



Developing minerals to provide the planet with environmentally sustainable carbon capture solutions to reduce greenhouse gas emissions

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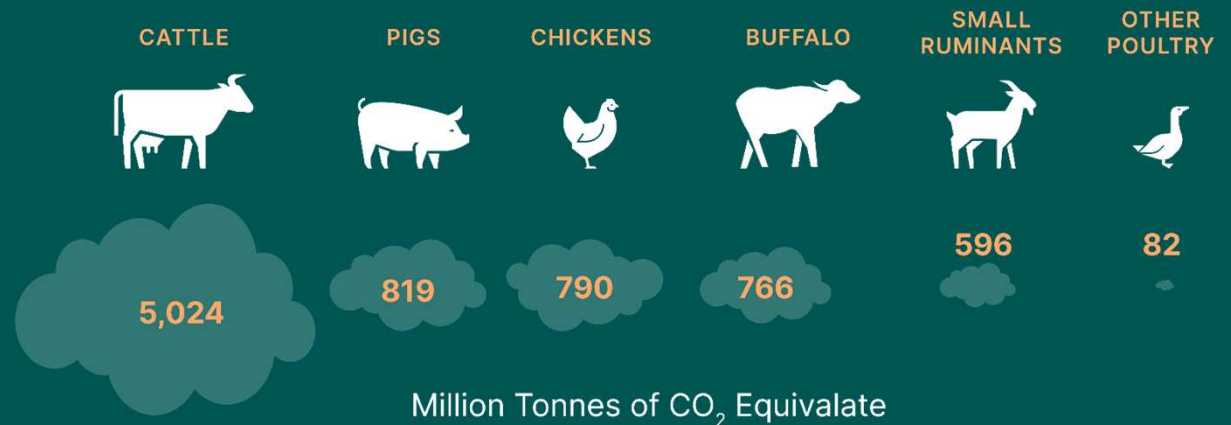
ESG Minerals: Who We are and What We do



Developing carbon capture technologies to reduce global methane (CH₄) emissions in the livestock industry, by leveraging the unique qualities of our Australian halloysite and kaolinite assets.

- Agriculture emits a quarter of global greenhouse emissions
- ESG Minerals is developing technologies for:
 - Reducing GHG emissions from the livestock industry
 - Carbon capture and re-utilisation to produce sustainable and carbon neutral products

GLOBAL ESTIMATES OF EMISSIONS BY SPECIES.



Includes emissions attributed to edible products and to other goods and services, such as draught power and wool. Beef cattle produce meat and non-edible outputs. Dairy cattle produce milk and meat as well as non-edible outputs

Source: Food and Agriculture Organization of the United Nations, 2017

GHG Emissions Reduction is here and now for Australia



COP 28 Pledge

Reduce global methane emissions below 2020 levels by at least 30% by 2030¹.

Australia is a top 5 global emitter of methane.



MLA Net Zero by 2030²

Australian livestock production, including lot feeding and meat processing, to be carbon neutral by 2030.

OTHER IMPORTANT DRIVERS



New Zealand Tax on Agricultural Emissions 2025³

One of the first countries to price agricultural emissions.



EU Carbon Border Adjustment Mechanism 2025⁴

Carbon pricing on all goods entering the EU

Sources:

- 1 Global Methane Pledge Ministerial, COP28, December 2023
- 2 Meat & Livestock Australia, CN30, February 2020
- 3 Ministry for Environment, Pricing Agricultural Emissions, November 2022
- 4 Carbon Border Adjustment Mechanism, European Commission, October 2023

The Earth has a serious problem. We are working on a solution.

Problems

Greenhouse gas emissions:
A global concern



Natural and low carbon footprint mineral

Kaolin and Halloysite at Cloud Nine is one of them

Solution: Potential Technologies



Feedlot supplement



Pasture supplement



CH₄CO₂ removal and utilisation

Clay mineral processing is a low emissions method

Cloud Nine is the Largest Kaolin-Halloysite Project in Australia

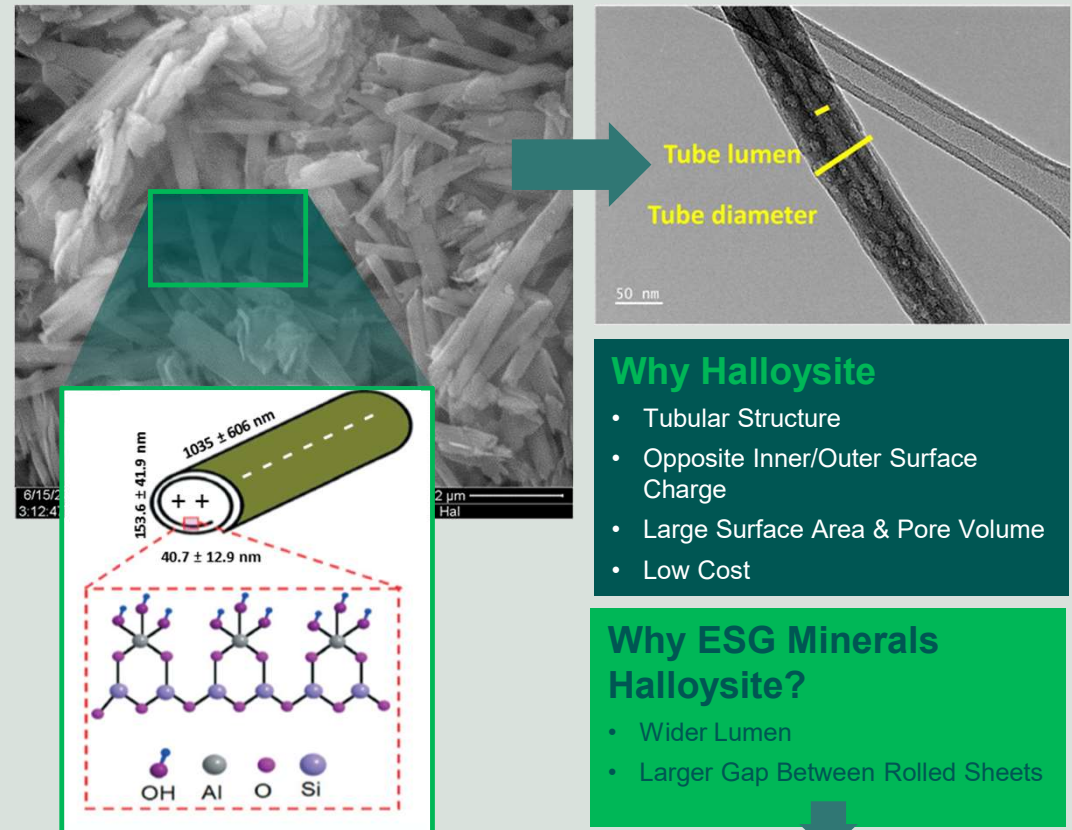


ESG Minerals is the 100% owner of the Cloud Nine kaolinite halloysite deposit located near the town of Merredin, ~325km east of Perth, Western Australia, which is host to a mineral resource containing 280Mt of bright white kaolinite and halloysite, essential minerals for carbon emission reduction.

- Largest kaolinite halloysite deposit in Australia.
- Cloud Nine halloysite nanotubes and platy kaolinite are suitable for adsorption.
- Facilitate carbon capture from GHG emitting substances including livestock excreta
- Reprocess into soil amendment materials.
- Low energy consumption, easy regeneration, durable & stable.
- Target markets include construction materials, filtration, fertilisers and soil amendment

Characteristics of Cloud Nine Halloysite and Kaolinite

- Cloud Nine halloysite nanotubes (HNTs) have exceptional luminance (adsorption capacity).
- Cloud Nine kaolinite is very platy and has an excellent shape factor – the surface area of each plate is very large compared to its thickness.
- Combined, the Cloud Nine halloysite and kaolinite have exceptional adsorbent and mechanical (high strength) properties.



Why Halloysite

- Tubular Structure
- Opposite Inner/Outer Surface Charge
- Large Surface Area & Pore Volume
- Low Cost

Why ESG Minerals Halloysite?

- Wider Lumen
- Larger Gap Between Rolled Sheets

Desired Properties for Adsorbent

ESG Minerals Research Investment



- crcCARE is an independent research and development organization, which also provides environmental policy guidance.
- ESG Minerals committed to three-year investment period of \$3.5m with \$2.5m spent so far.
- crcCARE undertaking two specific projects assessing Cloud Nine halloysite-kaolinite for:
 - Methane emissions reduction in the livestock industry
 - Carbon capture and utilisation
- Third and final year of collaboration to progress R&D with live trials.

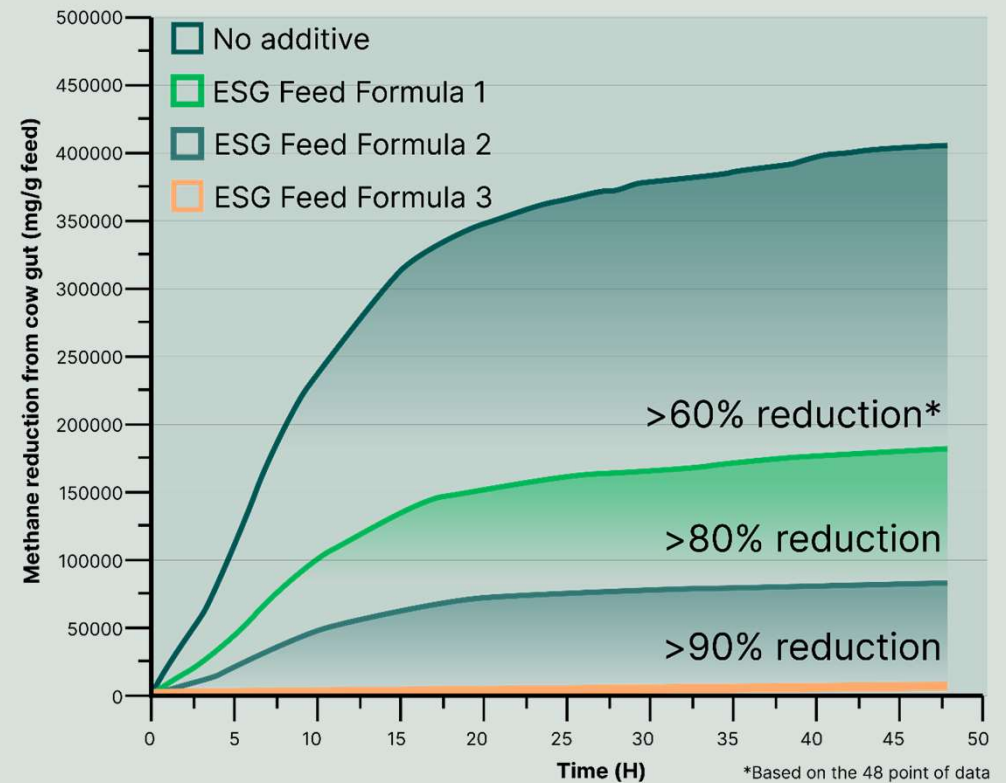
Live sheep lab scale testing conducted at University of New England, Armidale NSW



First round of live sheep trials undertaken Q4 2023, results awaited

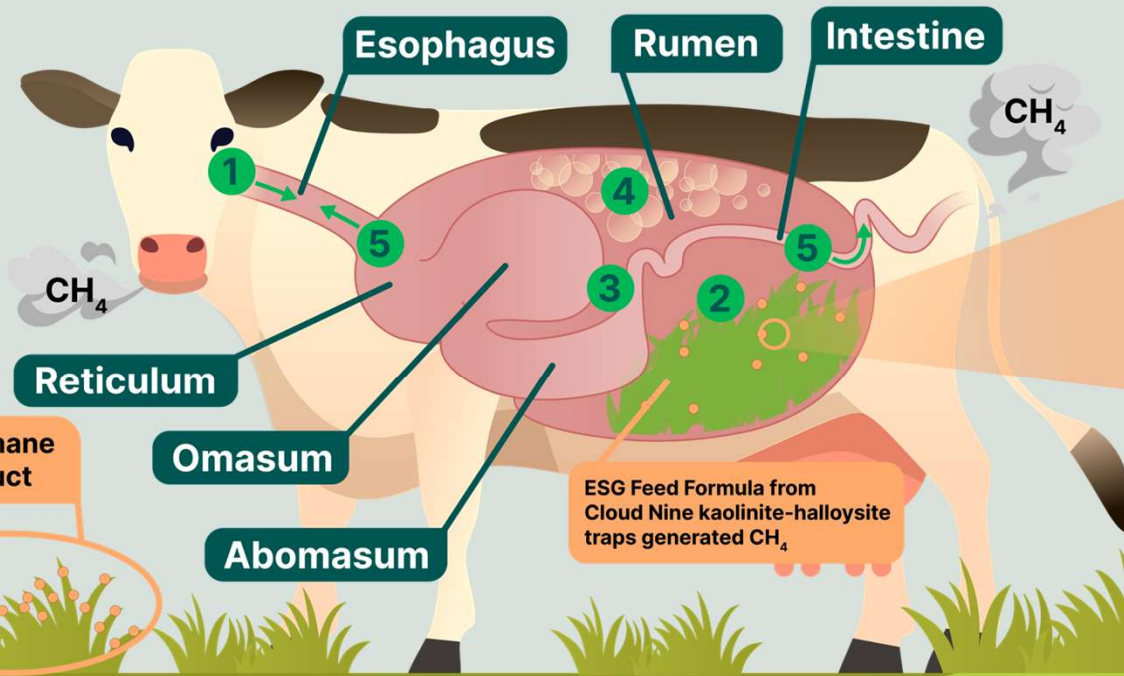
Tests Confirm Reduced CH₄ in Cows at Lab Scale

- ESG Minerals has patented three formulas proven to absorb enteric methane production.
- ESG Minerals' Feed Formulas contain modified Cloud Nine kaolinite and halloysite.
- ESG Minerals is the owner of the patents and crcCARE will earn royalties from the commercialisation of the patented IP.



Cloud Nine Halloysite/Kaolinite for Methane Emission Reduction in the Cattle Industry

- 1 Plant Material in
- 2 Bacterial digestion / fermentation
- 3 H^2 & CO_2
- 4 Methanogens
- 5 CH_4 Out



Less CH_4 produced with Cloud Nine Methane Reduction Product

(project preliminary result obtained)



Swollen Cloud Nine halloysite tubes and kaolinite plates after carbon capture

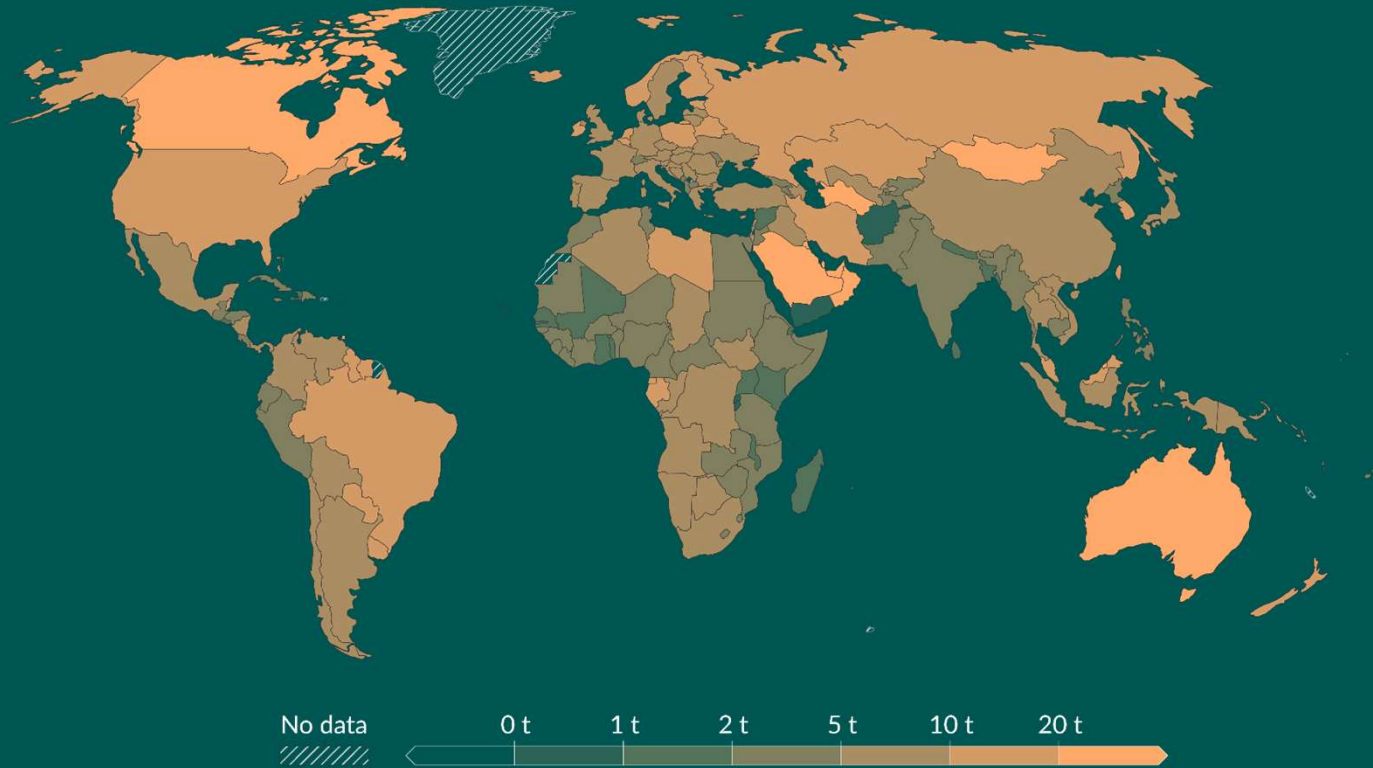
Cloud Nine Methane Reduction Product

ESG Feed Formula from Cloud Nine kaolinite-halloysite traps generated CH_4

Global Addressable Market

PER CAPITA GREENHOUSE GAS EMISSIONS, 2021

Greenhouse gas emissions include carbon dioxide, methane and nitrous oxide from all sources, including land-use change.



Data source: Jones et al. (2023); Population based on various sources (2023)
Note: Land-use change emissions can be negative. OurWorldInData.org/co2-and-greenhouse-gas-emissions

Cloud Nine Partnership Model



Next steps for ESG Minerals and crcCare



Milestone	Q4 2023	Q1 2024	Q2 2024	Q3 2024	Q4 2024
Live Sheep Trials					
Live Cattle Trials					
Feedlot Trials					
Broad Acre Pasture Trials					
Carbon Capture and Recycling into natural Fertiliser					
Carbon and Nitrous Oxide Capture and Recycling of Spent Materials					
File Global Patents for all Projects					
Prepare Final Report					
Bulk end-sure samples and end-user testing					
Offtakes and determination of pricing					
Economic model and scoping study					

Competition Analysis: other global livestock methane emission mitigating initiatives



Class	Synthetic Inhibitors	Selective Breeding	Vaccines	Natural Inhibitors	Other New
Description	Chemical compound inserted by capsule or feed additive (active ingredient 3-NOP ¹)	Generational genetic selection	Injection of CH ₄ reduction vaccine	Extract from algae (<i>Aspragopsis</i>) as feed supplement	Other new initiative
Effectiveness	Up to 30% CH ₄ reduction ²	10% CH ₄ reduction achieved in NZ sheep after 3 generations ⁴	Unknown	Trials have shown range of 20%-98 ⁹ (Ave 60%)	To be determined
Status	Undergoing laboratory trials.	NZ sheep trials ongoing. Cattle breeding trials less advanced due to cost. ⁶	Prototype development stage only. ⁷ Veterinarian practices and cost will determine adoptability. ⁸	Presence of natural toxins at high doses is a concern. ¹⁰ Large scale production is a significant barrier. ¹¹	For example: Rio Tinto has just committed to £150M to fund the Centre for Future Materials by the Imperial College London ¹²
Timing	2 – 5 years ³	2 years ⁵	>10 years	Available now	10+ years

Source references are contained in the Annexure section

References for slide 14

1. Dijkstra J et al. 2018 Short communication: Antimethanogenic effects of 3- nitrooxypropanol depend on supplementary dose, dietary fibre content and cattle type
2. Hristoz NM et al. 2015 An inhibitor persistently decreased enteric methane emission from dairy cows with no negative effect on milk production.
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4. Rowe S et al. 2019 Selection for divergent methane yield in New Zealand sheep – a 10 years perspective.
5. Beef Lamb New Zealand 2020 Low methane-emitting sheep a reality in New Zealand.
6. Fennessy PF et al. 2019 The potential impact of breeding strategies to reduce methane output from beef cattle.
7. Werdlock DN et al. 2013 Progress in the development of vaccines against rumen methanogens.
8. Ugochukwu AI et al. 2020 Driving adoption and commercialisation of subunit vaccines for bovine tuberculosis and Johne's disease: policy choices and implications for food security.
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12. <https://www.riotinto.com/en/news/releases/2023/rio-tinto-commits-150-million-to-centre-for-future-materials-led-by-imperial-college-london>



THANK YOU

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