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# Fact Sheet 3 - Biomass Energy

## LandFill Gas (LFG)

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|---|---|
| 2001 Capacity | Approx 100 MW |
| Technology Definition | Generated when organic waste in a landfill decomposes. Landfill gas consists of about 50 % methane ($CH_4$), 50 % carbon dioxide ($CO_2$). After collection, this gas can be converted, and used as heat or power. |
| Product(s) | • Heat and/or Power<br>• Emission Reductions<br>• Hedge against hydrocarbon fuel price |
| Equipment Manufacturing centers | • Engines: US, Austria, Germany, Spain<br>• Collection equipment: widespread availability |
| Technology Stage | • Mature technology for both collection equipment and power generation |
| Applications | • Large landfills can sustain utility sized power production. |
| Cost estimate for generation | Cost C$50 - 65/MWh<br>CAPEX: C$1400/kW<br>OPEX: C$28-$40/MWh |
| Impacts: Positive | • Reduces VOC emissions from landfills<br>• Reduces the unpleasant odors from the landfill<br>• Reduces the potential for underground migration of methane and the formation of explosive mixtures of methane and air.<br>• Leads to improvement in overall landfill management.<br>• Can provide a steady long-term supply of fuel in appropriately managed landfills.<br>• Provides an additional revenue source to municipality |
| Impacts: Negative | • Landfill gas production will decline once a landfill is closed to new waste streams.<br>• Nitrogen oxide emissions from the combustion of LFG (can be reduced depending on the conversion technology used and the application of NOx controls).<br>• If the LFG facility is poorly managed, leaking landfill gas may form an explosive mixture with air.<br>• Public perception that LFG collection and utilization is equivalent to burning garbage and profiting from LFG may counteract society's need to reduce the amount of garbage going to landfill. |
| Potential in Canada | • Potential for 50 MW or more to be developed. |
| Existing Barriers in Canada | • Poor economic justification given generally low electricity prices and lack of government incentives.(LFG is generally economical at large landfills or if the collection system already exists)<br>• Potential loss of emission reduction value if collection and destruction of LFG is required by regulation<br>• LFG is a population driven resource and as such there are a small number of viable landfills in Canada.<br>• Tightly controlled opportunities, few players in private sector waste management and associated challenges in developing municipal landfill sites<br>• Issues with market access for power sales in regulated markets.<br>• Poor economics for scale for applications on smaller sites |

# Anaerobic Digestion

| | Anaerobic Digestion, Municipal Solid Waste (MSW) | Anaerobic Digestion Farm feedstock |
|---|---|---|
| 2001 Capacity | 4 MW | 0MW |
| Technology Definition | Biological process that produces a bio-gas (methane ($CH_4$) and carbon dioxide ($CO_2$).<br>Produced from municipal solid waste. | Biological process that produces a biogas (methane ($CH_4$) and carbon dioxide ($CO_2$).<br>Produced from livestock manure, food processing waste, etc. |
| Product(s) | • Biogas - used to generate heat and/or electricity<br>• Fiber which can be used as a nutrient-rich soil conditioner<br>• Liquor which can be used as liquid fertilizer.<br>• $CO_2$ for greenhouse, and other industrial use if in large quantity | |
| Equipment Manufacturing centers | • US, Germany, Denmark, Belgium, Austria, Sweden, Finland | • Germany, Denmark, Switzerland, Sweden, Austria, Finland, Spain, U.K. & US |
| Technology Stage | • Commercially available in Europe<br>• Demonstration plant stage in North America<br>• Large facility in Ontario in process of attempting commercial operation. | • Commercially available in Europe for farm feedstock. |
| Applications | • Municipalities: Organic waste digestion after source separation | • Small applications, Farm specific: Waste processing & small power consumption.<br>• Regional, community based or intensive livestock industry applications. |
| Cost estimate for generation | Cost approx.C$60-70/MWh[1] (Higher costs for farm feedstock power generation[2])<br>CAPEX : C$6000/kWe[3] | |
| Impacts: Positive | • Minimizes odors, air pollution, and green house emissions<br>• Reduces VOC levels<br>• Reduced overall smog formation<br>• Extends landfill life by diverting organic MSW | • Reduces ground and surface water pollution<br>• Minimizes odors, air pollution, and green house emissions<br>• Increases the "spreadability" of processed animal waste<br>• Eliminates pathogens from recovered bio-solids. |
| Impacts: Negative | • Potential for ammonia production, which must be treated to avoid odour problems.<br>• Production problems liable to be major ones necessitating shut downs for several months | • Potential for ammonia production, which must be treated to avoid smells.<br>• Digestate must be disposed of if not sold as compost.<br>• Production problems liable to be major ones necessitating shut downs for several months |
| Potential in Canada | • Potential of 150 kWh per Tonne of source separated organic waste processed, net of plant process electrical consumption | • Approximately 1200 Cattle farm applications.[4]<br>• Approximately 700 hog farm applications.[5] |
| Existing Barriers in Canada | • Municipal waste requires cultural change to source separation. No obligation to source separate<br>• Separation after collection is economically prohibitive.<br>• Small compost market that can be saturated easily.<br>• Market uncertainty of treated manure effluent products (fertilizer and soil conditioner)<br>• Large up front capital costs<br>• Difficult to mix biogas with natural gas.<br>• Requires conversion of heating applications to low BTU burners. | • No obligations to collect manure or manage manure.<br>• Small compost market that can be saturated easily.<br>• Market uncertainty of treated manure effluent products (fertilizer and soil conditioner)<br>• Large up front capital costs<br>• Lack of experience with technology in Canada.<br>• Inadequate participation and commitment of the farm operator.<br>• Difficult to mix biogas with natural gas.<br>• Requires conversion of heating applications to low BTU burners. |

1. Assumes tip fee of $30/tonne
2. Feasibility study to be completed by the Chatam-Kent municipality by September 2002.
3. (not including benefit of heat generated)
4. Pembina Study for Shell Canada Limited, 2000
5. Pembina Study for Shell Canada Limited, 2000

# Gasification & Pyrolysis

| | Gasification | Pyrolysis |
|---|---|---|
| 2001 Domestic Capacity | 0 MW | >17 tonnes per day |
| Technology Definition | Conversion of organic feedstock to syn-gas (CO, $CH_4$, $CO_2$, $H_2$) through use of a oxygen bearing reagent. | Pyrolysis is the thermal decomposition of organic material at elevated temperatures in the absence of oxygen, producing bio-oil, gas and Activated Carbon. |
| Product(s) | • High Quality Synthesis Gas which can be converted to heat or power<br>• Recyclable Iron, Copper, Aluminum<br>• High Carbon Activated Carbon | • Bio-Oil<br>• Activated Carbon<br>• Synthesis gas<br>• Resins<br>• Specialty Chemicals |
| Equipment Manufacturing centers | • North and South America, Europe, Asia, Africa and Australia. | • Canada, Spain, Korea |
| Technology Stage | • Mature technology in other industries. Pilot technology for waste materials. | • Pre-commercial stage.<br>• Some units in operation. |
| Applications | • Distributed generation<br>• Possible fuels include:<br>  • Agricultural Residues<br>  • Automobile Shredder Residue (ASR)<br>  • Forestry Matter/Residues<br>  • Industrial Solid Waste<br>  • Municipal Solid Waste (MSW)<br>  • Shredded Automobile Tires | • Feedstock include, virtually all biomass, including forest and agri-cultural residues, energy crops, and municipal solid waste (MSW)<br>• Distributed power generation via gas turbines and stationary diesel engines<br>• Renewable chemical production in a bio-refinery concept. |
| Cost estimate for generation | Not commercial at this stage. Preliminary estimates are in the order of C$60-70/MWh. | BioOil production estimated a C$2-4/GJ<br>Power production estimates are in the order of $60/Mwh |
| Impacts: Positive | • Uses waste feedstock that would be combusted or landfilled.<br>• Lower particulate emissions than traditional combustion technology.<br>• Higher efficiencies than combustion technology.<br>• Reliable, dispatchable electricity | • Uses waste feedstock that would be combusted or landfilled.<br>• Reliable dispatchable electricity.<br>• Lower particulate emissions and higher efficiencies than traditional combustion technology.<br>• Fuel is storable, transportable and transformable. |
| Impacts: Negative | • High temperature gasification can lead to formation of chlorinated organics, which are difficult to remove.<br>• Produces particulates, tars and other impurities that require gas cleanup.<br>• High capital costs compared to conventional biomass technologies. | • Pyrolysis and gasifier streams may contain organic compounds of concern that are difficult to remove.<br>• Not yet commercially demonstrated.<br>• Bio-oil has lower energy density than liquid fossil fuels.<br>• Potentially $CO_2$ benefit neutral.[6] |
| Potential in Canada | • Small scale projects for distributed generation.<br>• High potential for wood and agricultural residues.<br>• Pilot gasification project, Kelowna, BC (BC Hydro & Ethopower) | • Unknown<br>• Potential for seasonal production in remote communities.<br>• Estimated potential for > 15,000,000 BOE per year |

6. 2000 International Conference on Biomass technologies, see externalities of biomass

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