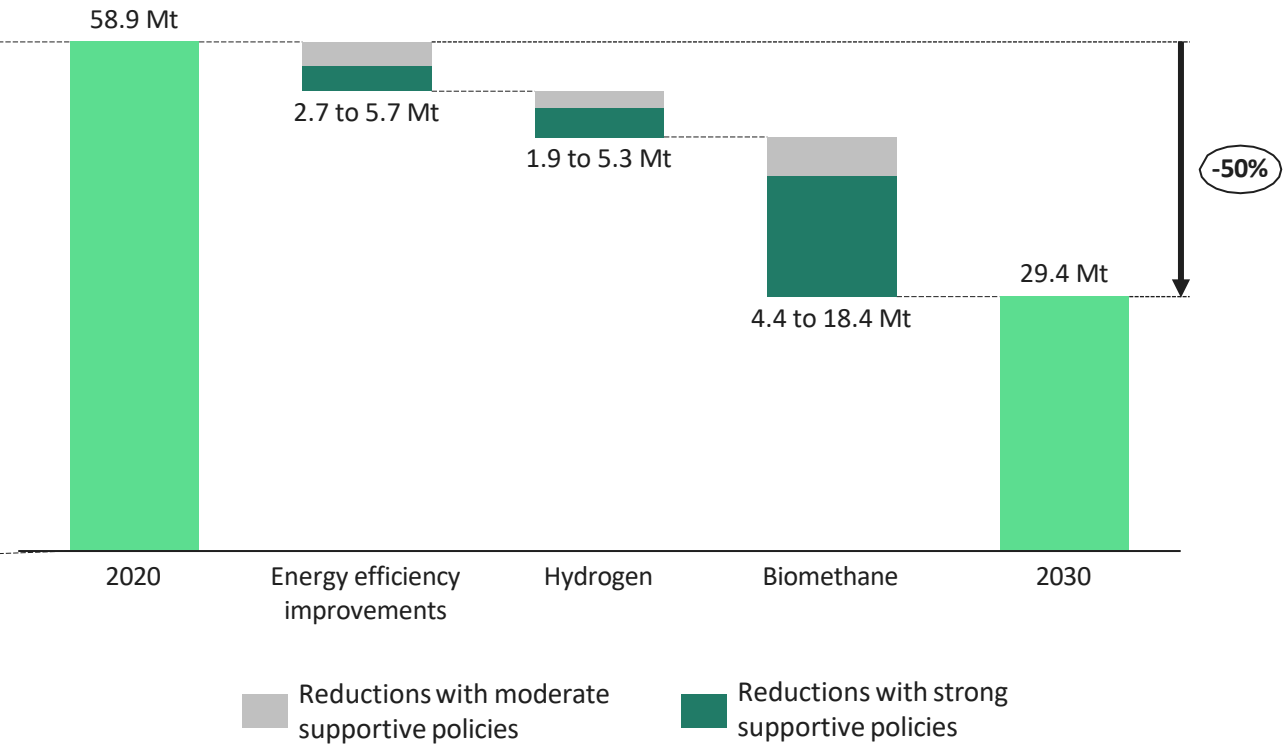
Australian domestic gas industry emissions

Units: Mt CO_2e (2020)



Contribution to 2030 emission reduction opportunity (Scope 3)

Units: Mt CO_2e (2020)



Scope 3 emissions reductions are enabled but not controlled by gas infrastructure owners; government policy would play a large part to drive renewable gas uptake.

4

Aggregated emission reduction opportunities for 2030

Supportive policy settings can enable between 16 to 50% emission reductions by 2030 from direct and indirect emissions sources from gas networks

Decarbonisation lever	Emission reduction opportunities with moderate supportive policies		Emission reduction opportunities with strong supportive policies	
	Overall reduction (all scopes)	*By lever*	*Overall reduction (all scopes)*	*By lever*
Fugitive emission reductions	**16 – 30%**	0.6 – 0.9%	**40 – 50%**	1.0 – 1.1%
Operational emission reductions		0.6 – 0.9%		0.9 – 1.0%
Increased end-use energy efficiency		4.4 – 5.6%		7.1 – 9.3%[3]
Hydrogen blending		3.1 – 5.3%		7.1 – 8.6%[1]
Biomethane (+synthetic methane)		7.2 – 17.4%		23.9 – 30.0%[2]

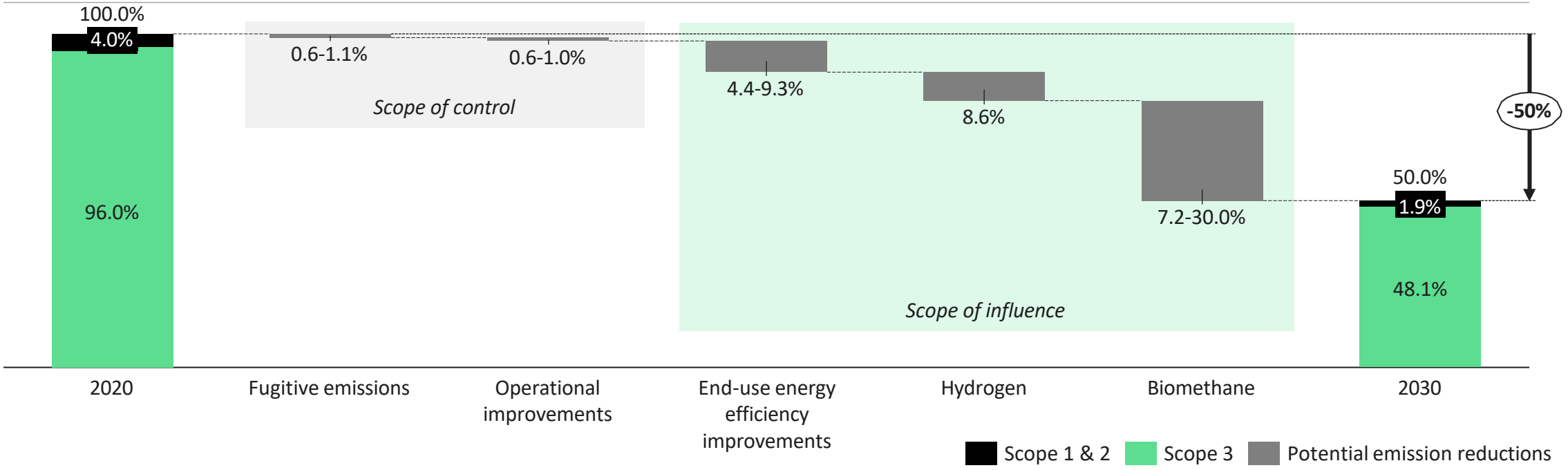
Notes: Reductions compared to 2020 baseline. Due to rounding, sums may differ by +/-1%. [1] This opportunity is broken down into 6.7% blending by energy or 20% blending by volume. The remainder of 9% hydrogen opportunity is made up of 3% of pure hydrogen networks (by energy) across the industry beyond a 20% hydrogen blending (by volume). [2] Current Australia's biomethane potential of ~500PJ; this reduction would require close to 80% of the current potential [3] Based on AGA's gas appliance star ratings, a 6-star water heater is 24% more efficient than 3-star, we have used the more conservative benchmark of 15% efficiency improvement in our modelling. Assuming normal replacement cycle and up to 150% faster replacement, we expect reduction of 10–25% for the residential sector over 2022–2030 (15% of total gas use). Manufacturing Gas Efficiency guide by CEFC expects at least 25% gas-use reductions from 2018 levels through equipment replacement, better maintenance and efficient process designs; we model a 10–20% efficiency improvement for manufacturing industry (29% of total gas use) over the same period.

Source: (1) Stakeholder interviews, (2) Enea analysis

Moderate supportive policies can achieve a 16 to 30% reduction in emissions while stronger settings may achieve up to 50% reduction

Contribution to 2030 emission reduction opportunity[1] for each key lever[2]

Units: %



Following uptake of hydrogen and bio- and synthetic methane in a scenario with strong policy support, ***we should expect the emission factor of the gas grid to fall from the current 51.56 kg/GJ to 31.49 kg/GJ[3] by 2030.***

Notes: [1] Baseline year standardised at 2020; despite some being reported for 2021 [2] Assumes no expansion in natural gas demand over the next decade

Sources: Stakeholder interviews and Enea analysis.

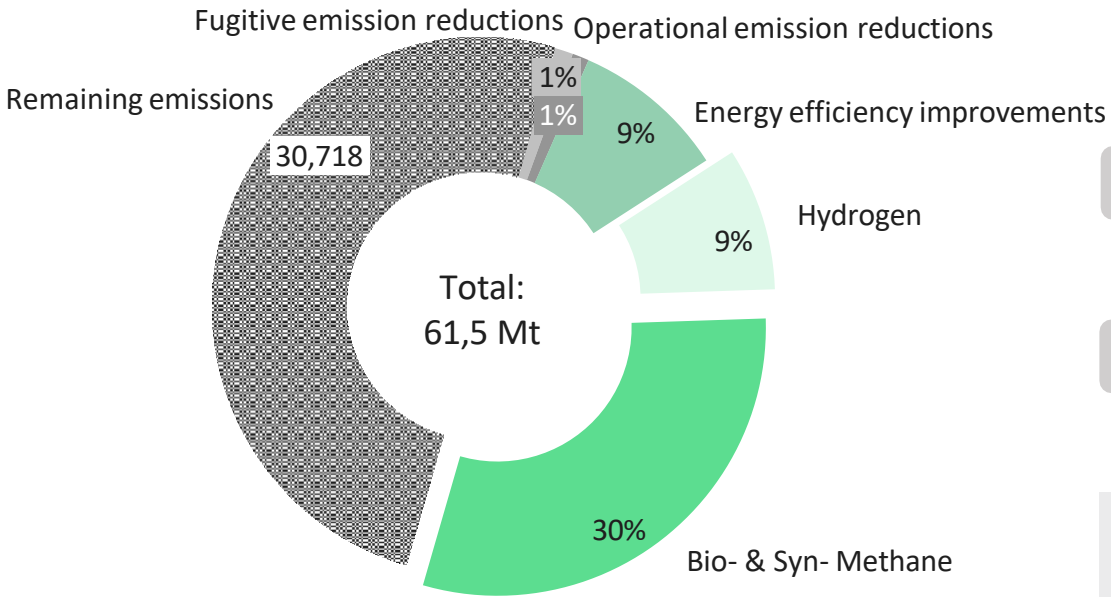
5

Recommendations for government policy

Most of the emission reductions opportunities will come from Scope 3, via a switch to renewable gases

2030 emission reductions opportunities by levers

Units: kt CO_2e (2020)



Key barriers to renewable gas transition remain:

1. No strong legal framework (e.g. targets, mandates, certificates) to drive industry action. Renewable gases are not recognised as a zero-carbon energy source in NGERS[1].
2. Public awareness is not high enough to provide sufficient scale in demand and adoption
3. The above barriers lead to a lack of business case for infrastructure investment to enable the transition

Policy recommendations for this report are thus prioritised based on how well they address these key barriers to renewable gas transition.

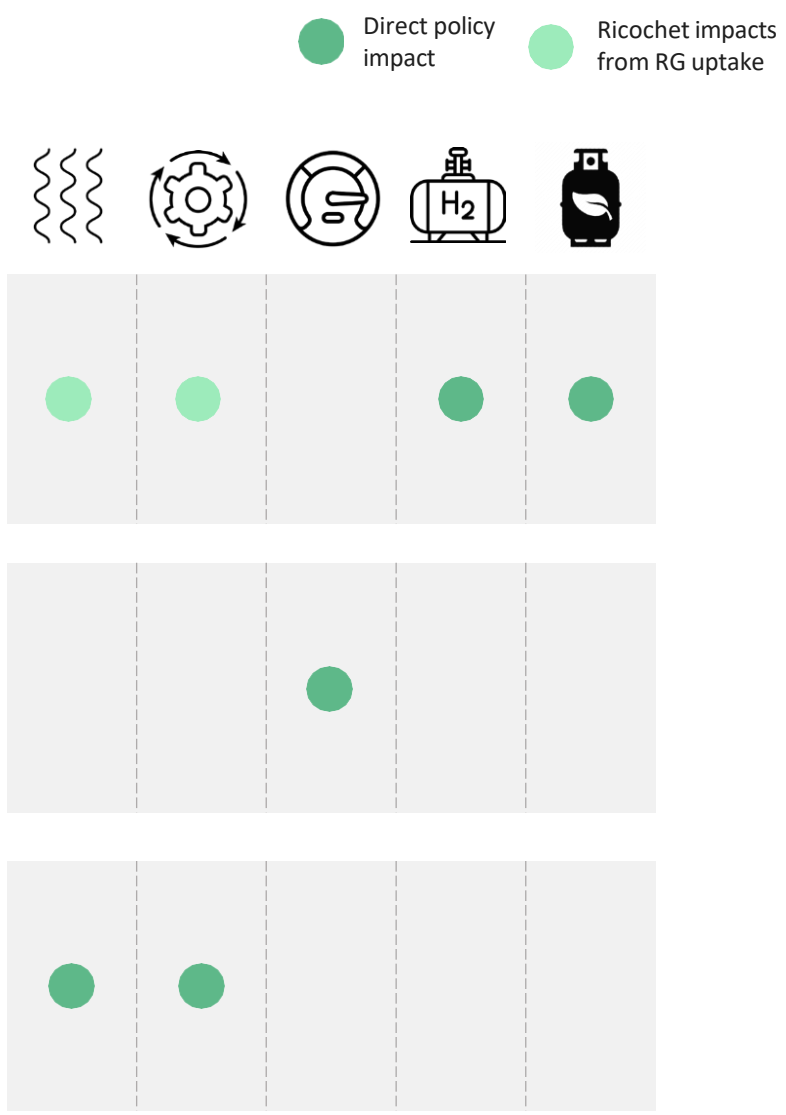
Note: [1] National Greenhouse and Energy Reporting Scheme (NGERS) by the Clean Energy Regulator (CER) of Australia

The gas industry has identified 3 key policies to unlock gas decarbonisation in Australia

Renewable Gas (RG) Target: A renewable gas target of at least 20% to 50% covering hydrogen, biomethane and renewable synthetic methane could support the Scope 3 emissions reduction potential identified within this report. Learning from the Renewable Energy Target, a certificate based mechanism with some level of guaranteed government certificate purchases may increase the likelihood of Renewable Gas Target success.

Increased Appliance Efficiency Mechanism: Combining a minimum 6-Star hydrogen ready appliance mandate with financial support for households to increase appliance replacement rates by 50% to 200% could deliver reduced gas use and reduced emissions for the same amenity while providing residential hydrogen readiness. The Victorian Energy Upgrades scheme, which is focused on enhanced electric appliance uptake, provides an example of how gas appliance replacement rates could be increased.

Allowing Infrastructure Emissions Reduction Cost Recovery: Changes to gas infrastructure regulation could allow regulated market carriage gas infrastructure to recover the cost of operational and fugitive emissions reduction. Under current regulation, market carriage infrastructure must demonstrate to the AER a zero or negative cost to customers to recover the cost of emission reduction, including fugitive emission reduction.

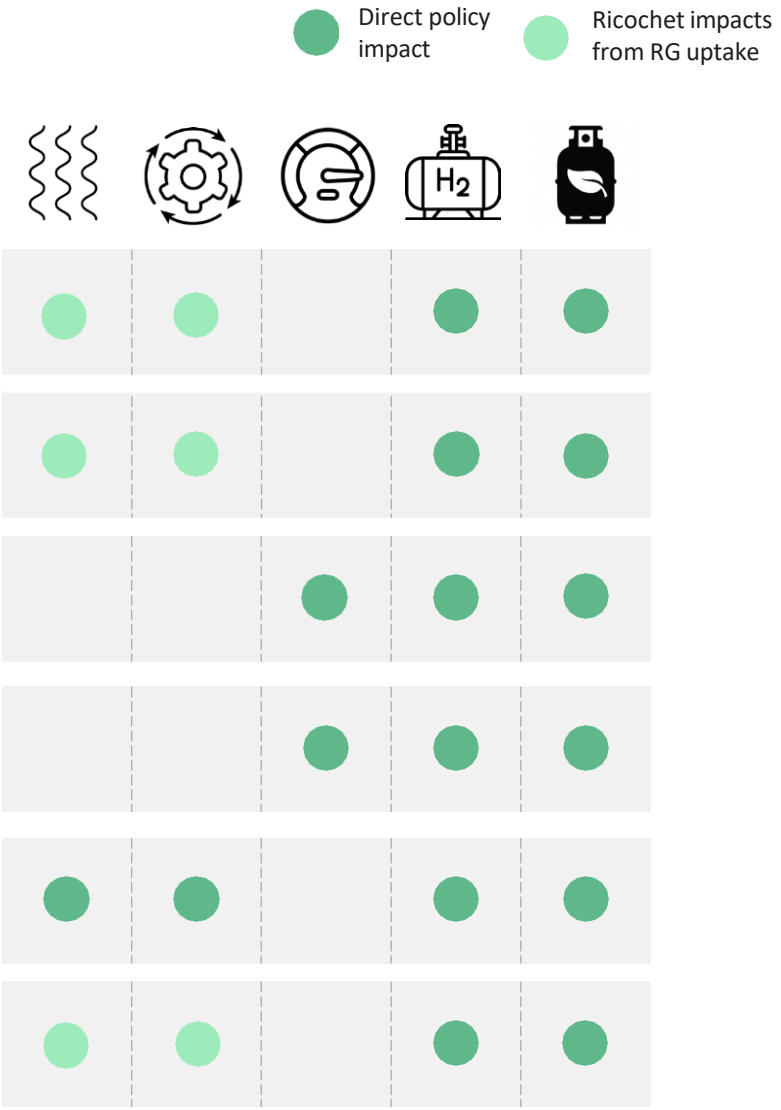


Fugitive emissions
Operational emissions
Energy efficiency
Hydrogen
Biomethane

Policy recommendations ordered based on their ability to address key barriers to RG transition

Note: Recommendations identified during gas infrastructure stakeholder interviews
Source: Stakeholder interviews, CSIRO, OECD

Longer list of supporting policy measures which could potentially deliver gas use emissions reduction (1 of 2)



Certificates and/or tariffs scheme: Establish a national certification scheme for renewable gases and renewable PPAs (Power Purchase Agreements). Link lowest cost producers with highest-value users across Australia. Or establish feed-in tariff system for renewable gases to improve investor certainty.

Accessibility of funding and grants: Provide funding to make transition to RG more affordable. Particularly important to subsidise hydrogen infrastructure to address cost barriers of injecting hydrogen in gas networks. Expand Emissions Reduction Fund criteria for biomethane in feedstock and anaerobic digestion.

Support for building insulation: Provide incentives (e.g. plot ratio or land intensification) for better insulation of buildings so as to contribute to reduced gas consumption for heating.

Building public awareness: Send clearer signals about the role of gas in the Australian energy transition, especially regarding industries that cannot easily electrify. Build wider public acceptance of pricing changes required to provide renewable energy alternatives.

Carbon prices and broader ACCU[1] accessibility: Allow gas network operators to generate ACCUs for more project types (not just gas venting prevention). Implement sufficiently high carbon pricing to effectively incentivise whole-of-industry action.

Clarity in national gas laws: Clarify who can own which assets and where, especially for hydrogen, to improve visibility for investment and divestment strategies. Update Australian standards for natural gas and stipulate clearly whether blended hydrogen is a renewable energy source.

Fugitive emissions | Operational emissions | Energy efficiency | Hydrogen | Biomethane

Policy recommendations ordered based on their ability to address key barriers to RG transition

Note: Recommendations identified during gas infrastructure stakeholder interviews; [1] Australia Carbon Credit Units (ACCUs)
Source: Stakeholder interviews, CSIRO, OECD

Longer list of supporting policy measures which could potentially deliver gas use emissions reduction (2 of 2)

Increasing supply sources for biomethane: Support industry in increasing biomethane supply sources to help with scaling up operation – some consider current opportunities as being too niche.

Enhancing collaboration with and across regulatory bodies: Ensure regulators work collaboratively to harmonise gas transition project implementation across states. Enable regulators (e.g. Energy Safe Victoria) to improve rules, specifications, and policies concerning green gas to foster its development.

Network regulatory incentives: Providing regulatory incentives for gas transmission network operators to minimise gas leakages and reduce fugitive emissions[1]

Co-optimisation: Support co-optimisation between gas and electricity infrastructure to deliver lowest cost energy products to consumers. The importance of electricity – gas system interfaces has been reinforced through recent electricity market challenges.

Support appliance swaps: Rebates and loans should be made available to households to enable the switch from less efficient appliances to hydrogen compatible appliances or more highly efficient gas appliances.

Fleet decarbonisation: Transition of company fleet vehicles to zero-emissions technologies such as hydrogen or electric vehicles must be supported as well through Government support in broadening model availability and expansion of refueling / charging networks.

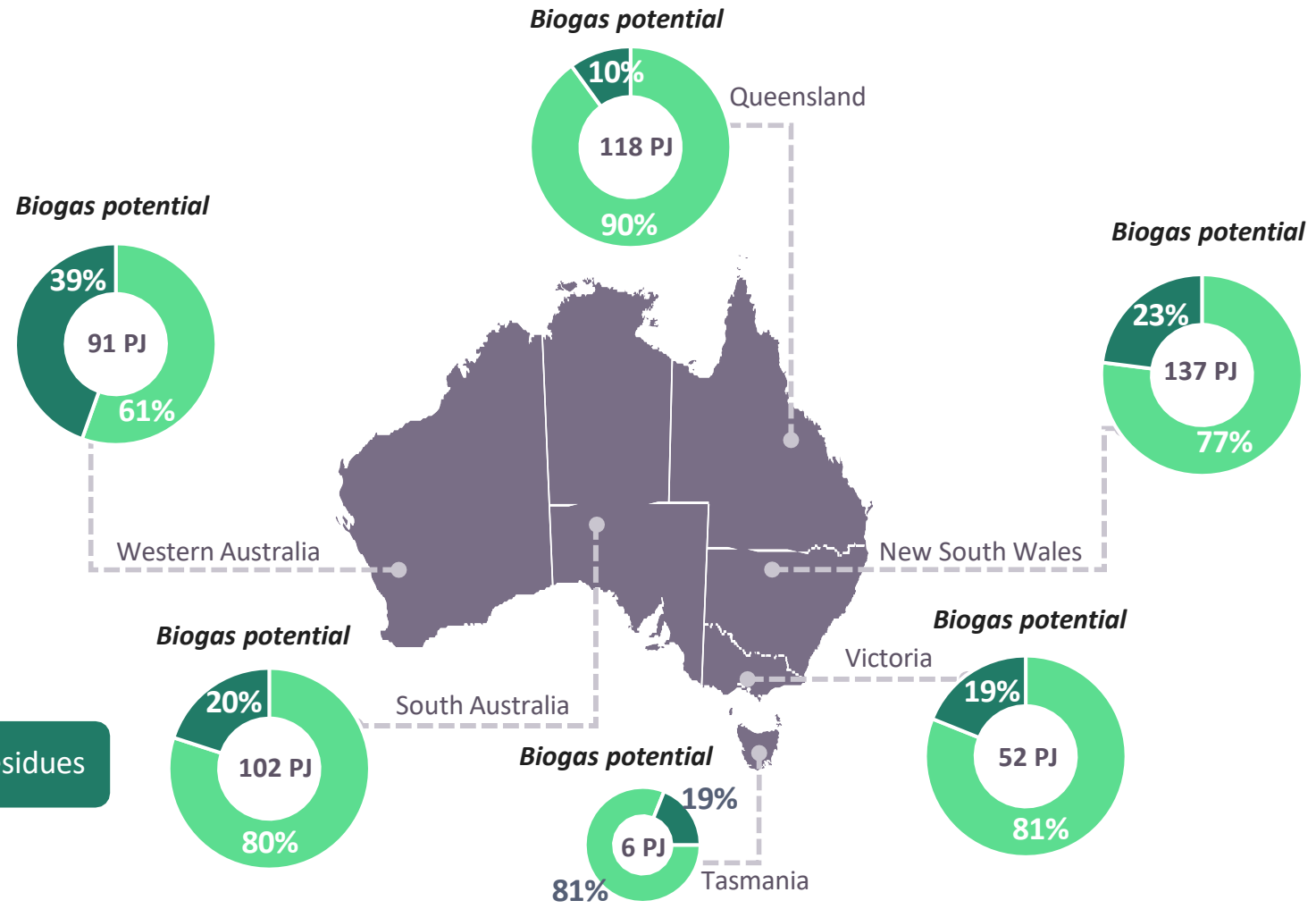
Notes: Recommendations identified during gas infrastructure stakeholder interviews; [1] The base price for transmission pipeilne contracts considers an allowance for the amount of fuel loss expected. There is limited incentives to stop leaks or make the pipe more energy efficient in this case

Source: Stakeholder interviews

6

Appendices

Australia's anaerobic digestion biogas technical potential is 506 PJ



Key:

Agriculture

Organic wastes & residues

For comparison, the 2019 – 2020 total domestic gas consumption was 1142 PJ.

Biomethane produced from upgraded biogas has the technical potential to cover 506 PJ.

However, there will be economic and logistic barriers in accessing feedstock.

Source: [1] Australia's National Bioenergy Roadmap [Enea 2022], and Enea analysis.

A snapshot of targets and achievements in key decarbonisation levers in other parts of the world

Hydrogen		UK gas grids to be able to accept 20% hydrogen blend from 2023 onwards
		French gas operators (GRTgaz, GRDF, Elengy) have proposed that the government should enact a 10% hydrogen blending target by 2030
		Portugal national hydrogen strategy (2020) targets 10 – 15% green hydrogen injection into gas networks
	avacon	Avacon (E.ON subsidiary) will progressively reach 20% hydrogen blend in its networks in Saxony-Anhalt (Germany) by 2023 (lab tests of end-use appliances indicate acceptance of up to 30% hydrogen blend)
Biomethane		Germany has a feed-in tariff for converting biomethane into electricity (via CHP) and quotas for vehicle fuels
	ENBRIDGE	Canadian utilities (e.g., Enbridge) are targeting 5% biomethane (RNG) in their networks by 2025 and 10% by 2030
		Injected biomethane reached 20% of natural gas consumption in Denmark (2020). The Danish Energy Agency estimates that by the end of 2022, biomethane will reach 25% of gas consumption
		Italian transmission system operators (TSOs) estimate up to 11% biomethane blend by 2030 and 18% by 2040
Fugitive emissions		Italian O&G supermajor Eni achieved 90% reduction in fugitive emissions between 2014 and 2020 (original target: 80% reduction vs. 2014 by 2025)

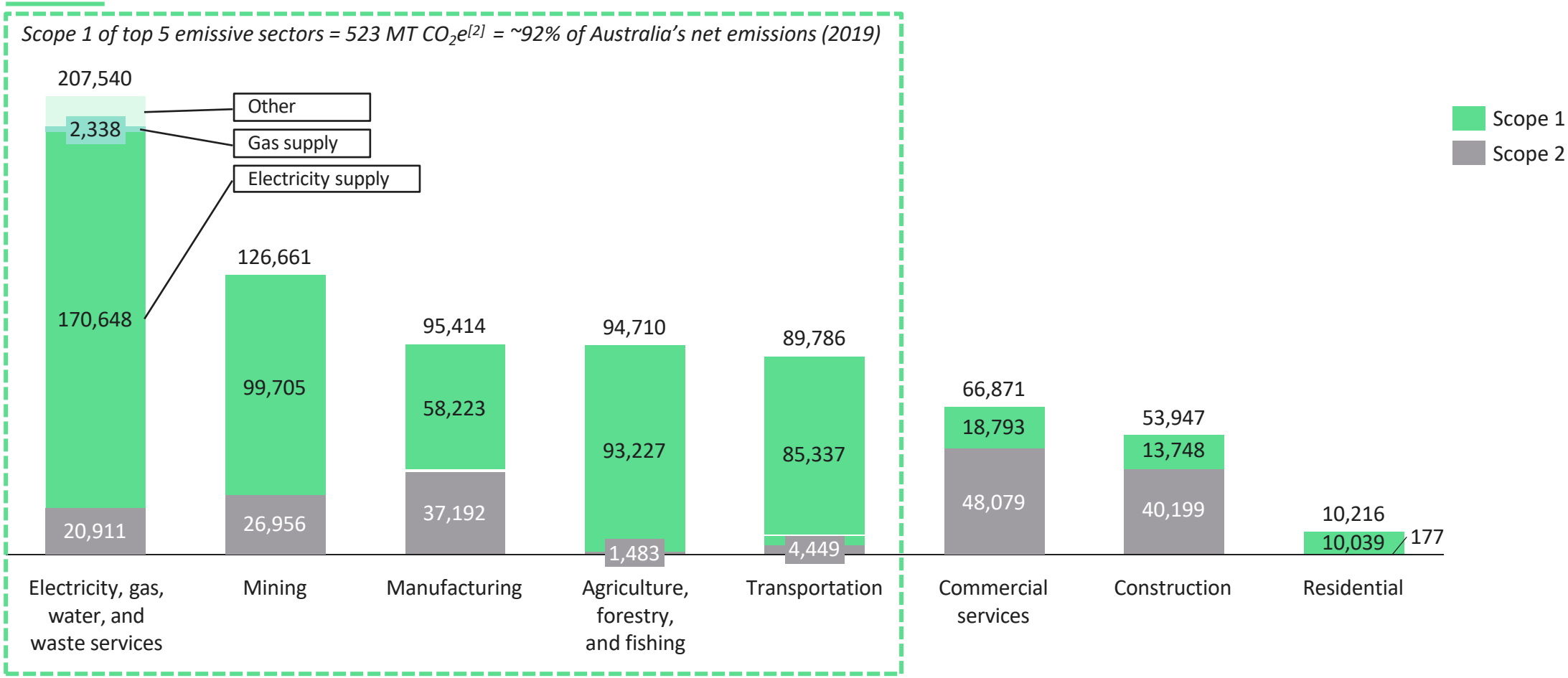
Sources: S&P, Hydrogen Central, Agency for the Cooperation of Energy Regulators (ACER): *NRA Survey – Hydrogen, Biomethane, and Related Network Adaptations*

Decarbonisation Government policy relevant to EU gas industries

Broader industry	• Recent changes to the *Regulation of the European Parliament and of the Council on the Internal Markets for Renewable and Natural Gases and for Hydrogen* (the Regulation) focus on supporting a **joint electricity, gas and hydrogen future**. • The *European Green Deal* outlines **the EU's decarbonisation roadmap**, with the inclusion of an energy system integration strategy and hydrogen strategy. It supports a minimum emissions reduction amount of 55% by 2030 compared to 1990 levels. • **Facilitating trade** through the removal of tariffs for cross-border interconnections and lowering of injection costs by 75% can simplify access to existing gas grids for green gas.
Options-specific	• With the aim of establishing **a market for hydrogen**, changes in the Regulation support investment in infrastructure and trade. The **European Network of Network Operators for Hydrogen** is also being established to "promote a dedicated hydrogen infrastructure, cross-border coordination and interconnector network construction, and elaborate on specific technical rules." • **Renewable gases will be certifiable** as a low-carbon gases under the EU's *Renewable Energy Directive* and the Regulation, allowing Member States to trade gas products more efficiently amongst themselves. • **Reporting requirements on methane emissions** for the oil, gas and coal industries are being reviewed through the *Regulation … on Methane Emissions Reduction in the Energy Sector and Amending Regulation (EU) 2019/942*, as well as requirements on detecting and repairing methane leaks and the limiting of venting and flaring activity.

Sources [1] https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en; [2] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2021%3A805%3AFIN&qid=1639665806476

End-use industries namely, utilities, mining, manufacturing, agriculture and transport constitute >90% of Australia's overall emissions



Notes: [1] Transportation includes *Residential (transport)* and *Transport, Postal and Warehousing* [2] Graphed figures includes direct and indirect emissions; this accounting also do not include Land-use, Land-use Change & Forestry elements of negative emissions.

Source: National Inventory by Economic Sector 2019 (DISER, 2021)

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