CANADIAN RESEARCH
REAL-WORLD IMPACT

KEEP THE BIOENERGY

Smarter RNG from Canadian Swine Manure





PEOPLE
PIGS
PLANET
PROGRESS

Recover more bioenergy. Reduce methane losses. Strengthen RNG climate performance.

1 Why this matters



Swine manure is both a methane-emission challenge and a renewable-energy opportunity.



Anaerobic digestion converts manure organics into methane-rich biogas that can be upgraded to renewable natural gas (RNG).



CH_4

Methane losses reduce both usable energy recovery and the climate benefit of RNG.

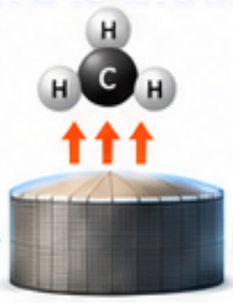


Stage-specific methane accounting connects methane losses with energy recovery and climate performance.

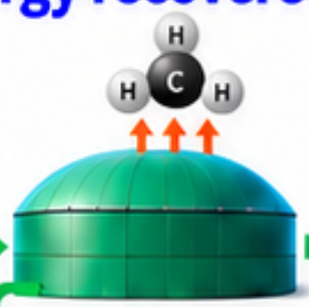
2 Where is bioenergy recovered—and where can methane be lost?



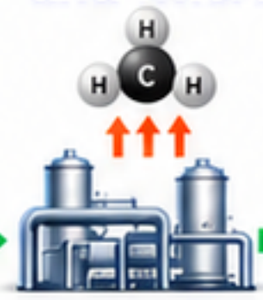
Swine manure
(excreted by pigs)



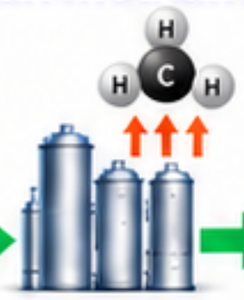
Manure storage
Potential methane losses (e.g., surface emissions, covers, fittings)



Anaerobic digester
Potential methane losses from digester equipment (e.g., seals, valves, overpressure)



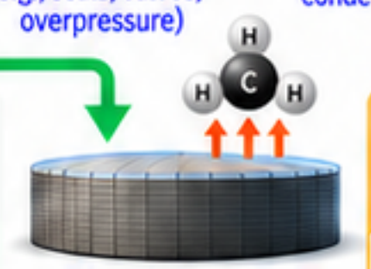
Biogas handling
Potential methane losses from pipes, compressors, condensate pots, flares



Upgrading
Potential methane losses from upgrading equipment (e.g., membranes, PSA, vent streams)



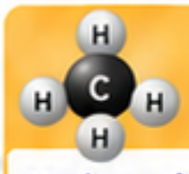
RNG
(renewable natural gas)
Lower carbon renewable fuel



Digestate storage
Potential methane losses (e.g., surface emissions, covers)

Captured methane = useful renewable energy

Methane captured from swine manure can be converted into biogas and RNG, providing renewable energy and displacing fossil fuels.



Escaped methane =
lost energy + reduced climate benefit

Methane that is not captured is lost energy and can increase the carbon intensity of RNG, reducing its overall climate benefit.

3 What the evidence shows



1,115 DAYS
Long-term swine manure-carcass co-digestion at 25°C



CH_4

60–70% CH_4
Sustained under low-to-moderate loading regimes



ANN
R^2=0.813
11 ML models across five families: ANN, ELM | RF, XGBoost, DT | SVM, GPR, KNN | PSO-ANN, GA-ANN | FL
Zero-leakage reactor-independent benchmark on unseen reactors.



EARLY WARNING FOR SYSTEM STABILITY
XGBoost detected emerging process instability before failure.

4 Integrated research framework

FROM REACTOR EVIDENCE TO FARM-SCALE PERFORMANCE

Tier 1 — 9 farms/facilities



Québec, Ontario, Manitoba
- Farm/manure data
- Digestate data
- Operational data
- Seasonal data
- Energy-use data

Tier 2 — 3 intensive monitoring sites



- Stage-specific methane measurements
- Leak hot-spot identification
- Higher-resolution monitoring



Measure → **Predict & Explain** → **Model & Evaluate** → **Improve**



- Farm and manure data
- Digestate data
- Operational data
- Energy use
- Seasonal variation



- ANN • XGBoost
- LORO/LODO
- SHAP
- Uncertainty analysis
- Early warning



- AAFC Holos V4.0
- Fuel LCA
- GHGenius/BC-LCFS
- CA-GREET



- Identify hot spots
- Compare scenarios
- Prioritize management practices

5 Research contributions



Emission hot spots & operating windows
Identify where methane losses are most likely to occur and define empirical ammonia–VFA stability ranges.



Holos-compatible swine-manure parameters & scenarios
Develop parameters and scenarios to support Holos applications and decision-making.



RNG carbon-intensity assessment & framework comparison
Assess how methane recovery and losses affect RNG carbon intensity using multiple LCA frameworks.



Evidence-based management recommendations
Provide practical, evidence-based recommendations for producers and industry.

6 Why producers should care



Recover more bioenergy
More renewable energy from existing resources.



Find methane-loss hot spots
Focus attention and maintenance where it matters.



Understand RNG climate performance
See how methane losses affect overall performance.



Support better decisions
Practical evidence to guide management and investment.

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Research infographic for PORC SHOW 2026 | English version