

12 Questions and Answers about Energy from Manure

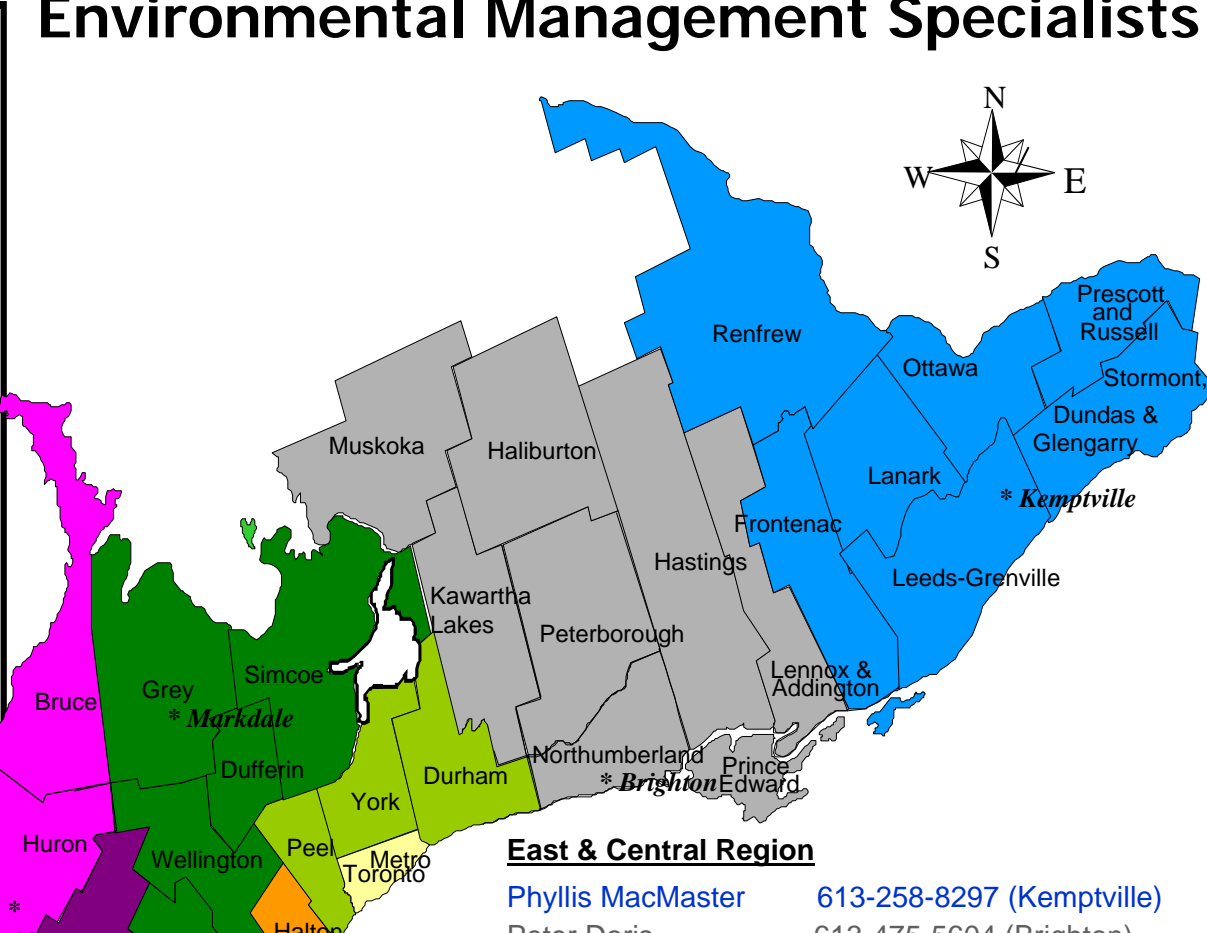
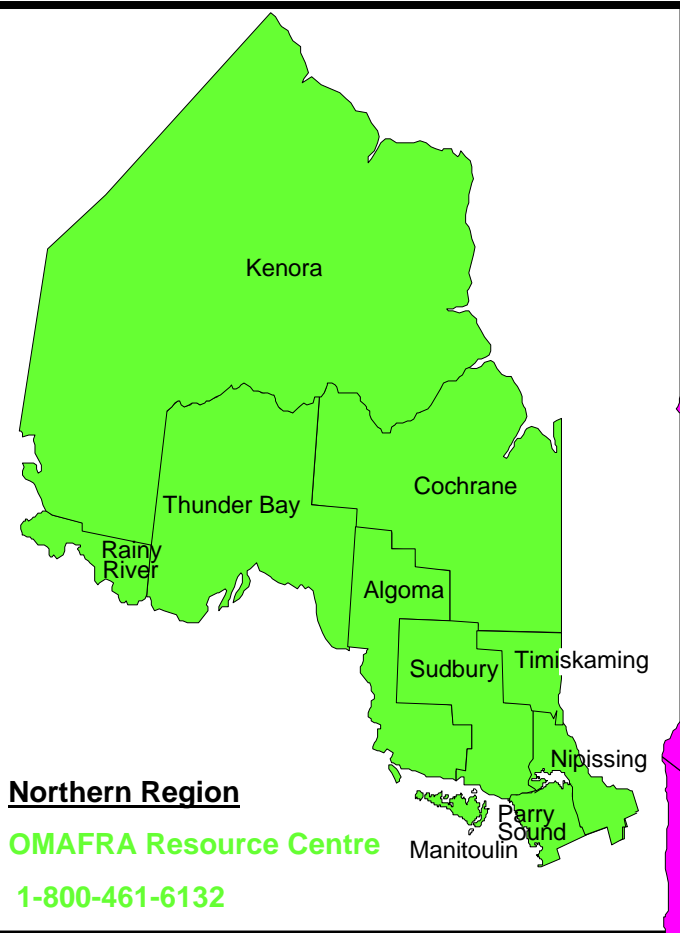
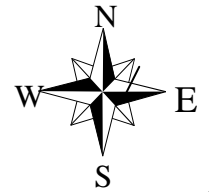
**Growing the Margins Conference
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Ontario Ministry of Agriculture,
Food and Rural Affairs**

Manure!



Environmental Management Specialists



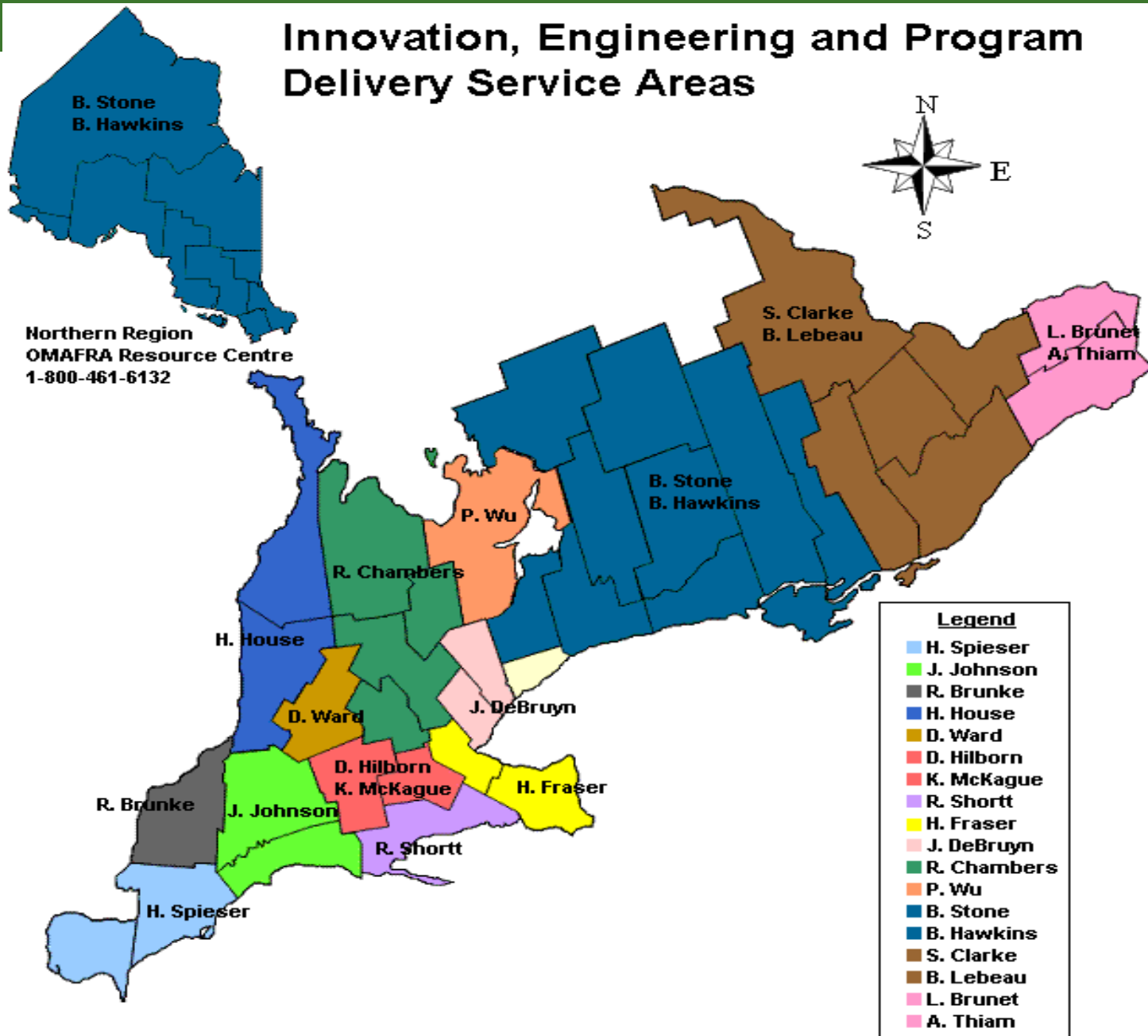
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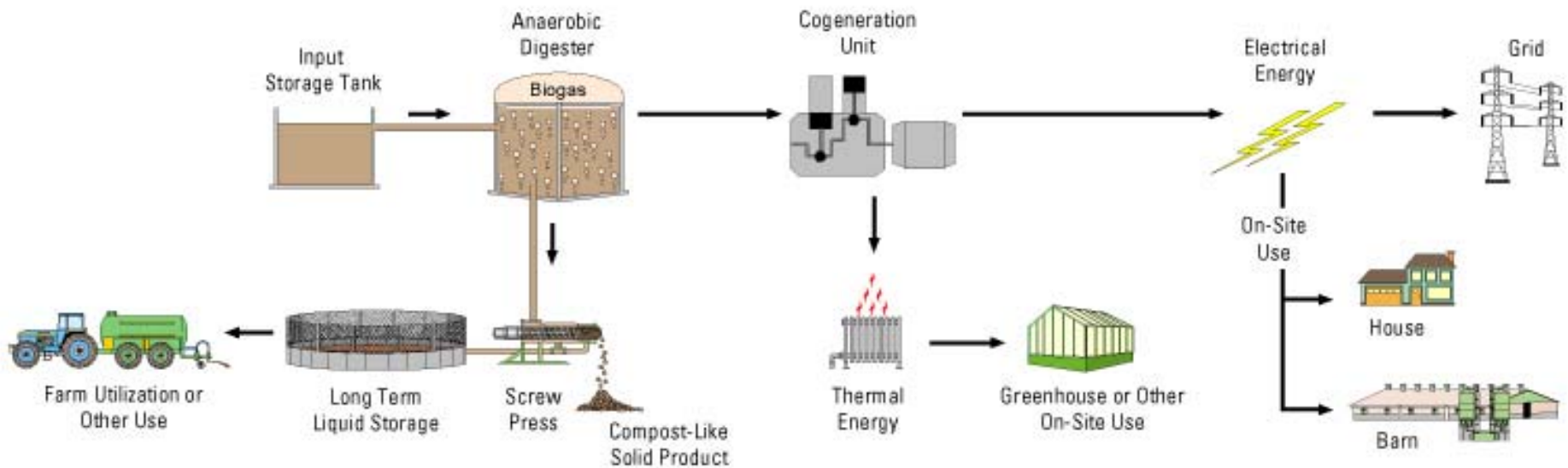
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Innovation, Engineering and Program Delivery Service Areas



Is there enough energy value in manure to even consider energy-from-manure systems?

- Yes, but...
- Possible energy uses:
 - Biogas:



Enough energy ... ?

Biogas – yes if:

- If you can secure value for the various benefits (energy, pathogens, odour, GHG, etc)
- Blended with off-farm materials
- New OMAFRA regulations – 25% off-farm materials without C of A
- Large systems (>300 kW?) using only manure could be economical, particularly if there is heat use (>50% of energy available as hot water)

Enough energy ... ?

Pyrolysis/bio-oil (400°C, absence of oxygen):



Enough energy ... ?

Pyrolysis – maybe

- Technology rapidly developing for on-farm use
- Bio-oil use remains to be demonstrated effectively
 - (contains 20-30% water)
- Opportunities in value-added bioproducts possible

Can I burn poultry manure on-farm?

Challenges

- **Moisture**
 - 8,500 Btu/lb (dry) – lots of energy in bedding
 - Poultry manure typically 30% to 40% moisture – cost to dry
- **Infrastructure**
 - Hot water will be used to transfer heat. Need larger system for viability
 - Material will not flow like pellets or corn kernels
 - There are a lot of minerals in the manure (hence the high nutrient value). This will lead to burning issues (clinkers, etc).
- **Air emissions**
 - No Certificate of Approval if on-farm and pure manure.
 - Odour complaints are possible
 - Still subject to restrictions if pollution is deemed to occur
- **Uncertain:** concentration of heavy metals?



Can I burn poultry manure on-farm?

Experience

- Minnesota facility
 - Combustion at 1500°C
 - burn turkey litter to generate electricity from steam turbines
 - dry the manure before they burn it
 - pay \$10-\$15/ton for manure
- Blended with coal (Texas A&M)
 - aids combustion
 - greater volatile matter on a dry ash free basis compared to coal
- Consider current fertilizer value (NMAN software) vs energy costs
 - broiler litter \$30-45 /ton
 - turkey litter \$35-55 /ton
- Soil Health
 - Need to put value on carbon in the soil



Can I use solid manure in an AD operation?

- Dry Fermentation
 - Garage-type digester
 - Blend 50 to 60% new material with 40% to 50% predigested material
 - Spray recycled liquid effluent
 - Multiple units for even gas production
 - 2 to 5 week retention
- Fully Mixed Digester:
 - Solid + Liquid inputs
 - Solid manure may need chopping
- Other:
 - Solid inputs (e.g. dog-food) – break apart for better digestion
 - Straw – chop to avoid floating scum layer





Can an AD digest poultry manure or other high-N manures on their own?

- Experience in Ontario digesting high-N materials
 - high in NH_3 biogas
 - High N in digester may results in inhibition of bacteria
- Other researchers: Mississippi – no problem – operated layer manure digester for over a decade! *Patent pending...*
 - Control, monitoring, consistent diet
- Rule of thumb for fully mixed digester:
 - maximum 25% poultry manure
 - blend with other manure types and/or off-farm materials



Can I add deadstock to my manure-based anaerobic digester?

- Deadstock will digest in an anaerobic digester
- Conventional digestion is not an effective prion treatment
- The Deadstock management industry is interested in exploring new ways to assist in managing deadstock

Deadstock in the “Farm System”

- Is the species of animal listed in the Dead Animal Disposal Act (DADA)?
 - Cattle, dairy, pigs, horses, sheep, goats
 - Current dead animal disposal legislation permits collection, burial under 60cm of earth and composting with 60cm or more of sawdust, or other biodegradable high in carbon content material.
 - Exploring as to whether AD can be defined as an option.
 - Transportation from farms owned by the same operator must use DADA markers
 - Deadstock from neighbouring farms may not be moved to central farm site for approved disposal
- If not listed in DADA, (ie poultry,) then digestion may be possible
- New AD regulations under the Nutrient Management Act allow for on farm material to be digested

Will ionophores in the feed reduce the yield of biogas?

- Intent of additives is to minimize methanogenic production in animal's gut (cattle and chicken broilers)
- increases carbon and nitrogen retention in animal (feed efficiency) - anaerobic
- Evidence of decreased biogas production in Ontario facility when additives began to be used
- Some evidence of “bounce back” once digester acclimatizes
- Recommendation:
 - Lab scale studies to test recipe



Value from Byproducts

- Depending on input, output has significant liquid
 - Screw press separator/high efficient centrifuge
 - Bedding Material for Animals
 - Fiber Material for Board and Plastic Reinforcement
- Liquid organic fertilizer for horticulture or golf courses?
 - Theoretical, but not clearly demonstrated
- Best value remains in land application:
 - Higher liquid content, N more readily available
 - Needs to beat fertilizer value (poultry \$30 to \$55/ton, dairy \$30/ton)
 - Centralized system: remote storage at cash-croppers' fields



What happens to the fertilizer nutrients after manure is digested?

Dairy Farm: Manure compared to Digestate

Analysis	Manure	Digestate	Difference
pH	7.03	7.86	0.85 (more basic)
Total volatile solids	5.38	5.33	-5%
Biological O ₂ Demand	1.37	0.64	-53%
Dry Matter	7.71%	6.53%	-13%
NH ₄ & NH ₃ -N	18	28	+55.5%

Consider the literature:

- Typically 50% C removal as long chains of carbohydrates convert to single-C methane
- Shift from 50% organic N to 20-30% organic, N more readily available
- There is minimal concentration of nutrients due to carbon loss

Summary of 41 compared samples from 1 Dairy Farm for 1 year

Analysis	Dairy Manure @ 7% DM Nutrients/1000 gallons	Dairy Digestate @ 7% DM Nutrients/1000 gallons
Total N	42	60
NH4 & NH3-N	18	28
N03-N	<1	<1
P ₂ O ₅ (long term pH ^{80%})	10.5	12
BOD	1.37 %	0.64 %
COD	5.03 %	6.06 %
Total Volatile Solids	5.38 %	5.33 %
Initial Dry Matter	7.71% (total solids)	6.53% (total solids)

*all numbers converted to dry matter basis for comparison; then converted both materials to a 7% DM so that we can compare apples to apples

Do I need to manage the digestate differently than manure that is not digested?

- More total Nitrogen in 1000 gallons of digestate than manure
 - Need to manage inorganic N effectively
 - Apply in-season to growing crops
 - Cover crops
 - Avoid fall application
 - Longer storage? Spring and summer applications
 - Cover long term storage to prevent volatilization
- Better control when applying to land
 - Digested manure flows more easily
 - Typically doesn't plug small diameter application equipment
- Variability between systems means each digestate must be tested

What's the minimum size of livestock operation to make a digester economical?

- Predictable: Electricity sales; energy replacement
- Unpredictable: tipping fees from food-based inputs;
 - smaller systems – cut costs – fewer controls – more risk
- **University of Guelph Study: (Mallon & Weersink 2007)**
 - Current RESOP 11¢/kWh (with peak power bonus of 3.5¢/kWh) viable for manure-only digesters > 300 kW (~1100 lactating cows), providing a return on investment of 8%. To obtain a 15% return on investment, a RESOP electricity value of 12 to 17.6 ¢/kWh is required.
 - 25% off-farm organic material decreases the required electricity price required by approximately 1 ¢/kWh. Incorporating energy crops increases the electricity price needed by approximately 4 ¢/kWh

Case Study: Pinehedge Farm – Josef Heinzle

- 65-70 milking cows, yogurt production facility, 6 m³/day manure
 - Equiv. to 1000 finishing hogs, or 100 sows F-F, or 300 sows SEW
- 500 m³ single digester tank
- 100 kW MAN gas engine
- **Costs**
- Total: **\$400,000**
- **Revenue:**
- 100 kW, 8000 hours, ~12¢/kWh (blended SOP price) = **\$90,000/year**
 - *Requires very rich diet or won't achieve this production level*
- Tipping fees
 - **\$20,000/year ?**
- Heat replacement at yogurt plant
 - Unsure of \$ value at this point
- RED program: grant ~**\$120,000** one time

Questions?

