Methane and Volatile Organic Compound Emissions in NSW

Stuart Day, Anne Tibbett, Stephen Sestak, Chris Knight, Paul Marvig, Scott McGarry, Steve Weir, Stephen White, Stephane Armand, Jennifer van Holst, Robyn Fry, Mark Dell'Amico , Brendan Halliburton and Merched Azzi

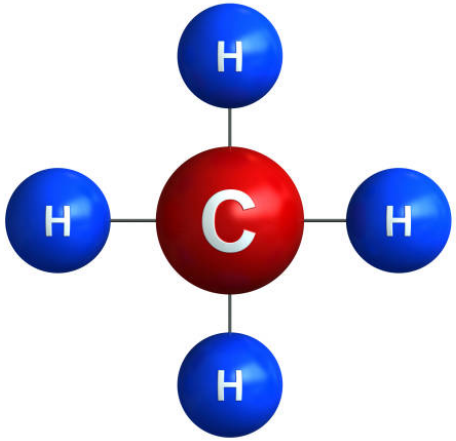
NSWEPA, AGL, Committee Members -12 September 2018

CSIRO ENERGY
www.csiro.au

Content

- Why – do this study
- How – we did this study
- What - we found (Camden results)

- What next – if time allows



Methane CH_4

Motivation - *WHY*

- CH_4 is a potent and abundant GHG contributing to climate change.
- . It is emitted from different sectors including: **oil and gas industry, coal mining, agriculture, landfills and wastewater.**

  + natural emissions
- In the troposphere, CH_4 reacts with NO_x to increase the tropospheric O_3 Concentration. Background O_3 increase has also been linked to the sharp increase in the CH_4 emissions.
- Slowly destroyed in the upper atmosphere – hydroxyl radicals
- O_3 is an air pollutants and also a GHG.

CH_4 control has climate, environmental, social and economical benefits.

Regulatory Drivers

- Currently, various government agencies are working towards, proposing or incorporating non-CO_2 mitigation into analysis and policy discussions.
- The sectors of:
  - Coal Seam Gas
  - Landfills
  - Coal Mines
  - Agriculture
  - Wastewater

  Have identified because of their potential for anthropogenic methane emission reductions :

Hence , From a regulatory perspective, the questions :

- *What are the baselines in selected sectors?*
- *Can we establish emission reduction potentials?*
- *How can we apply currently available **mitigation options and technologies** to existing methane emission*

Will require answers

Specific Properties of CH_4 Fugitive Emissions

- Methane Fugitive Emissions are associated with climate and environmental issues
- Represent a loss to selected industry - such as oil and gas or coal mining sectors.
- Worldwide reported data have been suffered from inconsistencies, uncertainties and divergence
- Fugitive CH_4 sources are intermittent, dispersed and can be inconsistent with flow, concentration and occurrences.
- These characteristics represent challenges for:

-identification **-Measurements at low concentrations**

-Flux characterisation (quantification not just identification)

-Source attribution **-Quantifying mitigation effectiveness**

Way Forward - *HOW*

- Select the appropriate instruments and analytical procedures to achieve better emissions estimation per identified emission sector.
- Develop methods for locating the sources of selected emissions
- Develop techniques and methods for analysing the obtained data from the identified sectors
- Clustering the analysis per sector to propose appropriate solution to control CH_4 emissions
- CSIRO is continually improving the science in this sphere through ongoing research

Sampling Sites - *WHERE*

- 16 sites selected for detailed measurements

A "snapshot of NSW methane emissions" at that time – may be different now .

How have methane concentrations changed due to changed activities?

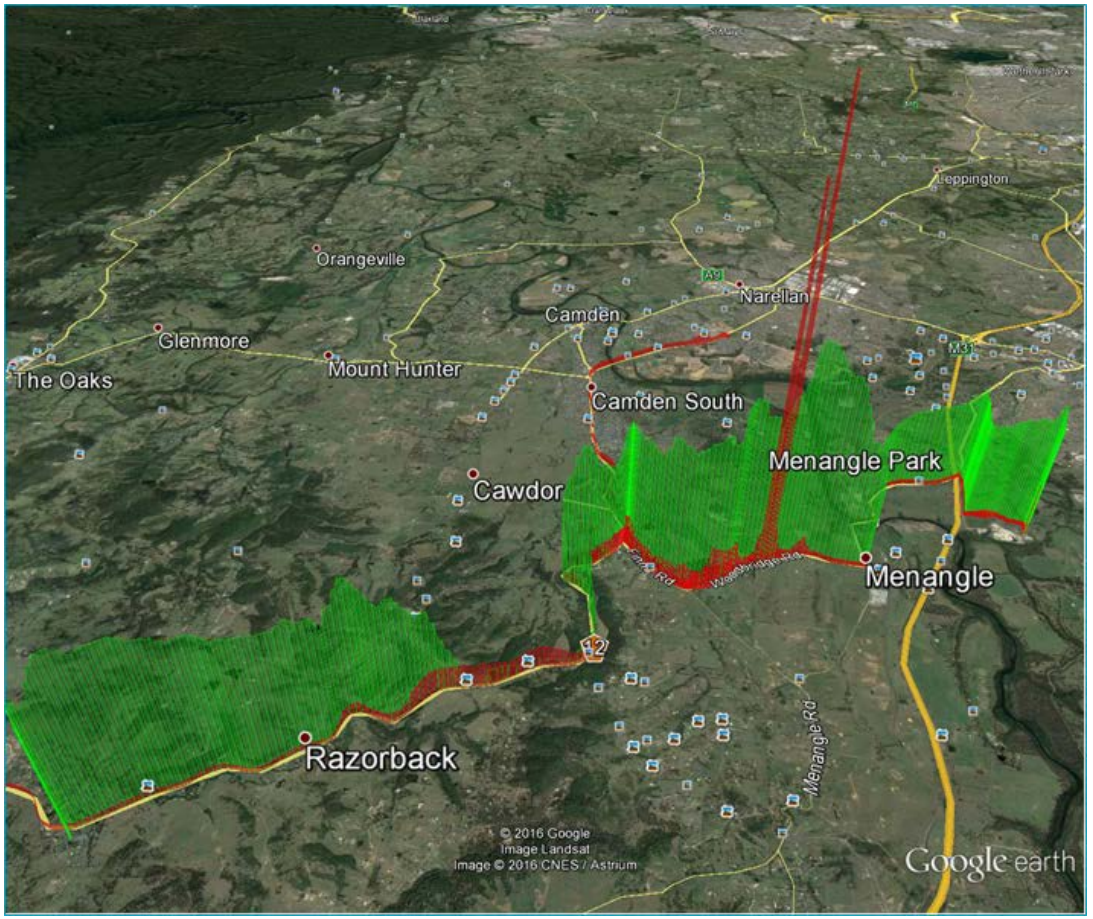
- CSG operations
  - AGL -Camden, Santos - Narrabri, Metgasco- Casino
- Landfills
  - Parkes, Newcastle
- Wastewater treatment
  - Picton, Singleton, Dubbo, Wagga Wagga
- Agriculture
  - Rice farm, feedlot
- Coal mining
  - Wambo, Rix's Creek
- Natural sources
  - Yaegl NR, Cuba SF

Methodology - *HOW*

- Methane emissions – ***where and how much?***
  - Trialled a range of methods
  - Deployed at the sites – estimates of emission flux
  - Measurements made across seasons
  - Ambient surveys across NSW
- Isotope characterisation – ***what source is CH_4 from?***
  - Sampled 'raw' gas where possible
  - Ambient samples
- VOC characterisation – **what source and what other air toxics?**
  - Ambient sampling at selected sites
  - Camden survey – seasonal sampling at 10 locations
  - Trace analyses of some CSG samples

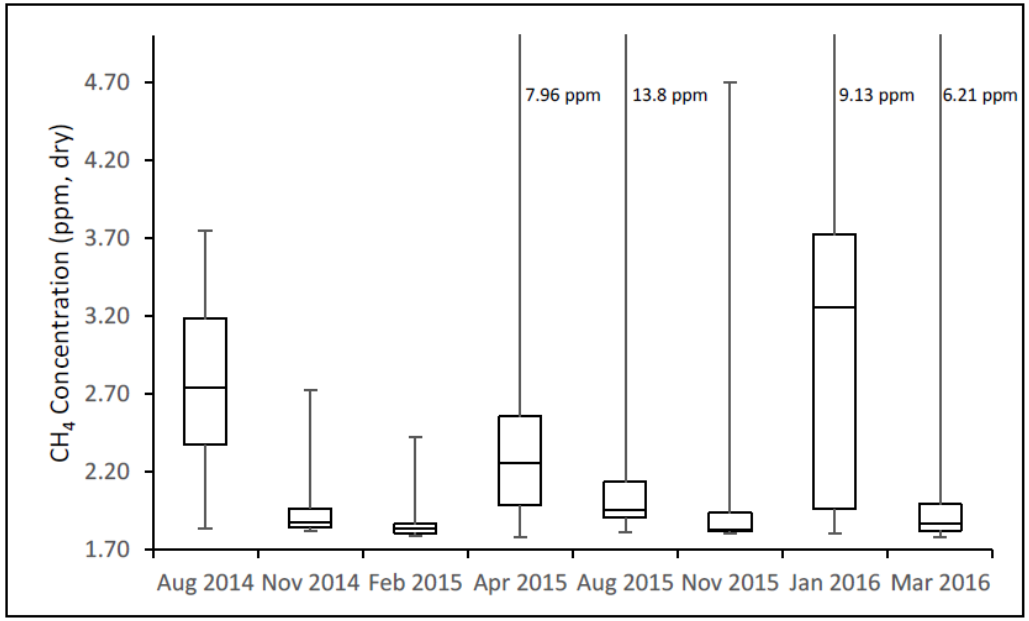
Methane Emissions - Camden

- Mobile surveys across NSW
  - Wheeled vehicle fitted with CH_4 analyser, GPS, anemometers etc.
  - Measuring at up to 2 Hz
  - Surveys made at highway speeds
  - Overlay CH_4 concentration on map
- Effective at locating sources
- Care when interpreting data
  - Concentrations affected on ambient conditions



Methane Emissions – Camden Background

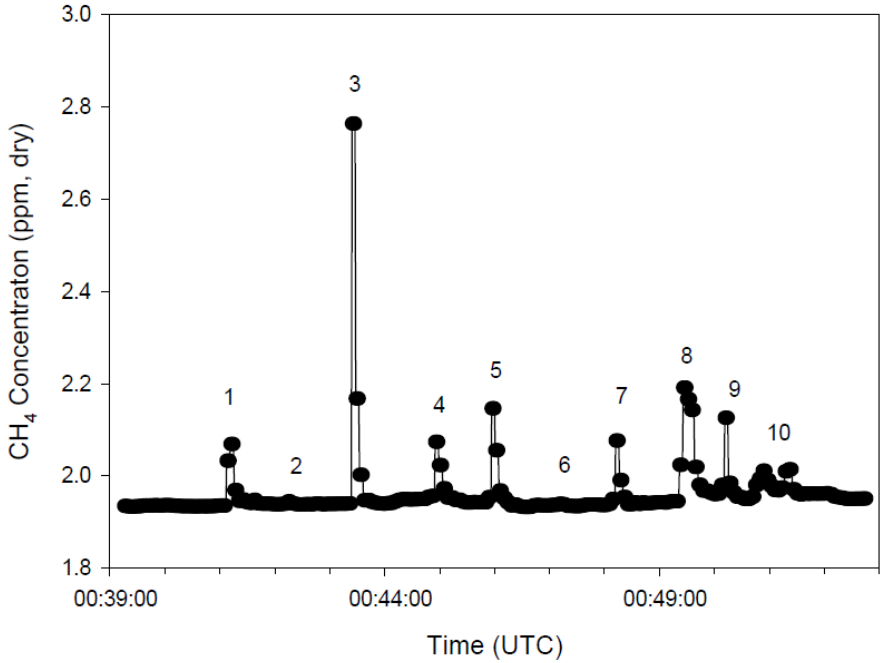
- Camden - Background
  - Generally elevated CH4 concentrations
  - Source/s remains unclear
  - No clear correlation with CSG operations
  - Spring Farm waste water treatment is a significant source – 13.8ppm measured



Box and whisker plot of ambient CH_4 concentrations

Methane Emissions - CSG Production

- AGL Camden - summary
  - Six pads (nine well heads)
  - Very low emissions (mostly zero)
  - Possible emissions detected during one survey on another well
  - During venting and repair CH4 concentration up to 20ppm were measured 20m from well
  - Water emissions very low, but most CH_4 likely to have been emitted previously



CH_4 concentration during circuits around a CSG well

Clarification regarding the magnitudes of detectable Methane concentrations

The methane peaks of the order of 800ppb or 0.8 ppm shown on the previous slide, while about 800 times larger than the Lower Detection Limit (LOD) of our instrument, are extremely small compared to the Lower Explosive Limit (LEL) of methane.

The LEL for methane starts at about 5%, or 50,000ppm (10,000pmm = 1%).

Thus the concentrations measured around the well heads are in the range of 50, 000 times smaller than the LEL.

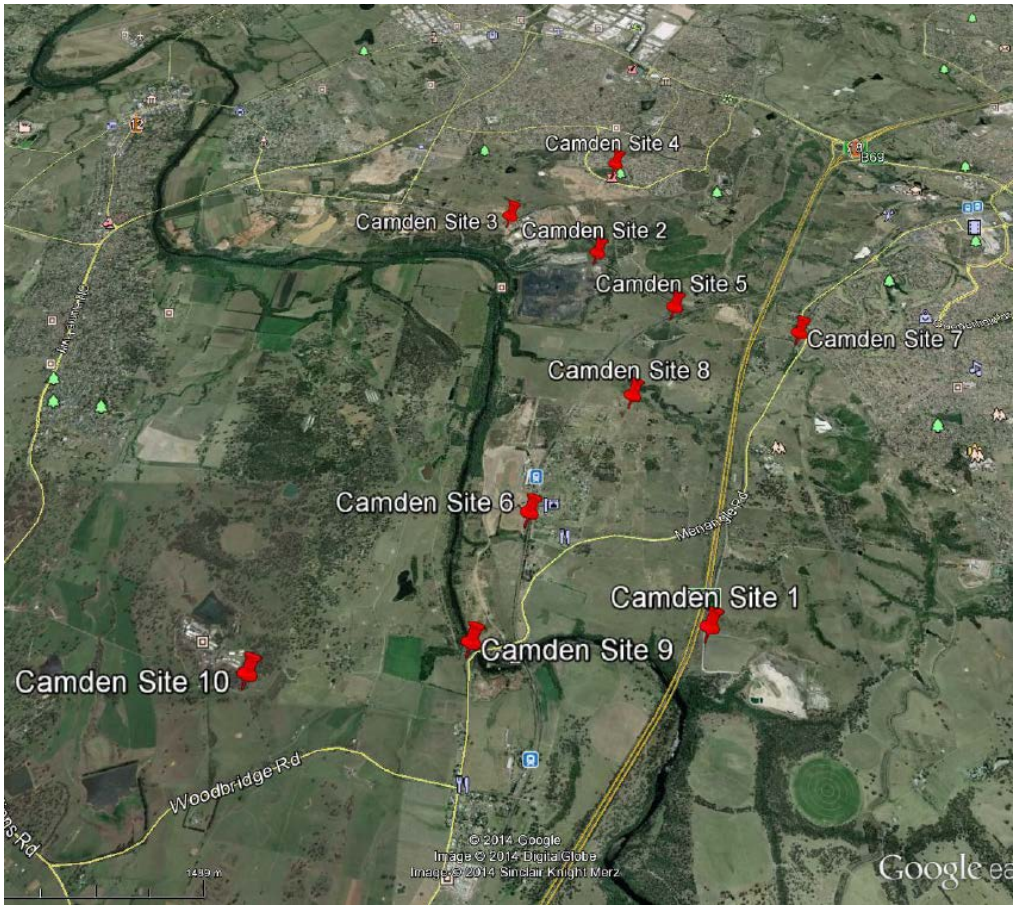
Also, there are very few field instruments that can measure to this small levels of detection or sensitivity. Thus most other instruments would not resolve such small concentrations and would just read 'zero' or 'noise'. Certainly all of the routine or industrial gas leak testing instruments that we have encountered have a level of detection of no better than 1ppm, but usually much higher than this depending upon the brand.

However, it is important to have this level of sensitivity for source identification and apportionment studies.

Summary – Camden Results

- VOC
  - 10 sites monitored for priority VOC's
  - 4 seasons - Winter, spring, summer and autumn
  - Ambient VOC's commensurate with expected suburban and semi-rural environments
  - Contribution from CSG not evident
  - Impacted from traffic related VOC's

- Isotopic analyses
  - No clear source was identified for the elevated background CH4
  - Likely CH_4 is from multiple sources



Conclusions - Camden

- Background Methane concentrations were generally higher then the state average
- CSG well emissions were generally small except during specific operations with maximum emission rate of 0.03g/min (150 Bovine units)
- No clear correlation between the higher measured background methane and CSG activity was found.
- Surveying, VOC and isotopic work indicate that the methane in the region is from a combination of sources.
- VOC results indicate that Vehicle and transport emission impact the area
- It is likely that further and more comprehensive studies such has been undertaken by CSIRO within both CSIRO and GISERA will provide a more detailed apportionment of methane emission in this area.

Conclusions for NSW Methane Inventory

- Very large and complex undertaking to measure all sources
  - Coal mining
    - Large source; fugitive emissions measured under NGERS; uncertainty low to moderate
  - CSG
    - Currently small source; emissions estimated under NGERS but uncertainty sometimes high; estimates improving
  - Agriculture
    - Large source, especially ruminant animals and feedlots; feasible to measure but published emission factors more practical
    - Rice farming very small source overall
  - Landfills
    - Significant source; difficult to measure but tracer shows promise
  - Wastewater
    - Probably relatively minor source; feasible to measure with chambers and tracer; most emission from biosolids storage
  - Wetlands
    - Probably minor source; difficult to measure
  - Biomass burning
    - May be significant at certain times; difficult to measure
- *This study, and other recent studies (GISERA), have indicated that experimental measurement, while difficult, are potentially an accurate means for estimating larger scale CH4 emissions for inventory requirements*.

Conclusions - Overall - simplified

Primary aim - develop a tractable methodology for quantifying methane emissions

- A range of methods have been evaluated and with many of these methods indication that they are effective at quantifying methane emissions from sources. Some of these are relatively mature while other are require significant refinement.

  Many of these techniques have been utilised for CSG emission flux estimation.

  (CSIRO/GISERA)

- It is unlikely that any one technique will be suitable for quantifying CH4 emission in all sectors and it is likely that a range of methods will be necessary. New, or adapted methods, will be necessary for new CH4 emission sources and technologies.

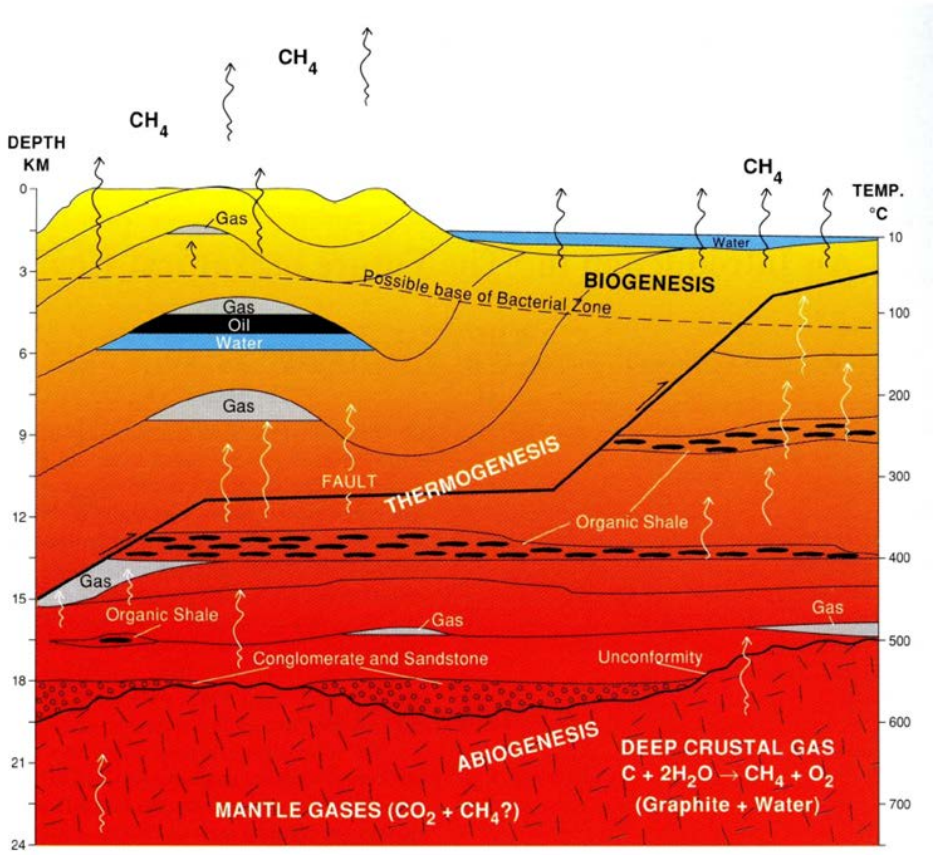
Thank you

BRENDAN HALLIBURTON
www.csiro.au

Methane Formation

Schematic of possible sub-surface methane generation pathways

- Abiogenesis – mantle gases and deep crustal gas
- Thermogenesis – burial and thermal heating of organic rich shales and coals
- Biogenesis – microbial and archaeal generation of methane under anaerobic conditions

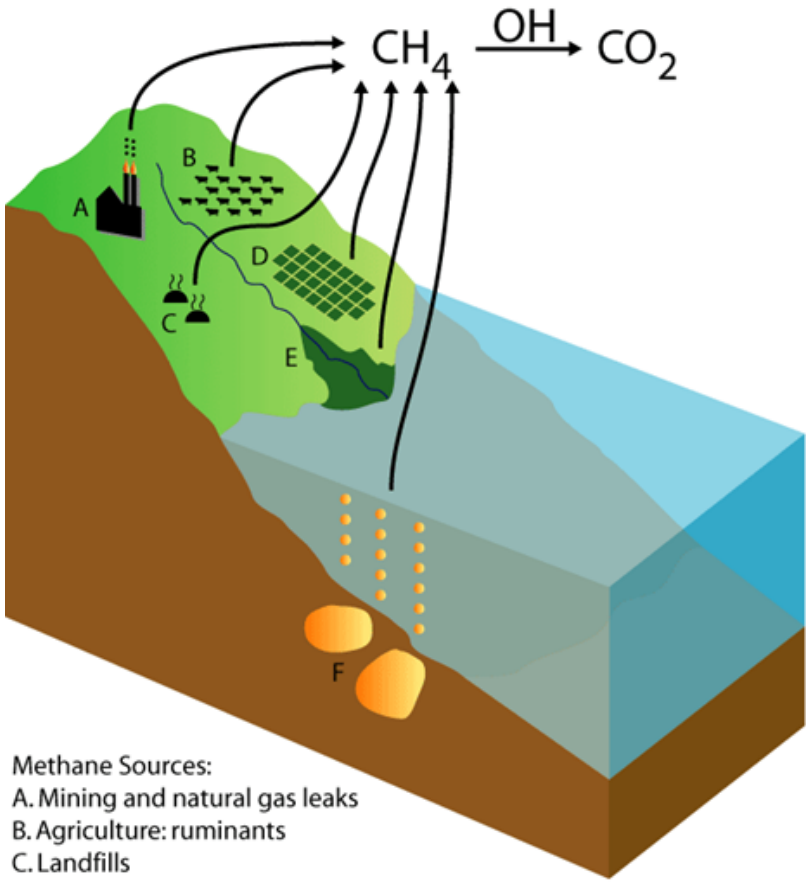


Howell et al, 1993

Methane Sources

Sources of methane in the environment

- Natural and anthropogenic emissions
- Other less studied sources include:
- Thawing of permafrost (Canada and Russia)
- Bushfires
- Hydrothermal vents and mid ocean ridge venting



Methane Sources:
A. Mining and natural gas leaks
B. Agriculture: ruminants
C. Landfills
D. Agriculture: rice paddies
E. Natural wetlands
F. Hydrates

NASA, GISS, 2013

Ground based surveying (mobile monitor)

Ground based monitoring would be undertaken using a 4WD vehicle equipped with a methane analyser, GPS anemometers etc.

CSIRO methane surveying vehicle

Flux Chamber Monitoring

Ground surface emissions

Long Term Flux Chamber Monitoring

Ground surface emissions

Aerial Monitoring

Flux emission monitoring emissions