

Preliminary
Results



Incorporating Sustainable Energy Decisions in Agriculture

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My PhD



- Incorporating Sustainable Energy Decisions in Agriculture
- Started in 2009
- Why?
- Interviews and surveys (completed in 2012)
- Thesis is 4 Papers:
 1. Energy savings (since 2004 baseline)
 2. Energy technologies implemented (2007 to 2012) and the reasoning behind decisions made
 3. Energy opportunities (and interest)
 4. Energy sustainability framework and case studies



This presentation will include some results from Papers 1 to 3

AGENDA



- Background
- Energy savings
- Energy upgrades on farms
- Sector specific information
- Decision making
- Questions



BACKGROUND

What was going on from 2004 to 2013?

- My MSc (2005 to 2007)
 - Baseline data on energy use (2004 usage data)
 - Energy conservation/ renewable energy use and interest (2005 data)
 - Results showed there was interest and opportunity
- Growing Forward programs (2008 to 2013)
 - Farm Energy Specialist, 191 assessments/audits on farms in NS
 - Plus 49 via NSAC
 - Energy Pilot Program, 16 projects and \$463,335 in funding
 - Environmental BMPs Energy Theme
- Conserve NS (Efficiency NS)
- Industry Research Chair in Energy Conservation, NSAC
- Community Feed-in Tariff (COMFIT)



ENERGY PRICING

Energy Type	2004 Price ¹	2011 Price	difference
diesel	\$0.799/l ¹	\$1.262/l ²	57.9%
electricity	\$0.10/kWh ¹	\$0.135/kWh ³	35.0%
gasoline	\$0.872/l ¹	\$1.254/l ²	44.8%
oil	\$0.676/l ¹	\$1.073/l ²	58.7%
propane	\$0.964/l ²	\$1.147/l ²	19.0%



ENERGY SAVINGS

2004:2011 Comparison

- There have been significant reductions in energy use on NS farms.
- For registered NS farms
 - There was a 32% ↓ in energy costs on NS farms
 - This is despite the energy pricing increases beyond the inflation rate.
 - Estimated savings are **\$9.5M/year** (2011 dollars).
- Savings are linked to energy reductions
 - Energy efficiency and conservation (EE/EC)
 - Renewables (RE)

The majority of NS farmers (72.9%) have made an EE/EC or RE upgrade on the farm between 2007 and 2012.





EE/EC/RE IMPLEMENTATION

Between 2007 and 2012

- 68.9% made an EE/EC upgrade
 - Top upgrade: Efficient lighting (51.2%)
 - Followed by Insulation and Efficient Windows
- 28.2% made a RE upgrade
 - Less than 10% of farms used renewable energy options in 2005.
 - Top upgrades: wood, photovoltaics, passive solar, ground source heat pumps, air source heat pumps and solar water.



FINDING of interest

- There is an opportunity to encourage RE through EE/EC programs.
 - NS farmers who have implemented an RE upgrade have also likely implemented an EE/EC upgrade.*

*There is a significant relationship between implementing EE/EC and RE on the farm ($p=0.001$).



SECTOR SPECIFIC FINDINGS



DAIRY

Although NS dairy farmers have decreased their electricity consumption, they have seen an increase in their electricity bills because of rate increases and increases in farm sizes.

Benchmarking: 57.2% ↓ in electricity use per 100 lb of milk produced (cwt)

Total Energy Use	% Change	Increase or Decrease
Electricity	20.0	↓
Gasoline	64.2	↓
Diesel	13.3	↑

Top Upgrades:

1. Lighting and natural ventilation
2. Heat exchanger (i.e. plate cooler)
3. Insulation
4. Heat recovery (i.e. heat reclaimer)



DAIRY IMPLEMENTATION

Between 2007 and 2012

- 69.2% upgraded to efficient lighting
 - FES site visits* showed the majority still had some inefficient lighting.
- 28.8% upgraded to a heat reclaimer and plate cooler, and 26.9% upgraded by adding one or the other.
 - FES site visits* showed
 - 33% had an opportunity for a heat reclaimer
 - 19% had an opportunity for a plate cooler

* 21 Dairy site visits by the Farm Energy Specialist in the Spring of 2012



94.2%

of NS dairy farms are interested in implementing an EE/EC or RE upgrade in the next five years.



BEEF

There has been a reduction in both the number of beef farms, and their size, this negatively impacts benchmarking.

- Benchmarking: 13.2% ↓ in electricity use per cow
- Energy costs: 19.6% ↓
 - This is mostly attributed to a 51.4% ↓ in electricity use.
 - Likely due to lighting upgrades
- Transportation fuel use: 37.1% ↓



BEEF IMPLEMENTATION

Between 2007 and 2012

- Lighting is the most utilized EE/EC upgrade on NS beef farms (34.1%)
 - FES site visits (10 farms) showed that 50% of the sites had some efficient lighting (i.e. CFLs), but 90% still had some inefficient lighting.

CFLs have been problematic. LED pricing, availability and functionality make them a good option today for cold barn environments.



POULTRY

Overall poultry production increased and energy efficiency on poultry farms increased. Poultry farmers also spend more on energy than any other farm type, so improved energy efficiency can have a significant financial benefit.

- 24.4% ↓ in energy costs
 - mostly due to a reduction in oil use
- 30.4% ↓ in electricity use since 2004.
 - Unfortunately, electrical costs have not decreased due to electricity pricing.
 - However, farmers have prevented their electrical bills from increasing dramatically.
 - Electrical bills make up over a third (36.3%) of NS poultry farm total energy costs.



FRUIT

Fruit farmers spent more on transportation fuels (45.6%) than other energy types.

- 35.0%↓ in energy costs
 - mostly from a reduction in electricity and gasoline use
- Diesel use ↑
 - showing a shift from gasoline to more-efficient diesel systems.
- Blueberry farmers decreased electricity use (43.0%↓), gasoline use (64.3%↓) and diesel use (9.4%↓) compared to 2004.

NS blueberry farmers have become more energy efficient as they are using less energy on more area.



VEGETABLE

NS vegetable farmers have become more energy efficient as they are using less energy on the same area.

- 39.2% ↓ in energy costs
 - mostly due to a reduction in electricity and gasoline usage
 - Shift away from fossil fuels
 - More vegetable farmers are using wood
- Vegetable farms are significantly different than fruit farms with respect to where they use energy.
 - Transportation fuels make up only 24.1% of the total energy expenses for vegetable farms (versus 45.6% for fruit).
 - Electricity expenses are the highest single energy expense on a vegetable farm (36.0% versus 20.1% for fruit).



SUPPORT



36% of respondents received some level of support* to evaluate their energy options.

Over **860** farmers received support for energy improvements by the end of 2012. This includes over **410** audits on NS farms compared to **36** audits by 2005.

* Support includes: energy audits, equipment reviews, farm visits by a professional, information provided by a professional



FINDING of interest

Those who received support were more likely to implement EE/EC and/or RE.

- All types of support were significantly related to implementing EE/EC
- An energy audit was the only type that was significantly related to implementing RE.

* There is a significant relationship between NS farmers who received support and those who implemented EE/EC or RE ($p=0$ and $p=0.003$ respectively).



TODAY'S SUPPORT OPTIONS

- Efficiency NS/Efficiency One
 - 1(877) 999-6035
- Homegrown Success Program (GF2)
- NSCC Middleton
 - Energy Sustainable Engineering Technology
 - Anne Lombardi, (902) 825-3491
- Ecology Action Centre Energy Team
 - (902) 442-0199
- Julie Bailey, baileyj@dal.ca
- Find an Energy Auditor



FINDING of interest

When deciding to implement an EE/EC upgrade, a farmer mostly considers monetary aspects, but will consider social, environmental and technical aspects when comparing alternatives*.

This is true for RE as well but social aspects are a secondary factor (second to monetary) when deciding to implement an RE upgrade.

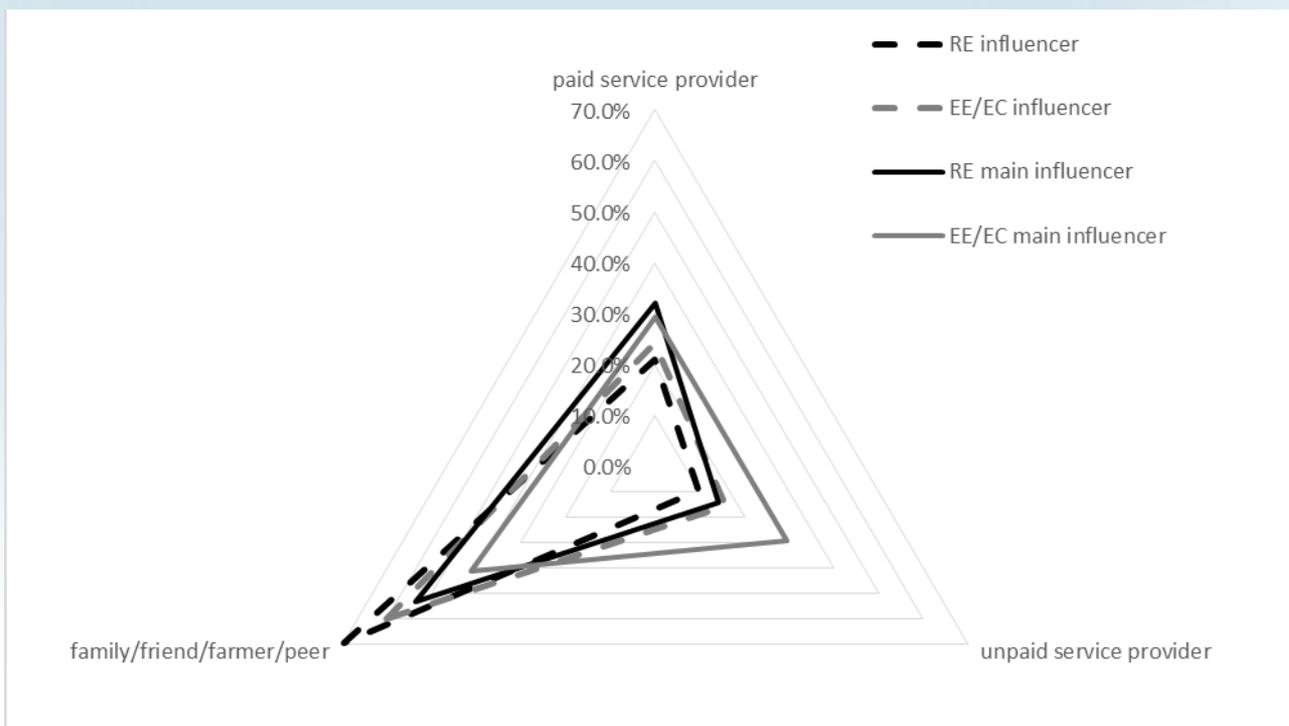
- E.g. self-sufficiency

*38.0% of those who implemented EE/EC (45.5% for RE) considered more than one alternative during selection of their technology.



FINDING of interest

42.7% (44.6%) of those who implemented an EE/EC upgrade (RE upgrade) had someone influence their decision.





FINDING of interest

Visiting other farms, the **Internet** and **factsheets** are the top three individual methods of information delivery for EE/EC and RE.

1. Via Other People

- 49.8% (EE/EC) and 42.0% (RE) of the information delivery mechanisms used were via other people (energy audits, service providers, peers, visiting other farms, someone visiting, telephone, email)

2. Via Media

- 31.2% (EE/EC) and 40.3% (RE) of the information delivery mechanisms used were via media (the Internet, printed and electronic media).



IN SUMMARY...

This is a success story that should be celebrated.



However, there are still opportunities for further reductions.



FOR ANOTHER DAY...

- More detailed information by Farm Type
- Obstacles
- Renos and New construction
- Program ideas
- Develop and test a framework to incorporate sustainability in energy decisions on the farm

Publications



- MSc

- Bailey JA, Gordon R, Burton D, Yiridoe EK. Energy conservation on Nova Scotia farms: Baseline energy data. *Energy* 2008;33(7):1144–1154.
- Bailey JA, Gordon R, Burton D, Yiridoe EK. Factors which influence Nova Scotia farmers in implementing energy efficiency and renewable energy measures. *Energy* 2008;33(9):1369–1377.

- PhD

- Bailey JA, Amyotte P, Khan F. Agricultural Application of Life cycle iNdeX (LInX) for effective decision-making. *Journal of Cleaner Production*. Volume 18, Issues 16–17, November 2010, Pages 1703–1713.
- Bailey JA, Duinker P, Amyotte P, Adams M, Khan F. Measuring Energy Conservation on Nova Scotia (NS) Farms: A 2004 to 2011 Comparison. *Energy*. Volume 113, October 2016, Pages 144–152.



Thank You

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