Cow Power to Horsepower: Sustainable Transportation for Whatcom County

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Thank you.
Vehicle History
Petroleum Challenges

Transportation Dependence
Energy Security
Peak Oil
Emissions
Global Warming
Petroleum Challenges = Opportunity

Transportation Dependence
Energy Security
Peak Oil
Emissions
Global Warming
Happy Cows
Dairy Waste Challenges

Water Quality
Air Quality
Global Warming Potential
Economic Cost
Global Warming Potential

International Panel on Climate Change: Methane is 23 times more effective than Carbon Dioxide

Global Emissions of Methane: 540 teragrams/year (tera = trillion)

Global Emissions from Ruminants (cattle, sheep, goats, deer): 12-15% of total
Solution: Anaerobic Digester
Anaerobic Digester Benefits

1. Creates three product streams while reducing waste: biogas, slurry, and solid
2. Biogas is ~60% methane, ~40% carbon dioxide and ~0.3% hydrogen sulfide gas
3. Burn methane to produce electricity (280-350 kW)
4. Liquid Slurry is pathogen free and may be applied to field without concern for run-off
5. Solids are 98% pathogen free and may be mixed with straw to reduce bedding costs
6. Dr. Craig MacConnell developed a peat moss substitute
7. Community food/food processing waste may be added
Andgar Corporation
Puget Sound Energy purchases power
**Digester Challenges**

- Capital cost of $1.2 million (2004)
- Power revenue $110,000-$140,000/year
- Electrical power equipment 40% total cost
- Requires innovative, willing power utility
- Hydrogen sulfide damages engine
- Grid may not be able to accept power
- Air quality regulations on I.C. engines
Solution: Biomethane for Transportation

Is it possible?
What is the quantity of the fuel?
What will it cost?
Are there any additional benefits?
What additional challenges are there?
WWU prototype refinery
Solution: Biomethane for Transportation

Support removal of dairy waste by improving economics of anaerobic digester

Biomethane is sold at $0.77 per gasoline equivalent gallon (GGE), natural gas at SEATAC is $1.87-2.50/GGE (variable)

Power 20-40,000 vehicles in Whatcom County with ~9-11 million GGE per year

Reduce Global Warming Potential

Low emissions of natural gas
Tour de Sol
Results

Inlet:
- CH4: 92.68%
- CO2: 0.03%
- H2S: 0%
- N: 4.77%
- O: 0.99%

Outlet:
- CH4: 94.88%
- CO2: 0%
- H2S: 0%
- N: 4.25%
- O: 0.87%

CH4 Flow:
- From B to A: 94.88%
- From D to E: 70.14%
- From G to H: 70.14%
What is the fuel quantity?

66,000 cows * 60 ft^3 = 3.96x10^6 ft^3/day CH₄
3.96x10^6 ft^3 * 904 BTU/ft^3 = 3.58x10^9 BTU
3.58x10^9 BTU / 115,500 BTU/gal (gasoline)
Result: 30,994 gallons of gasoline equivalent energy per day

Over 11 million gallons of gasoline equivalent energy per year
Additional Benefits: Global Warming Opportunity

Dairy waste from Washington’s ~250,000 cows create nearly 40 million kg of methane per year. Washington Dairies produce the equivalent of ~850 million kg carbon dioxide.

EPA: Average car produces 5195 kg carbon dioxide per year (~12,000 miles).

Anaerobic digesters could remove the global warming potential of 46,000 cars in Whatcom County.
Additional Benefit: Emissions

- Toyota Prius
- Honda Civic Hybrid
- V32

Graph shows emissions in g/km for different vehicles with categories for HC, CO, and Nox.
Thank You!

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Award Winner
EPA People Prosperity Planet