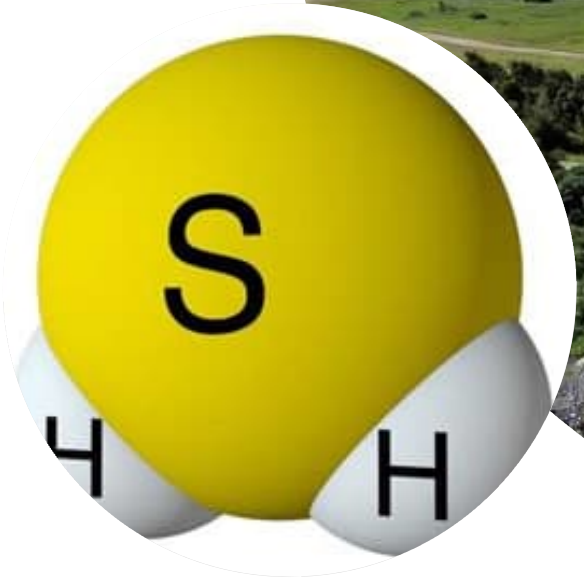

From Poo to You – Safe Biomethane

11th September 2023

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Worley Group

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Introducing the speakers

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Fact Sheet:
Malabar Biomethane Injection Project

Australia's first biomethane-to-gas network project will see thousands of Sydney customers using renewable gas, sourced from biowaste and blended with natural gas, for cooking, heating and hot water.

Jemena and Sydney Water are working together to generate biomethane at the Malabar wastewater treatment plant in South Sydney. The high quality biomethane gas will be injected into Jemena's New South Wales gas distribution network – the largest in Australia with around 1.5 million customers.

Initially, the Malabar facility will produce renewable biomethane (by volume) equivalent to the gas usage of approx. 6,300 homes per year with the potential to scale up to around 200TJs each year – equivalent to the natural gas usage of approx. 13,300 NSW homes per year, if put to use in the residential network.

The multi-million dollar project is jointly funded by Jemena and the Australian Renewable Energy Agency (ARENA) who will provide up to $5.9 million in grant funding.

ARENA

Jemena
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What’s the difference Biogas - Biomethane

Biogas

Biogas is the gas created when organic waste is decomposed in an oxygen-deprived environment through a process call anerobic digestion. The biogas composition produced by anerobic digestion depends on the starting organic materials and bugs but generally contains methane (typically 50 – 75%), CO_2 (25 -50%), organics, nitrogen, and H_2S.

Holds the potential to be a “renewable” replacement for natural gas as due to is naturally occurring nature and its easy adaptation to the current gas infrastructure. Sometimes call “green gas” and “renewable gas”.

Biomethane

Biomethane is the term generally used with the biogas is upgraded to removed the CO_2 and other contaminants to concentrations of up to 98% methane.

Safety Properties H_2S

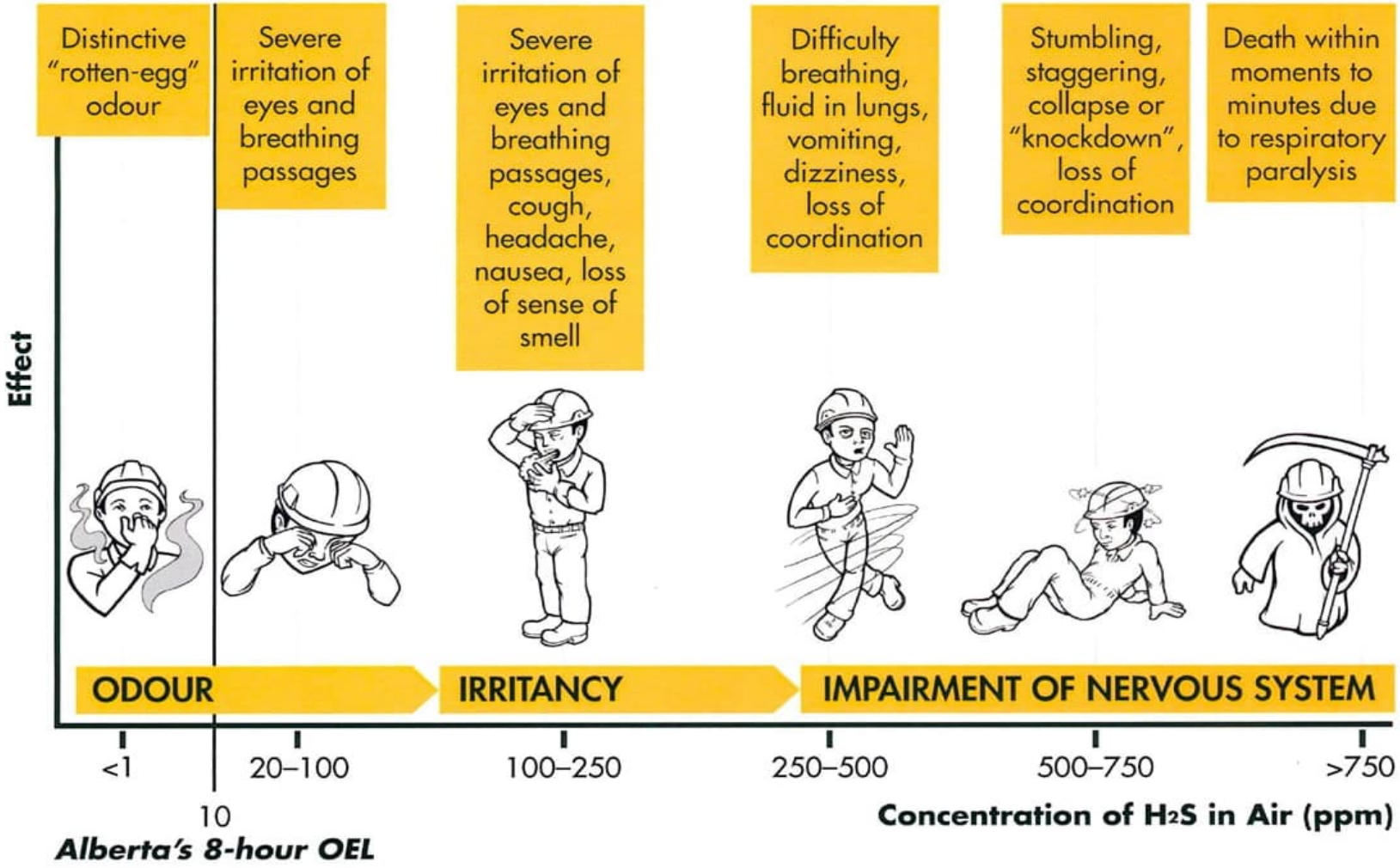
H2S Concentration, ppm	Health Effects	Official Exposure Limits
<.005	Threshold of smell (rotten eggs); normal background levels	
10	Not known health effects after daily exposure	TWA: Standard for a work period as per Worksafe Australia.
15	Start of eye irritation	STEL: Not to be exceeded in any 15-minute period as per Worksafe Australia.
20-50	Eye pain, headache, nausea, coughing	
50-100	Loss of smell after a few minutes, unconsciousness	
100	The maximum concentration from which a person could escape within 30 minutes without experiencing any irreversible health effects	IDLH: As defined by the NIOSH (US).
200-300	May produce unconsciousness and death in 1 to 4 hours of exposure	
500-700	Causes dizziness, potential collapse within 5 minutes	
700-1000	Rapidly becoming unconsciousness resulting in death within a few minutes.	
1000-2000	Immediately unconsciousness with no respiration, resulting in death.	

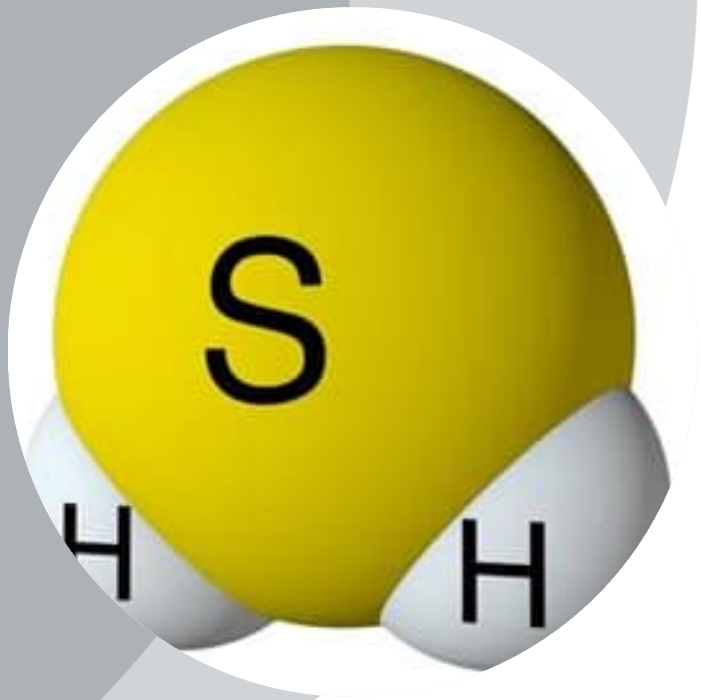
The biogas produced by anerobic digestion contains methane, CO2, organics and up to 1500ppm of H_2S. For comparison the gas pipeline specification is for less than the 10ppm (generally 5.7 mg/m3). Gas quality as defined by AS 4564:2020.

- Highly toxic – loss of consciousness after at low levels, respiratory paralysis and death
- Flammable – It's a flammable gas and the explosive mixture has a wider concentration range than methane
- Corrosive – concentration needs to be considered during material selection (NACE requirements)

- It is heavier than air – hence can accumulate in low lying areas, particularly confined spaces such as pits.
- Smell - It smells like rotten eggs at low concentrations but at higher concentrations it paralyses the olfactory nerve in the nose and hence destroys the sense of smell.
- Colour - It is a colourless gas so no visible sign of detection

EFFECTS OF H_2S EXPOSURE





It can’t happen to me!

Safety Moment

Hydrogen Sulfide Toxicity: Aghorn (Tx) Waterflood Station Incident

Description

- On October 26, 2019, an employee of a waterflood station responded to a produced water pump oil level alarm. The employee isolated the pump from the process but did not perform lockout/tagout (LOTO) to cut the pump off from energy sources. On the night of the incident, the pump automatically turned on, and water containing gas was released from the pump. The employee died from exposure to the gas.

- The employee's wife later entered the waterflood station through a routinely unlocked gate to search for her husband. She was exposed to the released H2S and also died.

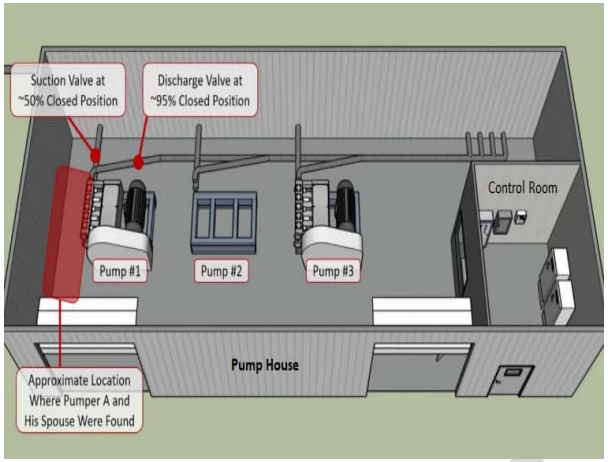
Insights and learning

- Hydrogen sulfide (H_2S) is a flammable, colorless gas with a characteristic odor of rotten egg. H_2S is both an irritant and a chemical asphyxiant with effects on both oxygen utilization and the central nervous system and could lead to death in high concentrations.

Concentration	Symptoms/Effects
0.0005 to 0.3 ppm	Rotten egg smell is first noticeable
100-150 ppm	Loss of smell
500-700 ppm	Collapse in 5 minutes. Death after 30-60 minutes.
700-1000 ppm	Rapid unconsciousness, immediate collapse within 1 to 2 breaths. Death within minutes.
1000-2000 ppm	Nearly instant death

References

1. https://www.csb.gov/csb-releases-final-aghorn-investigation-report/



Safety Moment

Hydrogen Sulfide Toxicity: Aghorn (Tx) Waterflood Station Incident

Description

Five safety violations contributed to these fatalities:

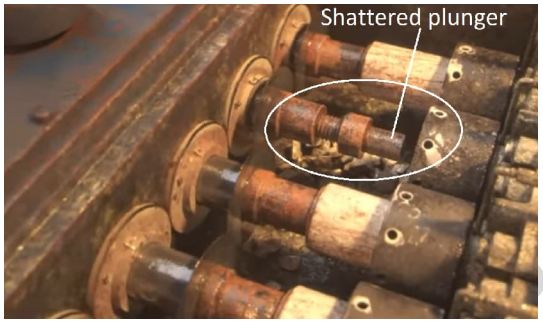
- Nonuse of PPE (personal H2S detector & alarm device) by the employee. He left it in the car in alarm condition upon entering the pumphouse.
- Nonperformance of lockout/tagout (LOTO)
- Inadequate ventilation of the pump house
- Nonfunctioning H2S Detection and Alarm System
- Lack of Safety Management Program
- Deficient Site Security : Unlocked gates allowed the employee's wife to directly enter the pumphouse exposing her to lethal levels of H2S.

Insights and learning

- In oil and gas industry, contact with H2S can occur due to leaks or mismanagement in hydrocarbon transport systems.
- Explain to workers and visitors the hazards of H2S.
- Conduct H2S safety training often and enforce safety management programme.
- Wear personal H2S detectors before entering work area and during work.
- Be aware of the wind direction. Act on alarms and move to safety.
- Follow and implement LOTO procedures.

References

1. https://www.csb.gov/csb-releases-final-aghorn-investigation-report/



Process Safety Fundamentals

"Be aware not alarmed"

Reference:

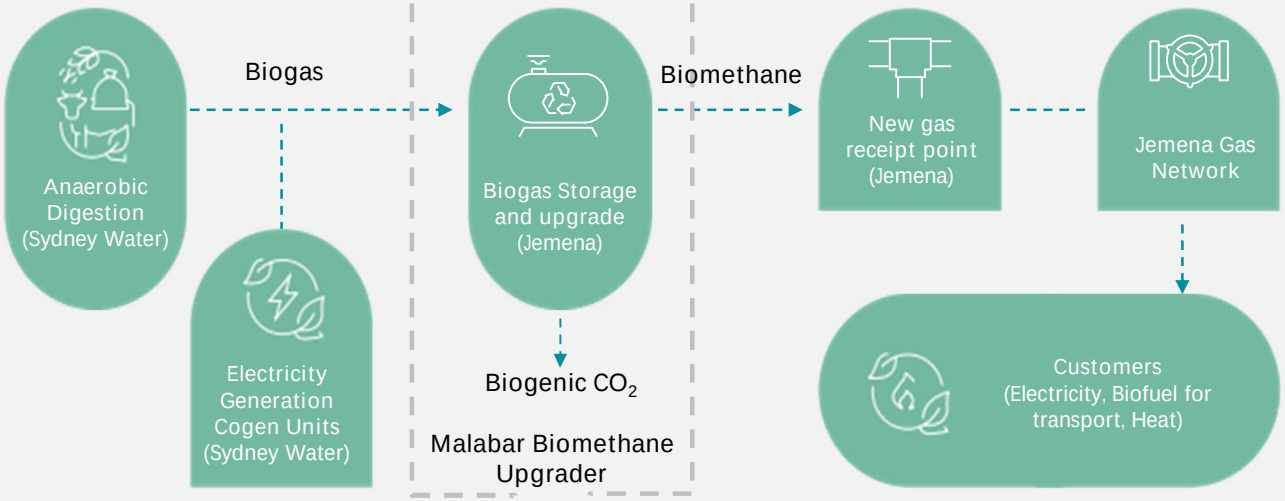
- IOGP Report 638: Process Safety Fundamentals

Case Study

Malabar Biomethane Injection Facility

Biomethane produced at Malabar will displace natural gas when it is injected into the gas network.

Methane is captured, optimised and re-used, instead of being naturally released into the atmosphere from its original waste source, so there are no additional emissions in the production process.

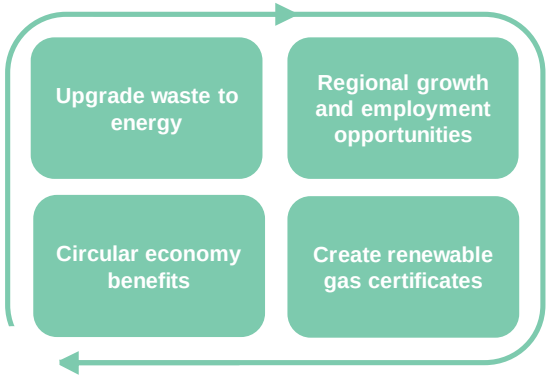


Biomethane: Boosting the Circular Economy

Biomethane is an example of waste recovery and reuse in the circular economy. It can be created by capturing biogas from decomposing agricultural, organic, and domestic waste, and removing the carbon dioxide. At our Malabar facility biomethane will be produced from wastewater, or biowaste.

Biomethane is indistinguishable to regular natural gas. It can be blended seamlessly into the existing Jemena gas network,and could provide enough renewable energy to supply thousands of homes and businesses.

The Malabar Biomethane facility will demonstrate the potential of a waste-to-energy industry which can reduce carbon emissions by replacing other natural gas sources, while creating jobs and many other circular economy benefits.

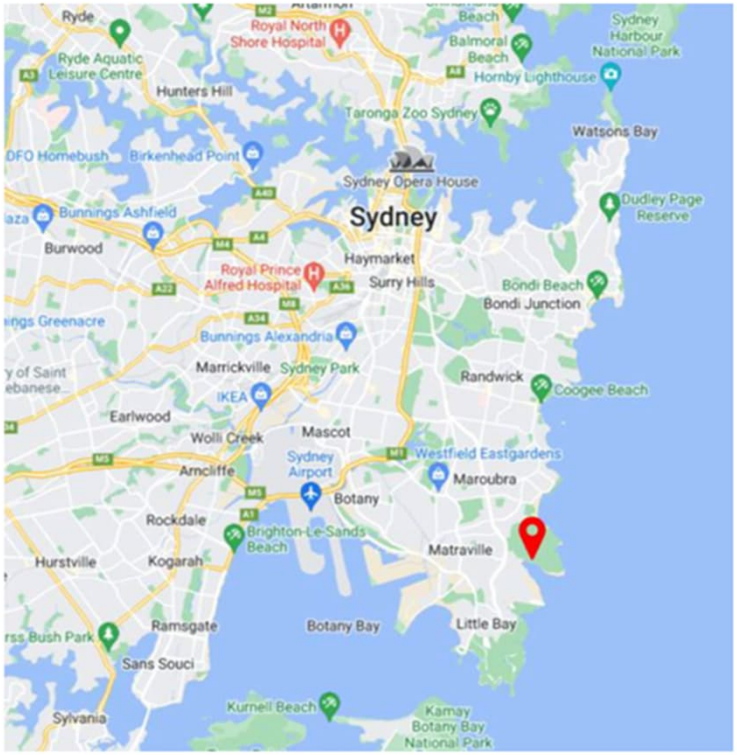


According to ARENA's Bioenergy Roadmap 2021, the Australian bioenergy sector could contribute:

	By the 2030's	By the 2050's
Additional $ GDP	$ 10 billion	$ 14 billion
Additional Jobs	26,200	35,300
Emission Reduction (% of 2019 levels)	9%	12%
Extra landfill waste diverted (vs 2019 levels)	6%	7%

Malabar Biomethane Injection Project - Location

The Malabar Biomethane Injection plant is located at Fishermans Road Malabar at the Sydney Water Malabar Treatment plant. The project is a joint initiative between Sydney Water and Jemena and has ARENA funding.



The biogas was originally used to produce electricity for use at the Sydney water facility and the new facility upgrades the gas to biomethane for injection into the gas pipeline network.

Facility Overview

The Malabar Biomethane Injection Project receives low pressure gas from the Sydney Water anerobic digesters. Biogas is stored in a low pressure biodome, around 4 KPag prior to being sent through pretreatment to remove hydrogen sulphide, liquids and other organic compounds, compressing and upgrading (CO_2 removal) and injection into the gas network.

The Biomethane Plant comprises:

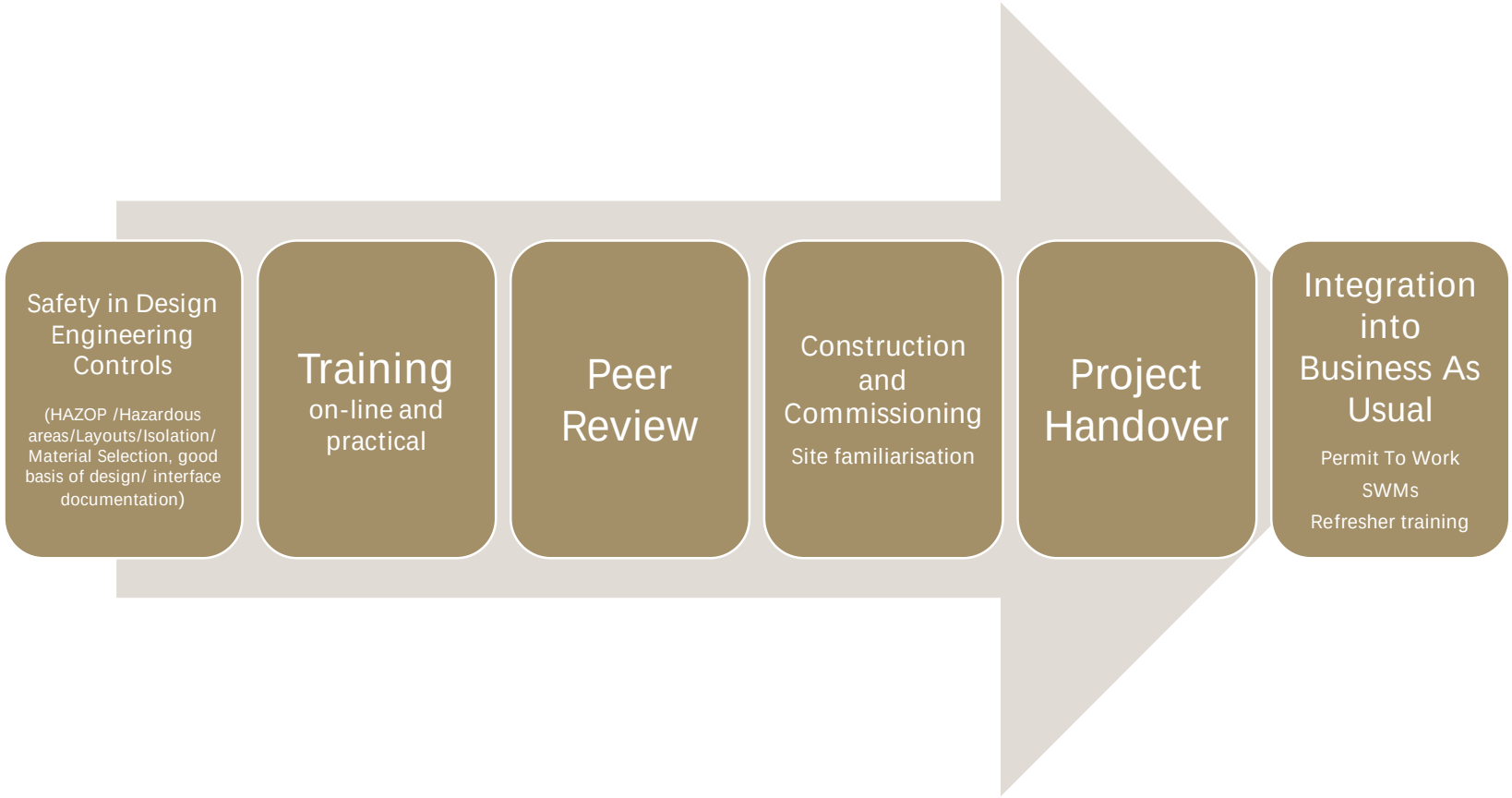
- Buffer Storage dome (Biodome)
- Odourant injection
- Gas blower to raise raw biogas to pre-treatment inlet pressure
- Cooler (liquid drop out)
- Activated carbon filter for H_2S removal
- Carbon filter vessel for removal of siloxanes and VOC's
- Compression (including cooling and further liquid drop out)
- Hollow fiber CO_2 removal membranes

Check out "From Poo to you" ARENA announcement for a video of inflation of the biodome https://arena.gov.au/blog/from-poo-to-you-biomethane-plant-opens/

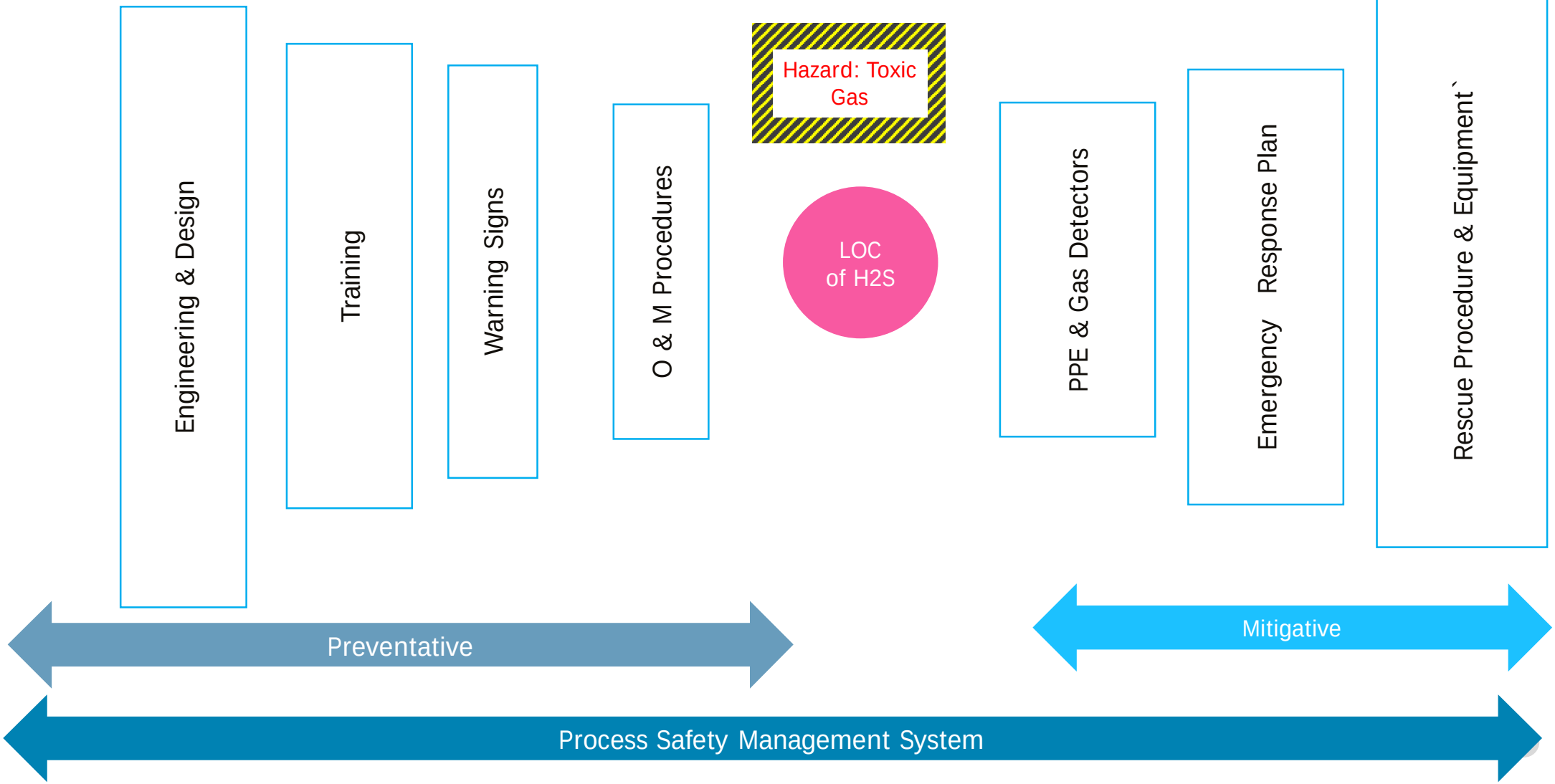

Renewable Gas
Supporting the energy transition
FIRE EXTINGUISHER
DANGER
H2S
MITSUBISHI
HEAVY INDUSTRIES
R32

The Challenge

Introducing a new hazard into an operating company that normally only deals with sales spec gas.



Bow Tie Analysis



Any Questions?

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Thank You – particularly to all involved in the project and supporting knowledge sharing.

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