Methane emissions starter playbook

Practical insights for getting started on methane abatement

October 2025

CLIMATE LEADERS COALITION

Acknowledgement of Country

The Climate Leaders Coalition acknowledges and pays our respects to Aboriginal and Torres Strait Islander peoples as the First Peoples of Australia whose ancestral lands and waters we work and live on.

We honour their wisdom and pay respect to Elders past and present, and acknowledge the cultural authority of all Aboriginal and Torres Strait Islander peoples across Australia.

Foreword

Methane is a greenhouse gas (GHG) with an impact 29.8 times greater than carbon dioxide over a 100 year period[1]. Methane is, however, short-lived with an impact 82.5 times greater than carbon dioxide over the first 20 years after being released into the atmosphere[1]. It is the second most abundant GHG, driving 30% of global warming through both human (anthropogenic) sources and natural activity.

[1] Intergovernmental Panel on Climate Change (IPCC) (2021), Sixth Assessment Report (AR6), https://www.ipcc.ch/report/ar6/wg1/chapter/chapter-7/#7.6
Emissions reporting in Australia, under NGER currently uses a global warming potential for methane of 28, this is based on IPCC(2014), Fifth Assessment Report (AR5), https://www.ipcc.ch/assessment-report/ar5/

For Australia, achieving methane reductions across the natural gas value chain offers environmental and economic benefits. As the natural gas sector has well-established abatement technologies, it serves as a practical starting point. Insights from this sector can potentially be used to inform emission reduction strategies in other sectors.

Climate Leaders Coalition (CLC) members from operating companies in the natural gas sector have come together to form a methane working group. Their aim is to assist economy wide methane emissions measurement, tracking and reduction to support goals of the Paris Agreement. Initially, they will focus on the natural gas value chain and work towards facilitating the transition of CLC members from estimating methane emissions using generic factors to direct measurement and abatement.

Many companies, including some CLC members, have already set targets to reduce methane emissions, often in line with the Global Methane Pledge.

As a first step, they have developed a set of enabling materials aimed to empower leaders in the natural gas sector and beyond to take meaningful steps to address their methane footprint. These materials are designed to assist companies in setting their ambitions, leverage existing knowledge and make progress in methane reduction.

This document is the Coalition's first effort to contribute to the broader goal of achieving significant methane reductions, which we believe are both necessary and achievable.

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Purpose of the Playbook

Objective of the enabling materials

We have developed this playbook to help members of the CLC and others to reduce their methane emissions.

In this playbook, you will find:

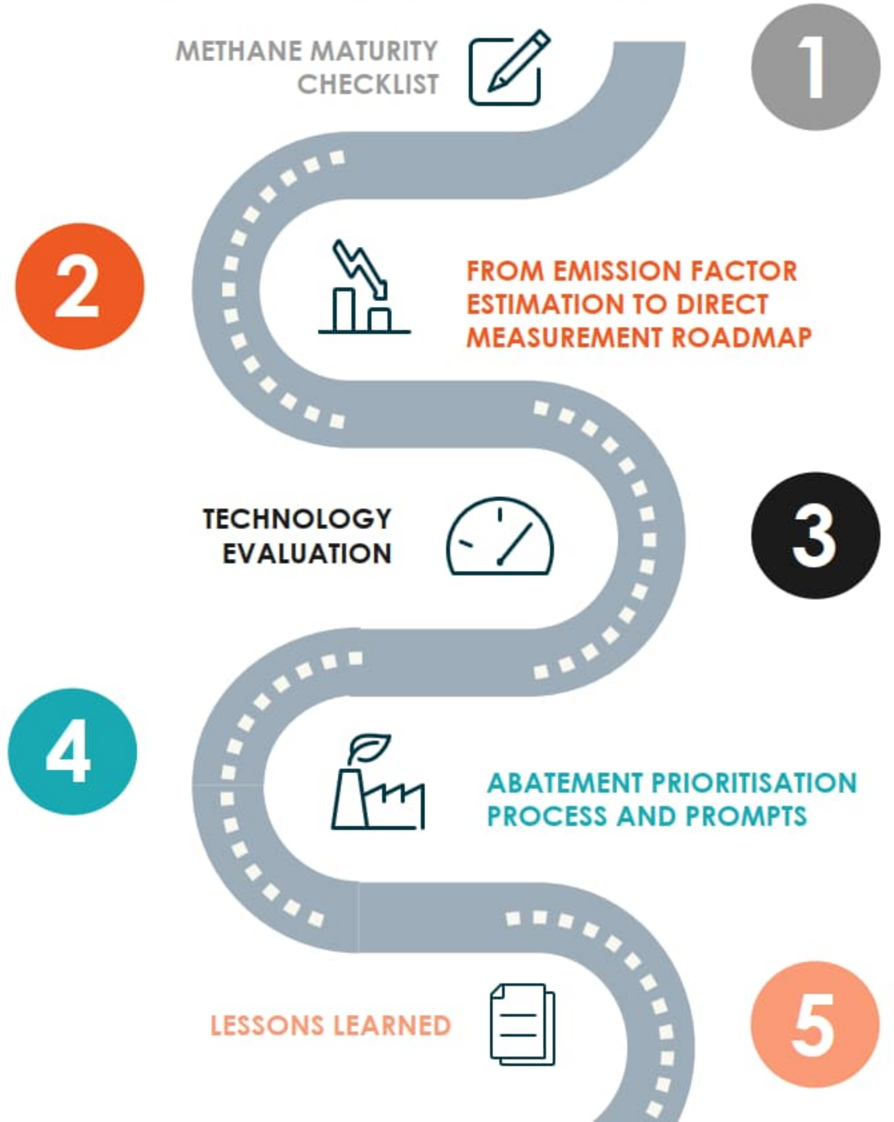
1. A **methane maturity checklist tool** to help you assess how to start, progress or show leadership in methane emissions management
2. A **roadmap** to help you better understand your emissions by moving from emission factored estimation to more accurate site-specific direct measurement-based estimates
3. An **evaluation of measurement technologies** that can be used to detect and measure methane emissions at your sites
4. An **abatement prioritisation process and prompts** which outlines steps to identify potential methane abatement opportunities for your assets and a number of example projects
5. A collection of **lessons learned from the methane working group** which can be used to support setting up a collaborative working group – these lessons may be applicable across any industry

The infographic on the right can help you identify your current stage in your methane reduction journey and the relevant materials that can offer support and insights for that stage.

What is not in the enabling materials?

There is no one-size-fits-all approach to methane reduction. We have developed this playbook with insights into methane management from participating CLC companies which, if applied to your own methane journey, should be interpreted with professional judgement and discretion. Although this document has been developed by companies operating in the gas sector, some of our findings or tools may still be useful in other sectors. You can contact the CLC if you'd like further information.

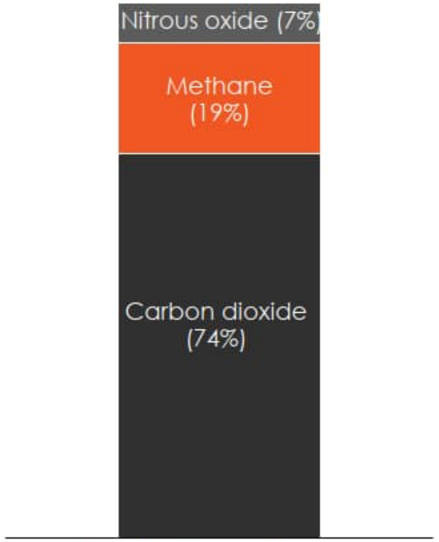
Where are you on your methane reduction journey?



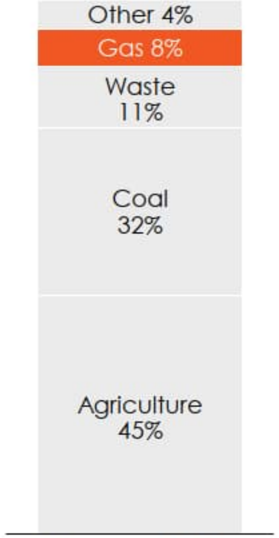
Why methane?

Methane continues to have significant impact on our climate, contributing ~19% of global GHG emissions[1] as shown in Figure 1.

The summation of the 2024 IEA Methane Tracker data in Figure 2 highlights that the natural gas sector, our current focus, makes up 8% of Australia's methane emissions[2]. This focus is due to the high maturity of existing solutions in the sector whereby there is a technical solution available to mitigate up to 72% of methane emissions from Australia's oil and gas operations[2], offering a substantial opportunity for immediate climate action.



Global GHG emissions by gas (Mt CO_2-e, 2023)[1]
Figure 1



Methane contribution within Australia (2023)[2]
Figure 2

Why abate?

Reducing methane emissions is crucial for limiting global temperature rise and achieving climate goals. Other reasons to abate methane include:

Business longevity

- Direct economic benefits from selling captured gas that would otherwise be emitted
- Reducing emissions supports business continuity during the energy transition

Customers and shareholders

- Reducing methane emissions intensity across the value chain supports customer decarbonisation efforts and provides a competitive edge through lower methane emission intensity gas versus competitors
- Meet stakeholder expectations regarding climate transition strategies and achieving stated GHG and methane targets

Changing legislation

Domestic and international regulations continue to evolve as countries seek to reduce their direct and indirect emissions. This may drive companies to be proactive in their efforts towards methane abatement.

How can you get started on reducing methane emissions?

Measurement is the essential first step in the journey to reduce methane emissions.

Our ability to abate methane, is in part, limited by our understanding of the source and quantity of emissions. Currently, methane emissions are reported using the National Greenhouse and Energy Reporting (NGER) scheme which permits many emission sources to be estimated based on operating metrics and emission factors, often derived from US data. For many oil and gas emission sources such as leaks, flaring and some venting sources, there is no direct measurement method available in NGER[3].

Direct measurement allows operators to refine the accuracy of factored estimates, allowing a clearer understanding of emissions quantity, progress tracking and reflect efforts in reducing emissions. Measurement practices should be validated to make informed decisions on methane abatement.

Once methane emissions are better quantified, we can prioritise and build business cases for methane abatement projects.

This playbook offers insights to help you on your methane reduction journey.

[1] EDGAR (Emissions Database for Global Atmospheric Research) (2024). https://edgar.jrc.ec.europa.eu/report_2024
[2] IEA Methane Tracker (2024). https://www.iea.org/data-and-statistics/data-tools/methane-tracker
[3] Climate Change Authority (2023). 2023 Review of the NGER Legislation. https://www.climatechangeauthority.gov.au/sites/default/files/documents/2023-12/2023%20NGER%20Review%20-%20for%20publication.pdf

An introduction to the Oil and Gas Methane Partnership (OGMP) 2.0

The OGMP 2.0 is the flagship oil and gas reporting and mitigation programme of the United Nations Environment Program (UNEP). OGMP 2.0 is an approach that could be applied amongst a range. The most appropriate approach to adopt will be dependent on individual company circumstances. The OGMP 2.0 have developed technical guidance documents (TGDs) which provide specific guidance. Many oil and gas companies are already committed to the OGMP 2.0 and achieving the gold standard. OGMP 2.0 also publishes methane emissions from member companies and other useful reports.

There are many other frameworks that could be used to measure and report emissions including GTI Energy's Veritas initiative and the MiQ Standard. For illustration, OGMP 2.0 has been used when describing measurement in this document.

OGMP 2.0 data reporting requirements are split into levels 1-5, per table below. the TGDs outline the reportable emission categories, various emissions sources and the level of detail required to achieve each reporting level.

Achieving the 'gold standard' requires level 4/5 reporting for material emissions
Level 4/5 reporting must be achieved within three years for operated assets and within five years for non-operated assets. Level 4/5 means that material emission sources are reported at level 4 with efforts to progress to level 5.
A company can achieve the 'gold standard pathway' before years three and five by submitting a level 1 or higher OGMP 2.0 compliant report for all applicable assets and a detailed plan for each asset to reach level 4 or 5 within the required timeframe.

Materiality rules help focus efforts on the largest opportunities to reduce emissions
Assessing materiality typically involves the following:

1. Assess emissions using best available data (for operated assets this should be level 3) to identify the most material sources
2. Commence level 4 analysis (e.g. direct measurement) on material sources
3. Review materiality to ensure increased data quality has not changed the materiality assessments

The reporting framework and TGD general principles outline the details and requirements.

Most natural gas facilities already report emissions via NGER using a combination of methods 1-3. Achieving OGMP 2.0 level 3 should require minimal effort where higher order NGER methods are already being used.

OGMP 2.0 Reporting Level Guidelines [1]

Level	Level 1	Level 2	Level 3	Level 4	Level 5
Measurement	Asset or country level	Source categories	Source type with generic emission factors (EF)	Source type with specific EFs and activity factors (AF)	Level 4 with reconciliation
Detailed description	One methane emissions figure for all operations in an asset or all assets within a region or country	Variety of quantification methodologies progressively reported up to the asset level	Reported by detailed source type using generic EFs, either from industry standards, manufacturers or literature.	Relevant methods include direct measurement, measurement-based EF, simulation tools, detailed engineering calculations. Varies per category under TGDs.	Level 4 with reconciliation via site/asset level measurements. Aim is to reconcile the source level inventory. Can be completed with live measuring technology from platforms such as fixed towers, aircraft and drones.
NGER Determination Equivalent[2]	N/A	Method 1	Method 2 & 3	Method 4 (not available for most categories)	N/A

[1] https://ogmpartnership.com/
[2] The NGER methods do not line up directly with OGMP 2.0 level guidelines. NGER method 1 breaks down fugitive emissions by source, making it typically more accurate than OGMP 2.0 level 2 which generates a total fugitives estimate for the asset.

Methane maturity checklist

This tool may help you assess how to start or make progress towards methane emissions management.

Set the right ambition	Measure your emissions	Set your team up for success	Maximise existing knowledge and operations
In the early stages, we are gathering information on methane emissions and aligning internally			
❑ **We have engaged with company leadership** to acknowledge methane is a problem and secured support to develop methane inventories and estimates	❑ **We have identified our major emission sources** and have estimated their emissions ❑ **Our reporting is equivalent** to OGMP 2.0 level 1/2 or other equivalent levels in relevant standards	❑ **We have developed and are accountable to CO2e KPIs** ❑ **We ensure all divisions are represented** and adequately resourced when discussing progress and prioritising abatement projects	❑ **We are leveraging data available within the organisation** for quantifying and understanding methane emission sources ❑ **We are actively expanding our methane knowledge by participating in information sharing** with peers to build our internal capabilities and knowledge
As we make progress, we are making methane a priority in our business			
❑ **We have set a methane reduction target** that considers national commitments and/or nationally determined contributions (e.g. the Global Methane Pledge or 1.5C pathways) ❑ **We have an internal carbon price** to prioritise sustainability projects ❑ **We have developed a methane reduction roadmap** to track our progress towards targets	❑ **We know our equipment inventory** and their associated emissions ❑ **Our reporting is equivalent to NGER method 2 or 3 where available** for oil and gas, OGMP 2.0 level 3 or other equivalent levels in relevant standards ❑ **We are piloting measurement** technologies across our network	❑ **We have a culture of prioritising sustainability initiatives** ❑ **We have allocated the required budget** to achieve our climate targets ❑ **We have developed and are accountable to methane specific KPIs** ❑ **We have systems in place to ensure we are continuously prioritising and executing methane reduction projects**	❑ **Our abatement activities utilise existing operations** where possible ❑ **We have a continuous learning process** to refine our methane strategy ❑ **Our abatement ideation process is comprehensive and efficient** (e.g. less detail required in early stages) ❑ **We regularly participate in information sharing** with peers to build our networks and partnerships
As we advance, we are focusing on verifying, reconciling and reducing our methane emissions			
❑ **We have set an ambitious methane reduction target** beyond minimum national commitments ❑ **Our ambition extends to** joint venture operations ❑ **We publicly report our progress** against annual methane goals	❑ **Our reporting is equivalent to the highest available reporting method under NGER** for oil and gas, OGMP 2.0 level 4/5 or other equivalent levels in relevant standards - we measure emissions by source at ground level and verify them with top-down data sources ❑ **Our methane reporting is verified** by an external party	❑ **We have a business score card that comprises of sustainability goals** that apply to incentive schemes (if applicable) ❑ **Our decision-making forums have cross functional representation** that consider a range of factors including financial and emissions to arrive at the correct decision	❑ **We have developed a marginal abatement cost curve** tailored to our organisation ❑ **We aspire to be a leader** and advocate for the industry to "set a standard" in methane responsibility

From emission factor estimation to direct measurement roadmap

We have developed a three-phase 'emission factor estimation to direct measurement' roadmap which outlines steps that you can take to help your company build methane calculation or measurement maturity. The insights from this roadmap are based on key learnings from the group and other global initiatives.
This phased approach allows you to identify and refine which emission sources are the most material at each phase, ensuring efforts are appropriately prioritised.

i Improve your emissions estimation → **ii** Move from emission factored estimation to direct measurement → **iii** Improve and validate your measurements

PHASE i Improve your emissions estimation

Companies reporting under NGER will typically already have emissions estimated at a source level with generic emission factors. Effort to improve emissions estimation should focus on areas where lower method orders are used (e.g. fugitives).

Step 1. Lay out pathway and build internal buy-in	• **Lay out a clear business case with reasons to improve emissions estimation** (e.g. reporting requirements), tailored to the relevant stakeholders • **Identify internal and external data sources that may support the business case**, e.g. finance teams will often have accurate estimates of unaccounted for gas, operations may have direct measurement data or NGOs are beginning to publicly report company methane emissions • **Make the ask specific** by explaining what you want to do and what resources you will need; emphasise the **relatively minimal costs** required to improve calculation methods (no additional equipment required)
Step 2. Scale and operationalise	• **Address any gaps in your knowledge of equipment and emissions inventory,** to enable identification of calculation gaps • **Determine areas** to improve emissions calculations, with input from existing reporting obligations (e.g. NGER) • **Understand what emissions data exists in the organisation** (e.g. financial accounting data) and collate this data • **Collate emissions factors and equations** • **Set up tool / spreadsheet** to estimate emissions by type (e.g. OGMP 2.0 level 2) and/or source (e.g. OGMP 2.0 level 3)
Step 3. Record and manage data	• **Design and set up robust structures for data capture** (e.g. a database with consistent fields) and a data governance process so captured data can be easily accessed, utilised and deployed for future use cases • Assess whether **updated emissions estimations** meets higher order **NGER methods** (if applicable) and determine whether to update reporting method • **Engage with assets early to understand source materiality profile** and identify major emission sources – this can be used to focus efforts for direct measurement pilots and prioritising emissions abatement opportunities

From emission factor estimation to direct measurement roadmap continued…

i Improve your emissions estimation → **ii Move from emission factored estimation to direct measurement** → **iii Improve and validate your measurements**

PHASE ii Move from emission factored estimation to direct measurement

This phase may be cyclical as technologies are trialled and your understanding of emissions improves. Understand your objectives for measurement then strategically trial technologies using your materiality assessment.

Step 1. Lay out pathway and build internal buy-in	• **Tailor your engagement with each stakeholder** based on their perspectives (e.g. with a compelling narrative considering qualitative benefits backed by data-driven insights) • **Articulate clear understanding of pilot costs and effort** to meet direct measurement goals
Step 2. Select technology, design pilot(s) and build business case	• **Understand your measurement objectives** (e.g. OGMP 2.0 compliance) and the level of sampling required from a pilot to achieve these • Use your phase 1 **emissions source materiality profile** to **identify measurement technologies** that meet your specific use cases and review technologies already trialled or used within the business • Match **technology attributes to your measurement needs**, balancing trade-offs e.g. between coverage and sensitivity; combining sampling strategies and technologies can help verify emission rates • **Build a business case** for measuring methane emissions as a pilot to gain leadership buy-in • Set **success metrics** to assess technologies following the pilot(s)
Step 3. Run pilot(s) and capture learnings	• **Run pilots** of shortlisted technologies, **ensuring you have capability to robustly analyse trial results**, or engage external support if required • **Investigate and reconcile trial emission results** with alternative measurement technologies and/or engineering calculations • Assess technology against success metrics and **capture learnings, costs and effort** to run pilot(s)
Step 4. Build business case to scale up	• **Estimate cost and effort** required to scale up direct measurement, using selected piloted technologies • **Use initial results to scale impact and demonstrate wins** e.g. reduced emissions, economic benefits • **Build business case to scale up** and **lay out plan** with clear steps, milestones, resourcing, sequencing • Include **less tangible benefits** in business case – especially forward-looking considerations (e.g., increasing regulation, public scrutiny), in addition to immediate financial benefits • **Inform stakeholders of progress**
Step 5. Scale and operationalise	• **Prioritise areas to roll out** direct measurement to, using the materiality assessment from previous phase and technology trials • **Use existing operations to measure where possible** to minimise costs (e.g. land/aerial surveys) • **Look for opportunities to partner** with others across the value chain to potentially save mobilisation costs, if relevant
Step 6. Record and manage data	• Have **robust structures to capture data and ensure data integrity**, so it can be easily deployed to different uses in future • Assess whether captured data meets **NGER method 4 requirements** (if applicable) and determine whether to update reporting method • **Inform stakeholders of the outcomes** of the trial

From emission factor estimation to direct measurement roadmap continued…

(i) Improve your emissions estimation → (ii) Move from emission factored estimation to direct measurement → (iii) Improve and validate your measurements

PHASE (iii) Improve and validate your measurements

Validation is typically a periodic comparison of source-level and site-level measurements to improve accuracy, thoroughness and confidence in measured emissions.

Step 1. Lay out pathway and build internal buy-in	• Use the data from previous phase to build business cases to **continue to trial other measurement technologies, validate emissions and demonstrate the value in understanding actual emissions** • Emphasise that it is better to get ahead of **ever- improving public knowledge of methane emissions** with internal site-level measurements and reconciliation – public data, such as from satellites, is getting better and more granular
Step 2. Select technology, design pilot(s) and build business case	• **Understand your objectives** (e.g. to improve and validate your measurements) • **Select technology, understanding the site-level / top-down methods and limitations:** some technologies may be better suited to site-level measurement, others could be weather-impacted or have less specificity
Step 3. Run pilot(s) and capture learnings	• **Ensure you have the capability to perform robust analysis on trial results**, or engage external support if required • **Run pilots** of shortlisted technologies, **investigating and validating trial emission results** with alternative measurement technologies and/or engineering calculations; ensure that there are suitable resources available during the pilot to support any investigations of identified emissions with source-level measurements • Assess technology against success metrics and **capture learnings, costs and effort** to run pilot(s)
Step 4. Build business case to scale up	• **Estimate cost and effort** required to scale up and measure at site level using selected technology and **articulate benefits of validation** in comparison to costs • Include **less tangible benefits** in business case – especially forward-looking considerations (e.g., increasing regulation, public scrutiny), in addition to immediate financial benefits
Step 5. Scale and operationalise	• **Deploy selected technology** • **Validate** data captured at site-level with source-level. • **Iterate the validation process**, collecting a higher number of source- and site-level data (as temporal conditions and emissions persistence can affect measurements) • Use validated measurements **for materiality assessment, to refine the source-level measurement approach and to inform operations and maintenance activities** where helpful (e.g. where to focus leak detection and repair programs)
Step 6. Record and manage data	• **Consider sharing learnings or data with others** to enable improvement across the value chain. • Have **robust structures to capture data and ensure data integrity**, so it can be easily deployed to different uses in future • Assess whether reconciled data meets **NGER method 4 requirements** (if applicable) and determine whether to update reporting method

Technology selection

When selecting a measurement technology, it is necessary to consider both its attributes and your use cases, as these can vary significantly. Your choice will depend on your specific objectives and whether you have conducted any prior measurements. Once you have identified and pinpointed your most material emissions sources, and defined your use cases, the specific attributes required from the technology can be refined and this will guide you to select the most relevant technology.

Key learnings for technology selection[1]

1. **Understand your objectives for measurement** – e.g., abatement, reputation, regulatory compliance
2. **Understand the technology attributes that matter** based on your specific measurement requirements
3. **Different technologies have variation in use cases** – understand what your use cases are to inform which to select

Methane detection technology filtering tool

The International Association of Oil and Gas Producers (IOGP) has developed a **methane detection and quantification technology filtering tool.**
This tool can assist you in selecting the most appropriate measurement technology based on selecting area characteristics, purpose of deployment and desired technology characteristics.
Find out more here.

2 10 key attributes to consider when selecting a technology[1]

Performance and functionality for relevant use cases

1. Detection / Quantification
2. Temporality
3. Localization

Implementation and practicality across applications

4. Scalability
5. Deployment risk
6. Technology readiness
7. Environmental Factors

Data management and compliance

8. Data reporting
9. Data security
10. Compliance

3 Different technology is suited to different use cases

- **Bottom-up technologies** have various use-cases. For example, area towers are useful for ongoing, facility-level monitoring. Meanwhile, handheld devices are best suited for localisation of small leaks, and vent condition monitoring
- **Top-down technologies** need careful selection. For example, drones and satellites are limited in uses requiring detailed quantification and exact location of sources, but can pinpoint large anomalies across wide areas
- **Engineering calculations** are useful for estimating emissions where the parameters are well understood e.g. compressor blowdowns

Examples of these technologies and their use cases are presented on the following pages.

[1] Joynes Ian, O'Keeffe Rory, Manolas Yvette (2024) Developing a 'fit for purpose' approach to measuring methane emissions. The Australian Energy Producers Journal 64(S1), S148-S153.

Measurement technologies

A combination of technologies will be required for measuring emissions, as each application will involve different scale, sensitivity and cost. As a starting point, for those looking to gain an understanding of the technology types available, this table shows a comparison of various bottom-up and top-down measurement technologies against a set of variables, noting that there is a lot of nuance within each category (e.g., sensor type, deployment method, etc.) and vendor offering which may impact detection capability and thresholds.

These insights are considered accurate at a point in time, as per the understanding of working group members. Some of these technologies may not be available locally and compliance with reporting frameworks (e.g. OGMP 2.0) may also need to be considered.

	BOTTOM-UP MEASUREMENT				TOP-DOWN MEASUREMENT	
Technology	**Fixed meter/monitor**	**Handheld device**	**Vehicle/mobile lab**	**Area tower/monitor**	**Drone/aircraft with sensors**	**Satellite[2]**
Description	For vented methane sources, in-line flow meters measure flow of methane in pipes	Analysers[1], infrared cameras or lasers visualise methane in an area	Onboard equipment and sensors map emissions over different areas	Mounted equipment (Infrared gas analysers and lasers) detect methane in a fixed area	Infrared sensors or lasers measure methane concentration over a broad area	Advanced infrared sensors map large flares and plumes
Ability to detect and quantify emissions	Can detect and quantify using the same kit	Detects emissions. Some technologies quantify directly, others may need external software	Detects emissions. Emission rates or flux are calculated using wind data and modelling with external software.	Detects emissions. Emission rates or flux are calculated using wind data and modelling with external software.	Detects emissions. Emission rates or flux are calculated using wind data and modelling with external software.	Detects emissions. Emission rates or flux are calculated using wind data and modelling with external software.
Frequency	Continuous	Episodic	Episodic	Continuous	Episodic	Episodic
Detection threshold (sensitivity)	<1 kg/hr to 25 kg/hr	<1 kg/hr to 25 kg/hr	Usually <1 kg/hr	<1 kg/hr to 25 kg/hr	1 kg/hr to 50 kg/hr	100 kg/hr to 1,000 kg/hr
Coverage/ scale	Within an operating unit	Multiple operating units per day	Multiple sites per day	Portion of site	Regional – one site per 1-2 days	Global – multiple regions per day

[1] Vapour analysers can be for toxic (TVAs) or organic vapour (OVAs)
[2] Satellite is not permitted for reconciliation under the OGMP 2.0 guidelines.

Examples of methane sources and measurement techniques[1]

The table below outlines various bottom-up and top-down measurement technologies and their applicability to various use cases based on our collective experiences. This is a non-exhaustive list of example technologies and the applicability of the technology to your emission source will need to be discussed with the relevant vendor as the technologies are continuously evolving, emerging or becoming obsolete and may not be available locally. These insights are considered accurate at a point in time, as per the understanding of working group members. Compliance with reporting frameworks such as OGMP 2.0 may also need to be considered.

		Fugitives	Continuous vents	Periodic/intermittent vents	Combustion slip	Flare slip
	Source / Technology	Valve stems, flanges, valve bodies, threaded fittings	Compressor seals, piston rods, acid gas removal, analyser manifolds	Open ended pipes, pressure relief valves, blowdowns, gas turbine starts	Gas turbines and boilers	Flares (air and steam assist)
BOTTOM-UP MEASUREMENTS	**Land based technologies:** • Differential absorption LIDAR • Handheld cameras e.g. Optical gas imaging camera • Handheld methane selective laser and hi-volume sampling • Handheld sensors Portable detector/ Personal gas monitor	**Differential absorption LIDAR** is useful for quantification however, it is difficult to localise sources when sources are aggregated. **Handheld cameras** are often used for leak screening and quantification. However, may have issues of confounding effects with other hydrocarbons or water vapour. **Handheld methane selective lasers** are useful for localisation of small to large sources, but typically need a reflective surface. **Handheld sensors** use near field PPM measurements and can classify leaks.	**Differential absorption LIDAR** is useful for quantification however, it can be hard to localise sources when sources are aggregated. **Handheld cameras and methane selective lasers and sensors** can be used for condition monitoring, but quantification accuracy varies. **Handheld methane selective lasers** typically need a reflective surface.	**Differential absorption LIDAR** is useful for quantification, however, needs to be used frequently to identify small duration sources. **Methane selective lasers and sensors** can be used for condition monitoring. However, the selective lasers typically need a reflective surface. **Handheld cameras** are useful for condition monitoring, but quantification accuracy varies.	**Differential absorption LIDAR** is useful for source quantification. **Handheld methane selective lasers** and **sensors** can be used to detect combustion or flare slip. However, selective lasers typically need a reflective surface. **Grab-bag sampling** can be used to quantify combustion or flare slip. However, this requires physical access to the source wither via temporary or permanent platforms. **Handheld cameras** can detect abnormal operation on flares. However, this method interacts with heat signatures. Handheld cameras may also be able to detect combustion slip however, some may not work for high temperatures.	
	Fixed or land based technologies: • Line of sight sensors e.g., cameras, lasers	**Line of sight sensors** may detect and localise fugitive sources but requires proximity and line of sight from source.		**Line of sight sensors** are useful for detection of unknown routine events.	**Line of sight sensors** can monitor combustion efficiency, but only some work at high temperatures.	**Line of sight sensors** can monitor flare combustion efficiency. Only some work at high temperatures. The stack's diameter impacts effectiveness.

[1] Adapted from: Joynes Ian, O'Keeffe Rory, Manolas Yvette (2024) Developing a 'fit for purpose' approach to measuring methane emissions. The Australian Energy Producers Journal 64(S1), S148-S153.

A commonality for all technologies and sources is that continuous vent sources may cause interference with the detection of other emission sources and that these technologies may require consideration of prevailing winds.

Examples of methane sources and measurement techniques[1] continued...

	Source / Technology	Fugitives	Continuous vents	Periodic/intermittent vents	Combustion slip	Flare slip
	Source / Technology	Valve stems, flanges, valve bodies, threaded fittings	Compressor seals, piston rods, acid gas removal, analyser manifolds	Open ended pipes, pressure relief valves, blowdowns, gas turbine starts	Gas turbines and boilers	Flares (air and steam assist)
BOTTOM-UP MEASUREMENTS	**Fixed technologies:** • Fixed point continuous sensors e.g. Ambient monitors • Aerial/fixed towers	**Fixed point sensors** can detect sources within the sensor range. More sensors are needed for larger sources and areas. Aerial/fixed towers monitor large areas and may be useful at a large facility level.	Having a sufficient number of **fixed point sensors** on vents may reduce commissioning issues. **Aerial/fixed towers** monitor large areas and may be useful at a large facility level.	**Fixed point sensors** are useful for detection and diagnostics of unknown routine events. **Aerial/fixed towers** monitor large areas and may be useful at a large facility level.	**Fixed point sensors** can be used for combustion slip e.g. using continuous emissions monitoring systems (CEMS). **Aerial/fixed towers** monitor large areas and may be useful at a large facility level.	**Fixed point sensors** can be used for flare slip e.g. CEMS. **Aerial/fixed towers** monitor large areas and may be useful at a large facility level however, may have difficulties detecting flare slip due to the height of the flare.
ENGINEERING CALCULATIONS	**NGER reporting context**	Method 1 (fixed value) or higher order methods using leak/no leak factors.	Aggregated in with fugitives' method or prescribed fixed factors. Engineering calculation allowed for some sources.	Included in other factors; Engineering calculation used when material.	Fixed generic factor for slip from combustion sources which is not based on the specific asset or equipment item.	Fixed factor for slip, higher order method considers hydrocarbon content in flared gas.
ENGINEERING CALCULATIONS	**Indirect – engineering calculation**	Component counts and leak factors.	Can be used where source does not change but may not detect abnormal operation.	Useful for inclusion of emissions from known routine events which can be counted using other input data.	Cannot detect machine performance changes, unless combined with periodic tests and algorithm tuning.	Techniques are available to measure destruction efficiency in real time, technology is maturing.
TOP-DOWN MEASUREMENT	**Techniques include:** • Aircraft-based gas sensors • Drone-based gas sensors • Satellite-based gas sensors	Some **aircraft-based gas sensors** may be able to detect to low emission levels, however, other sources may inhibit localisation. **Drone-based gas sensors** are useful for quantification, but small sources may be aggregated into other sources making localisation challenging. **Satellite-based gas sensors** have limited ability to detect at low enough levels and accuracy required at present.	**Gas sensors on aircraft** and **drone** platforms are useful for quantification at an instrument or group of component level. **Satellite-based gas sensors** are useful for performance monitoring of super large emitters, generally larger than 100 kg/hr but limited by detection thresholds.	**Gas sensors on aircraft** and **drone** platforms are useful for quantification, however, requires frequent deployment to identify small duration sources. **Satellite-based gas sensors** have limited ability to detect at low enough levels and accuracies.	Some **aircraft-based gas sensors** can detect combustion slip from exhausts, but algorithms may require modification. Gas measurements derived from **satellite-based gas sensors** may need modification of algorithms. **Drone-based gas sensors** can be used to quantify emissions, however, algorithms may require modifications and could be constrained by exhaust plume temperature and plant layout.	**Gas sensors on aircraft** and **satellites** are useful for detection of abnormal operation of flares. However, the algorithms may require modification. **Drone-based gas sensors** are useful for flare quantification and destruction efficiency measurements when combined with a CO_2 sensor, but algorithms may require modification. Additionally, if flares are co-located, it may not be able to differentiate the source.

[1] Adapted from: Joynes Ian, O'Keeffe Rory, Manolas Yvette (2024) Developing a 'fit for purpose' approach to measuring methane emissions. The Australian Energy Producers Journal 64(S1), S148-S153.

Steps to identify and prioritise methane abatement opportunities

After measuring our methane emissions across the natural gas value chain, how might we eliminate or reduce them? This flowchart outlines a typical cyclical process that we can take to identify and prioritise methane abatement opportunities. This process[1] focuses on the initial stages before further engineering studies. The following pages list some opportunities identified through this process.

	Baselining	Framing and Opportunity Identification			Scoping and Analysis	
	1. BASELINING	**2. FRAMING**	**3. IDEATION**	**4. SCREENING**	**5. OPPORTUNITY DEFINITION**	**6. OPPORTUNITY ANALYSIS**
	Baseline methane emissions of a facility / asset as best as possible using measured data	**Define the context, company drivers, key objectives and identify the valuable goals**	**Identify the largest sources of methane at your site and generate ideas to reduce or eliminate these emissions**	**Identify preferred opportunities for further analysis using a multi-criterial assessment (e.g., commercial, technical and strategic criteria, etc.)**	**Define emissions abatement, cost and scaling of opportunities to build a business case for each opportunity**	**Conduct cost-benefit analysis and sensitivity plots to develop a shortlist of projects prioritised for further work**
Insights	• Using measured data to baseline emissions can help companies quantify potential methane reductions and benefits. *After measuring or baselining emissions you may identify quick win abatement opportunities that you implement immediately.*	• Early alignment on drivers and objectives ensures everyone understands the purpose and desired outcomes • Clear drivers and milestones support decision-making by highlighting priorities and success factors	• Hold a workshop to brainstorm diverse ideas for methane abatement • Involve a cross-section of personnel, including experienced operations and maintenance staff • Consider opportunities to change ways of working or optimising operating / maintaining facilities as well as equipment modifications	• Screening focuses efforts on ideas more likely to be successful • Consider emissions reduction potential and environmental benefits alongside technical and commercial criteria • Consider the ease of implementation and whether your site is greenfield or brownfield	• Establish consistent commodity pricing across all projects • Consider carbon tax savings in abatement project business cases • Consider the impact of increased saleable gas from methane abatement	• Developing a marginal abatement cost (MAC) curve is a useful tool to compare relative cost and emissions impact • Sensitivity analysis can be useful to test opportunity robustness and support decision making • Consider other business objectives when prioritising projects
	What's your existing emissions?	*What's possible?*			*What's preferred?*	

Review measured data and revisit brainstormed and screened ideas to identify and prioritise other methane emission reduction opportunities

Execution Team: There are benefits in using a dedicated team for this process, whether internal or external to the company, that is equipped with the necessary tools and resources to facilitate and conduct the review.

[1] Process based on: Dwyer Jessica (2024) Why global decarbonisation requires cross-sector understanding. Australian Energy Producers Journal 64, S548-S551.https://doi.org/10.1071/EP23159

Prioritised methane abatement prompts

As a group, we brainstormed a non-exhaustive set of methane abatement ideas for gas processing facilities which you could consider in your methane reduction journey. We categorised the abatement opportunities into three categories based on abatement potential and return on investment. The opportunities are prioritised based on our group's experience, however, the suitability of certain opportunities may differ for your site.

Quick wins

These opportunities typically provide high return on investment but have a smaller abatement impact.

High abatement potential actions

These opportunities typically offer high abatement potential and high return on investment.

Future considerations

These opportunities include both high and low abatement opportunities with lower return on investment. They are good to have but not the top priority.

There is no one-size-fits-all approach to methane abatement. These opportunities are intended to be used as starting prompts to explore what could be done to your site. Hence, it is important to consider the factors most relevant to your site e.g. greenfield or brownfield modifications.

Quick wins

Typically lower cost and high return on investment but smaller abatement impact.

Venting

- Route seal gas to flare to reduce vented emissions
- Avoid facility blowdown events and planned venting where possible
- Tanker/truck loading vapour recovery
- Reduce purge time for compressors
- Install a vapour balance system on tanks
- Use a pressurised hold system to avoid blowdowns
- Increase maintenance frequency of rod packing replacement on reciprocating compressors
- Use a mobile flare to avoid venting where possible (e.g., maintenance, pigging activities, etc.)
- Consider alternative rod packing types to minimise vented emissions

Leaks and fugitives

- Proactively test equipment to understand leak rates
- Improve predictive maintenance using reliability data/LDAR data
- Replace high leak rate equipment with lower leak rate equipment (e.g. valves)
- Review operating envelope to limit avoidable pressure safety valve (PSV) lifts

Flaring and incomplete combustion

- Review operating practices around flaring to reduce non-emergency flaring
- Ensure flare is continuously lit and operating per design
- Run close to best efficiency point (to reduce incomplete combustion)

Prioritised methane abatement prompts continued…

High abatement potential actions

High abatement potential and typically high return on investment.

Venting

- Vent gas recovery system
- Eliminate methane stripping gas from TEG regen system (e.g. use inert gas or capture and recycle methane)
- Use nitrogen to replace fuel gas purge (on tanks or flares)
- Use exhaust gas as blanketing gas instead of fuel gas or nitrogen
- Replace wet seals with dry seals on centrifugal compressors
- Replace natural gas driven devices with instrument air or electrically-powered devices to eliminate venting emissions
- Blowdown capture (at transmission and storage stage)

Leaks and fugitives

- More frequent leak detection and repair (LDAR) program
  Quantification of emission rates can also help you understand the materiality of sources and justify other methane abatement opportunities

Flaring and incomplete combustion

- Design 'no routine flaring' as best practice for new facilities
- Flare gas recovery
- Improve combustion efficiency through flare tip technologies (at processing stage)

Future considerations

Typically lower return on investment.

Venting

- Implement a portable vent recovery system for maintenance
- Capture or flare gas from exploration wells
- Electrify natural gas driven equipment to eliminate venting emissions and combustion slip
- Replace traditional centrifugal pumps with magnetic drive pumps to remove the seal system and eliminate venting from seals
- Replace centrifugal compressors with hermetically sealed compressors (e.g. a magnetic, no seal system)
- Install a plunger system (i.e. artificial lift) to manage liquid build up, on wells that require blowdowns to remove liquids
- Install seal gas recovery systems on compressors
- Replace seal gas with inert gas
- Capture blowdowns during gas processing stage

Flaring and incomplete combustion

- Flare gas recovery at transmission and storage stage
- Replace natural gas fuelled equipment (e.g., gas driven power generators, gas driven compressor turbines, etc.) with electrically-powered equipment

Lessons learned from the methane working group so far…..

Here is a collection of valuable lessons and insights from our experiences in the methane working group. The insights cover the formation of a working group, effective team collaboration, commitment to methane reduction and early experiences in scoping out pilot projects.

We want to share these insights to help others working in a collaborative group setting across companies and other industries. We have learnt that working together with other companies not only accelerates progress but also enhances collective understanding of methane emission management.

Establishing a working group

Collaborative learning
Sharing of knowledge across companies can accelerate understanding and drive collective progress in methane measurement.

Unified vision
Group alignment on the project vision and objectives is essential. This collective focus drives innovation, enhances coordination and ensures long-term success.

Early trust and support
Establishing trust between companies is essential. This foundation fosters effective collaboration, allows the group to challenge the status quo and enhances the success of joint initiatives.

Leadership buy-in
Without senior leadership buy-in, initiatives may struggle to gain momentum and achieve their goals.

Collaboration

Data sharing framework
Exploring opportunities to share data and gain collective insights to enhance overall understanding. Developing a framework requires significant upfront focus.

Impact of group results
Publishing results from a larger group gains more attention and influence than individual results and amplifies impact.

Cost savings through consolidation
Consolidating efforts across companies can save costs and optimise resources, such as sharing mobilisation / de-mobilisation costs for measurement campaigns.

Awareness of regulatory changes
Collaboration across companies assists in enhancing awareness and knowledge sharing for those operating across different jurisdictions where regulations are evolving.

The pilots

There is no one-size-fits-all approach
There is no single measurement system that can capture all emissions.

Unexpected emission sources
Measuring methane emissions may reveal emissions to be different to what is expected. Being prepared for these discoveries is crucial for comprehensive mitigation efforts.

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