Agricultural Biomass Heating
PART 1 – Demonstration Hydronic Heaters
PART 2 –RETScreen Analysis for Poultry

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OBPC information day
2015 - March 27th

Ontario

Outline

- Demonstration project using briquettes of agricultural and agro-forestry biomass
  - Project fostered by OSCIA
  - Demonstrate efficiency
  - In 2015 : finding raw or processed agricultural biomass in briquette or bricks to heat the small greenhouse in winter 2015-16; please call me for availability/supply offers
- Southgate Township; End of project – which site would make sense for poultry district heating?
  - OMAFRA FANVENT software + NRCan RETScreen analysis

Forman Farms – Construction Pictures


Insulated hot water tanks (buffers)
fröling
FHG
Modern hydronic heater


Outdoor wood “furnace”
POLAR
FURNACE

Southgate Township: Biomass Heat Pilot Project – District Heating for Poultry – RETScreen Analysis

Hydronic heater, district heating sizing and RETScreen Analysis for OMAFRA *Pilot Project: Biomass for Heat and other Applications*

Terrence Sauvé, OMAFRA

PART 2

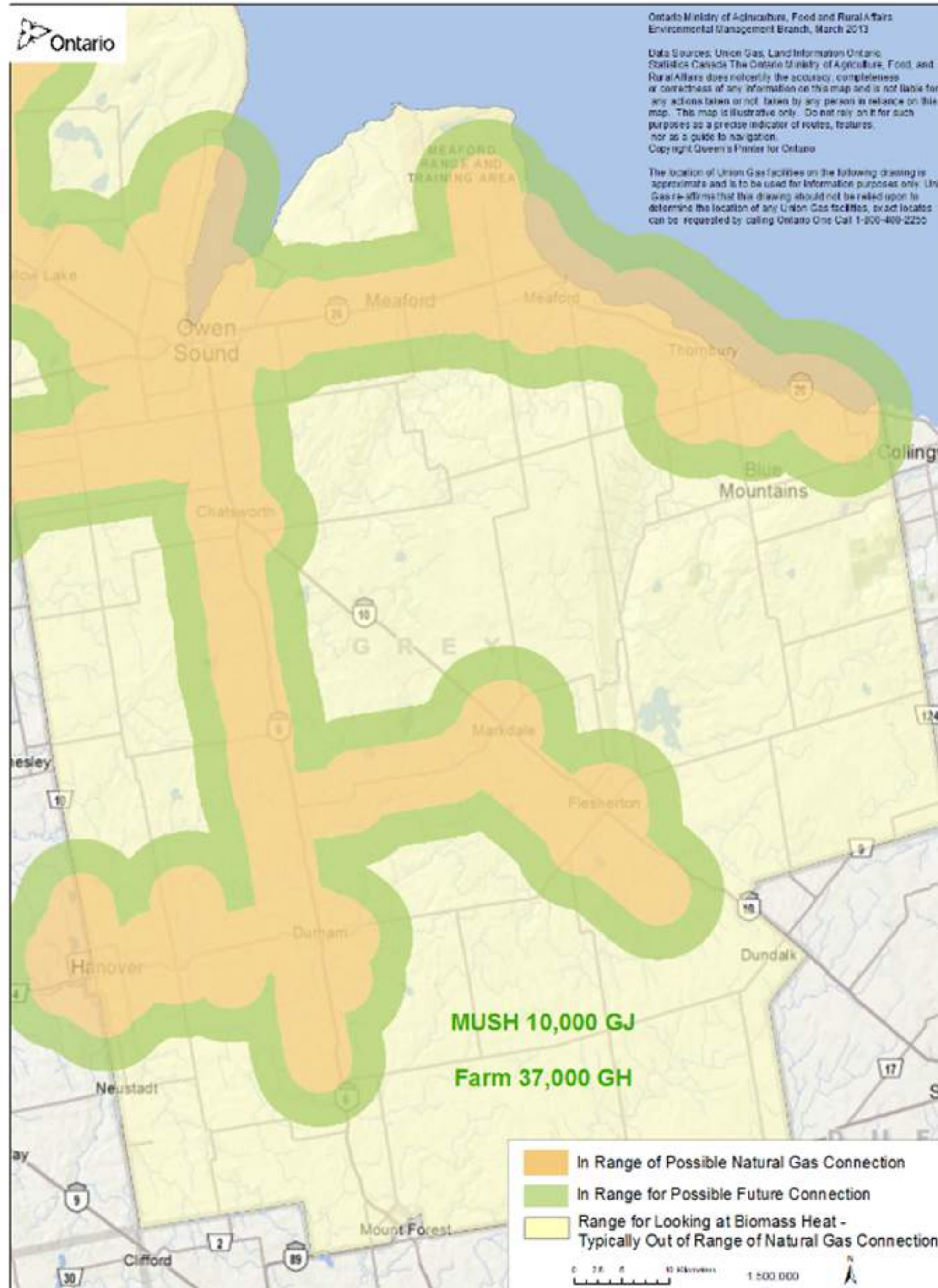
Ontario

Outline

- Follow up on Southgate Township Poster by University of Guelph
- GIS analysis located “large clusters” of heat users
- Study demonstrated potential for Southgate Township to be heated with energy crops and surface area required to grow them

- Fictitious scenario : Which site could we look at if we are to source local un-densified agricultural biomass in a retrofit situation? (Danish model)

Pilot Project Southgate Township



RETScreen for Poultry Heating?

- – OMAFRA's FanVent software evaluated to establish peak heat loss of buildings (8 barns)
- – RETScreen uses AHSREA conductive heat loss which produces a less accurate outcome than FanVent
- – RETScreen provides payback based on fuel and equipment costs
- – Would not recommend this practice for a real case scenario (fine tuning of FanVent + RETScreen required – We are verifying with NRCan for this situation / *Under development*)

District heating – 3 properties – Cluster #6

Heat load sizing - Cluster #6

Cluster #6 analysis

- It would cost $75,000 of biomass using $0.07/lb @ 7,530 BTU/lb for 85% on overall seasonal efficiency (with modern technology and water storage)
- 6,173 million BTU/yr with 469 tons of dry agricultural biomass (does not account heat loss of district heating)
- 66 acres of Miscanthus OR 140 acres of switchgrass required (no storage loss accounted)
- Switching fuel, yearly savings fuel costs of:

  Oil #2; 209,000L/yr @ $1.00/L =

  $134,000 savings/yr

  Propane ; 308,000L/yr @ $0.60/L =

  $110,000 savings/yr

RETScreen – Cost and Financial Analysis

- Obtain consultant pricing for hydronic heater and district heating piping
- Supplier of district heating seriously doubted the payback of connecting the third (furthest) barn
- Initial costs $697,000 (feasibility $10,000)
- Maintenance / yr $10,000 + Overhaul at year 10; $50,000
- Loan payments of $53,000 per year
- IRR pre-tax of 30.5%, simple payback 7 yrs, equity payback 4 yrs + NPV $1,315,000
- Annual life-cycle savings of $66,000/year

RETScreen – Sensitivity – 3 properties

RETScreen Sensitivity and Risk Analysis - Heating project

☑ **Sensitivity analysis**

PAYBACK yrs

Variables: fuel cost (propane $0.60/L and crop $0.07/lb), capital costs, interest rate; ORANGE=bad

Perform analysis on	Equity payback	
Sensitivity range	50%	
Threshold	7	yr

Propane + 25% cost

Energy crop cost + 50%

$		39,455	59,182	78,910	98,637	$ 118,364
		-50%	-25%	0%	25%	50%
92,492	-50%	18.8	> project	> project	> project	> project
138,737	-25%	4.0	7.0	16.6	> project	> project
184,983	0%	2.0	2.5	**3.5**	5.6	14.7
231,229	25%	1.3	1.5	1.8	2.3	3.1
277,475	50%	1.0	1.1	1.2	1.4	1.7

Propane + 25% cost

eg. Exchange rate +25% CAN$

$		348,684	523,026	697,369	871,711	$ 1,046,053
		-50%	-25%	0%	25%	50%
92,492	-50%	> project	> project	> project	> project	> project
138,737	-25%	3.3	7.8	16.6	> project	> project
184,983	0%	1.2	2.1	**3.5**	5.5	8.6
231,229	25%	0.7	1.2	1.8	2.6	3.6
277,475	50%	0.5	0.8	1.2	1.7	2.2

Propane + 0% cost

Interest rate on loan 7.5%

$		2.50%	3.75%	5.00%	6.25%	% 7.50%
		-50%	-25%	0%	25%	50%
92,492	-50%	> project	> project	> project	> project	> project
138,737	-25%	14.6	15.7	16.6	17.6	18.5
184,983	0%	3.0	3.2	**3.5**	3.8	4.2
231,229	25%	1.7	1.7	1.8	1.9	2.0
277,475	50%	1.2	1.2	1.2	1.3	1.3

RETSCreen – 2 Properties? + Analysis

- Smaller piping network (only 2 properties) and smaller straw boiler with a propane condensing peaking boiler
- Initial costs $541,000$ (feasibility $10,000)
- Maintenance / yr $10,000 + Overhaul at year 10; $50,000
- Loan payments of $39,000 per year
- IRR pre-tax of 14.7%, simple payback 10 yrs, equity payback 7 yrs + NPV $466,000
- Annual life-cycle savings of $23,000/year

RETScreen – Sensitivity – 2 Properties

RETScreen Sensitivity and Risk Analysis - Heating project

☑ Sensitivity analysis

PAYBACK yrs

Variables: fuel cost (propane $0.60/L and crop $0.07/lb), capital costs, interest rate; ORANGE=bad

Perform analysis on	Equity payback	
Sensitivity range	50%	
Threshold	7	yr

Propane + 25%

Energy crop cost + 50%

$						$
		22,442	33,663	44,884	56,105	67,325
		-50%	-25%	0%	25%	50%
54,138	-50%	> project	> project	> project	> project	> project
81,208	-25%	11.9	17.3	> project	> project	> project
108,277	0%	3.4	4.6	7.2	15.7	> project
135,346	25%	2.0	2.4	3.0	4.0	5.9
162,415	50%	1.4	1.6	1.9	2.2	2.7

Propane + 50%

eg. Exchange rate +25% CAN$

$						$
		270,500	405,750	541,000	676,250	811,500
		-50%	-25%	0%	25%	50%
54,138	-50%	> project	> project	> project	> project	> project
81,208	-25%	7.4	18.7	> project	> project	> project
108,277	0%	1.9	3.8	7.2	15.3	17.7
135,346	25%	1.1	1.9	3.0	4.7	7.1
162,415	50%	0.8	1.3	1.9	2.7	3.7

Propane 0%

Interest rate on loan 7.5%

$						%
		2.50%	3.75%	5.00%	6.25%	7.50%
		-50%	-25%	0%	25%	50%
54,138	-50%	> project	> project	> project	> project	> project
81,208	-25%	> project	> project	> project	> project	> project
108,277	0%	5.6	6.3	7.2	8.4	12.8
135,346	25%	2.7	2.8	3.0	3.3	3.5
162,415	50%	1.7	1.8	1.9	2.0	2.1

Cluster #6 - Comparison 3 vs 2 properties

Which site could we look at if we are to source local un-densified agricultural biomass in a retrofit situation? (Danish model)

- Economies of scale for equipment (hydronic heater and also the piping and retrofitting)
  - 3 properties viable at $0.60/L LP
  - 2 properties viable at $0.90/L LP (+%50 base fuel cost)
- <u>Both projects depends </u>on a very high seasonal efficiency (+85%) which can only be obtained through best available technology in combustion controls and properly sized water buffer
- The increase capital cost to connect more barns (via district heating) pays back a lot quicker than anticipated!
- <u>Both projects are clear winner </u>at $0.90/L propane

Conclusion

- The “Danish poultry district heating with straw” fictitious scenario:
  - Cluster #6 in Southgate Township would make the project feasible financially at 0.60$/L propane for district heating in a retrofitting scenario for non-densified (bales) energy crops
  - >140 acres of switchgrass = 470 t = ~950 bales
  - 3 properties viable now at $0.60/L propane;
  - 2 properties only good at +$0.90/L propane

- The capital costs of connecting customers pays out quicker than anticipated (3rd property was +900 m away from 2nd property in scenario)

Next steps

- What do we do with smaller clusters?
  - Medium size greenhouse (1,500 m^2) on LP or Oil?
  - Smaller hydronic heaters for each barn?
    - Fuel is pelletized or briquetted at what cost
    - Is the equipment able to handle agr. fuels or wood based fuels only
    - Storage of fuels; 60 t large silos + smaller 4 t bins at hydronic heater
    - Could we test emissions agr. pellets at Confederation College in Thunder Bay?

Questions?

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Thanks for allowing this quick update!

Small Biomass Boiler Technology

T. Sauvé, P.Eng.

Factsheet

FACTSHEET 14-009 AGDEX 737/120 APRIL 2014

Choosing biomass to create heat is an option for small farm operations interested in reducing the high cost of fossil fuel hot water heating systems. Using locally produced biomass can lead to significant cost savings and support the local economy. Due to recent advances in combustion controls and improved efficiencies of the heating network, small biomass heating systems below 300 kW (1 MBTUh) have low emission profiles that make them an attractive option to consider.

This Factsheet provides information on six technologies and management options available

> For a description on the different sizes of fuels compatible for automatic fuel feeding, see the OMAFRA Factsheet, *Biomass Densification for Energy Production*, available online at www.ontario.ca/omafra.

Get professional advice on the proper sizing based on heat load to obtain a lower seasonal fuel cost. A high-efficiency biomass boiler that is oversized for the heat load will consume more fuel, fail prematurely and will not be able to offset the higher capital costs over the life of the equipment.

Technology options + basic comparison with traditional hydronic heaters

Factsheet 14-009 Available on Web since October 2014