METHANE TO MARKETS

COUNTRY PROFILE FOR ANIMAL WASTE MANAGEMENT

CANADA

1. Summary of emission and characterization of the animal waste management sector

a. Briefly provide information on national and regional methane emissions for animal waste management systems by type of system and animal type

In 2004, Canada's greenhouse gas emissions were 758 Mt CO_2 equivalent (Mt CO_2e). Of this, the agricultural sector accounted for 7.2 % of the national total, or 55 Mt CO_2e (Environment Canada, 2006). Major sources of agricultural greenhouse gas emissions include enteric fermentation (24 Mt CO_2e), agricultural soils (22 Mt CO_2e) and animal waste management systems (9 Mt CO_2e). Emissions from animal waste management systems include methane (CH_4, 3.9 Mt CO_2e) and nitrous oxide (N_2O, 5.4 Mt CO_2e).

On a provincial basis, Québec and Ontario have the greatest CH_4 emissions from manure management systems (Table 1), whereas emissions are smallest in the Atlantic Provinces (Newfoundland and Labrador, Prince Edward Island, Nova Scotia and New Brunswick) and in British Columbia.

Table 1: Methane emissions by animal waste management system and province in 2004.

Animal waste management system	Atlantic Provinces	Québec	Ontario	Manitoba	Saskatchewan	Alberta	British Columbia	Canada
	MT CO_2e							
Pasture, range and paddock	0.003	0.017	0.030	0.021	0.041	0.089	0.014	0.22
Solid storage	0.007	0.035	0.050	0.023	0.042	0.092	0.021	0.27
Liquid storage	0.130	1.023	1.008	0.393	0.264	0.445	0.124	3.39
Composting	0.000	0.000	0.001	0.001	0.001	0.003	0.000	0.01
Anaerobic Digestion	0.000	0.000	0.001	0.000	0.001	0.002	0.000	0.00
TOTAL	**0.14**	**1.08**	**1.09**	**0.44**	**0.35**	**0.63**	**0.16**	**3.9**

Source: Modified from Vergé et al., 2006

Nationally, 87 % of CH_4 emissions from animal waste management systems originate from manure stored as a liquid, while the remainder of emissions are nearly evenly split between solid storage and manure deposited on pasture, range and paddock. On a provincial basis, between 71 % (Alberta) and 95 % (Québec) of total CH_4 emissions from manure management systems originate from liquid storage systems.

The pork industry is the largest contributor to CH_4 emissions from manure management (2.2 Mt CO_2e), followed by the dairy industry (1.1 Mt CO_2e), the beef cattle

industry (0.5 Mt CO_2e) and the poultry industry (0.1 Mt CO_2e). All other animal production industries (sheep, goats, bison, horses) were relatively minor contributors (< 0.05 Mt CO_2e) to emissions from manure management systems.

b. Briefly describe current animal waste management practices (e.g. land application, pasture/range, solid storage, liquid storage, lagoon) and livestock types (e.g. Swine, dairy cattle, beef cattle, poultry)

There is little comprehensive data on manure management practices across Canada. A survey of the dominant manure management systems in Canada was completed in 2001 as a part of the Farm Environmental Management Survey (Statistics Canada, 2003), and has been supplemented by work conducted by Marinier et al. (2004). These surveys found that manure management systems vary across Canada and by industry. The pork industry stores the majority of its manure as a liquid or slurry (Table 2) and the dairy and poultry industries also store a significant proportion of their manure as a liquid, whereas in all other industries this is a relatively minor form of manure management. The beef cattle industry, which produces the most manure in terms of volume in Canada, stores about 1 % of all manure as a liquid, with the remainder of manure either stored as a solid, or is unmanaged (deposited on pasture, range and paddock). Other forms of manure management systems that are of significance at the national scale in Canada include composting (beef cattle manure) and anaerobic digestion (beef cattle, swine and laying hen manure).

Table 2: Percentage of manure stored in an animal waste management system by animal type in Canada.

Animal Type	Pasture range and paddock	Solid storage	Liquid storage	Composting	Anaerobic digestion
			%		
Beef cattle	48	47	1	3	1
Dairy cattle	18	40	42	0	0
Swine	0	3	96	0	1
Laying hens	0	70	29	0	1
Broiler chickens	0	99	1	0	0
Turkeys	6	94	0	0	0
Sheep	62	38	0	0	0
Goats	60	40	0	0	0
Horses	57	43	0	0	0

Source: Marinier et al., 2004

On a provincial basis, solid/semi solid storage is the most common manure management system, representing 69 % of farms across Canada, with the practice being most prevalent in the eastern provinces. Liquid manure storage is most common on farms in eastern Canada, especially in Québec (Table 3), because of the predominance of the dairy and pork industries in this region which store a greater proportion manure as a

liquid. In contrast, the prairie provinces, especially Alberta and Saskatchewan store little manure as liquid because of the predominance of the beef industry. In addition, a significant percentage farms in the prairie provinces report no manure storage system because cow/calf beef operations graze their animals year round on pasture and range and have no need for a manure management system. The prevalence of liquid manure storage in the eastern provinces explains why CH_4 emissions from waste management systems are highest in Ontario and Québec.

Table 3: Percentage of farms employing a given animal waste management system by province, 2001.

Province	Liquid Storage	Solid/semi-solid storage	No storage
		%	
British Columbia	14	51	43
Alberta	4	56	43
Saskatchewan	2	63	36
Manitoba	11	81	13
Ontario	19	80	11
Québec	36	74	5
New Brunswick	13	84	--
Nova Scotia	21	88	6
Prince Edward Island	9	92	5
Newfoundland	25	86	--
Canada	**14**	**69**	**24**

Source: Statistics Canada, 2003

Note: Totals do not add to 100 % because farms may store manure both as liquid and as solid/semi solid

-- Totals withheld by Statistics Canada to maintain confidentiality

Animal population is generally increasing in Canada (Table 4). In 2004, national beef cattle population was 14.6 million head, up 39 % since 1990. Similarly, the swine population was 14.7 million head in 2004, up 44 % since 1990, while the total poultry population (layers, broilers and turkeys) was 154.8 million head, up 33 % since 1990. The national dairy cow population is in decline in Canada, down 29 % to 1.1 million head in 2004 since 1990. This has occurred because milk production per cow has increased, allowing national milk production to increase slightly, despite a declining dairy cow population.

Animal population in Canada is not evenly distributed. In general, the beef cattle industry is predominantly in the Prairie Provinces, especially Alberta, where 40 % of the population resides. In these regions, improved and unimproved pasture are more available during the warmer months for grazing, whereas in eastern Canada the land available for grazing is more limited. In contrast, the dairy industry is concentrated in Ontario and Québec, which houses 75 % of the dairy cows in the country. Similarly, the pork and poultry industries are predominantly in Ontario and Québec where 55 and 60 % respectively of the populations resides.

Table 4: Animal population by province in Canada for 1990 and 2004.

Province	Beef Cattle		Dairy Cows		Swine		Poultry*	
	1990	2004	1990	2004	1990	2004	1990	2004
	Million head							
British Columbia	0.59	0.77	0.08	0.08	0.24	0.17	11.86	23.72
Alberta	4.11	5.95	0.11	0.09	1.72	2.03	9.78	14.88
Saskatchewan	1.94	3.17	0.05	0.03	0.76	1.31	4.08	5.72
Manitoba	0.92	1.56	0.06	0.04	1.21	2.86	7.39	9.61
Ontario	1.85	1.91	0.45	0.35	2.98	3.66	37.65	55.47
Québec	0.85	1.06	0.54	0.41	2.95	4.28	25.23	36.62
New Brunswick	0.08	0.07	0.02	0.02	0.08	0.12	2.61	4.03
Nova Scotia	0.09	0.08	0.03	0.02	0.13	0.10	3.72	4.53
Prince Edward Island	0.08	0.07	0.02	0.01	0.11	0.13	0.40	0.43
Newfoundland	0.00	0.00	0.00	0.00	0.02	0.00	1.31	1.82
Canada	**10.5**	**14.6**	**1.4**	**1.1**	**10.2**	**14.7**	**104.0**	**154.8**

Source: Statistics Canada, 2005a; 2005b

* Poultry population is not estimated on an annual basis and the 2004 population has been calculated by extrapolating the poultry population trend between the 1996 and 2001 census to the year 2004.

c. Briefly provide information on methane recovery practices in use

Anaerobic digestion of manure and recovery of methane represents a small, but growing percentage of manure management systems in Canada. Currently, there are 10 anaerobic digesters in operation in Canada (Figure 1), evenly split between the prairie provinces of Alberta, Saskatchewan and Manitoba and the farming areas of southern Ontario and Québec.

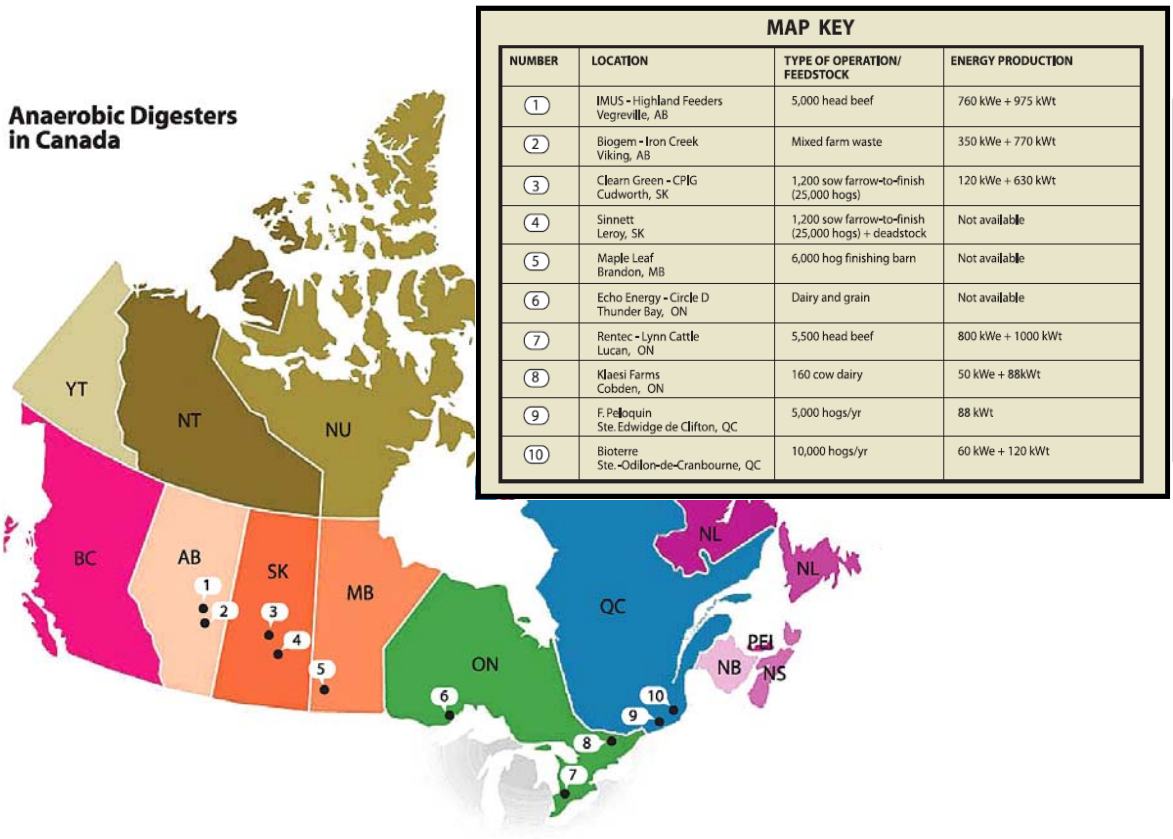

Figure 1: Location of anaerobic digesters in Canada.

There are several different types of digesters in operation in Canada ranging from low temperature (15 ºC) to high temperature (55 ºC) which typically produce biogas with a methane content ranging from 50 to 70 % by volume. Feedstock for the digesters range from cattle, swine and poultry manure to agri-residues and municipal solid waste (MSW). Complete information on all of the digesters in Canada is not currently available, however five of the digesters which are a part of the Energy Cogeneration from Agricultural and Municipal Wastes (ECoAMu) program led by Agriculture and Agri-Food Canada (AAFC) do have more detailed information, which is summarized in Table 5.

Table 5: Anaerobic digestion sites in Canada that are a part of the Energy Cogeneration from Agricultural and Municipal Wastes (ECoAMu) program.

Location	Funding (K)	Company	Type	Feedstock	Head	Status	Outputs	Web links
Vegreville, Alberta	$ 7,800	Highland Renewables	Thermophilic (55 ºC)	Beef cattle manure	7,500	Operational	Electricity, Heat, Reusable water, Bio-based fertilizers	http://www.arc.ab.ca/Index.aspx/ARC/5791
Ste-Edwidge de Clifton, Québec		BioTerre	Psychrophilic (15-25 ºC)	Swine manure	5,000	Operational	Electricity, Heat, Bio-based fertilizers	www.bioterre.com
St-Odilon-de-Cranbourne, Québec	$ 2,375	BioTerre	Psychrophilic (15-25 ºC)	Swine manure	10,000	Operational		
Cudworth, Saskatchewan	$ 3,962	Clear-Green Environmental Inc., CPIG, Saskpower, Ag-West Biotech	Mesophilic	Swine manure	1,200	Operational	Electricity, Heat, Bio-based fertilizers	http://www.clear-green.com/
Lucan, Ontario	$ 6,760	RENTEC Lynn Cattle Company Inc.	Mesophilic	Beef cattle manure	5,500	Under construction	Electricity, Heat, Reusable water, Bio-based fertilizers	http://www.rentec.ca

2. Describe the key stakeholders in the animal waste management sector

Stakeholders in the animal waste management sector include livestock farmers and the organizations that represent them, including the Canadian Cattlemen's Association, the Dairy Farmers of Canada, the Canadian Pork Council and the Chicken Farmers of Canada. The Government of Canada is a major stakeholder, because of its interest in promoting environmentally benign manure management practices, in developing alternative revenue streams for producers and because of its interest in reducing greenhouse gas emissions and improving air quality. Private sector companies involved in waste processing and green energy have invested time and money in the development of anaerobic digestion and are stakeholders in this issue, as are the scientists and researchers that often collaborate with these private companies. Citizens living in rural/agricultural communities are major stakeholders because of air quality and odor issues associated with waste management transport and disposal.

3. Overview of methane recovery potential

There are approximately 121,000 farms reporting livestock in Canada (Statistics Canada, 2003) ranging from small scale mixed family farms to large scale specialized industrial farms which collectively generate in excess of 140 Tg of manure on an annual basis. The potential for methane recovery is greatest in areas with high livestock density that can ensure a consistent year round supply of manure feedstock. Therefore, the potential for methane recovery is greatest for large scale swine, dairy, beef feedlot and poultry operations.

A comprehensive analysis of the methane recovery potential in Canada has not been completed. However, preliminary studies have indicated that current greenhouse gas emissions reduction would be 30 Mt CO_2e by 2030 assuming that 30 % of livestock manure is treated using anaerobic digestion. This decrease in GHG emissions would be achieved through a reduction in CH_4 emissions from animal waste management systems, a reduction in CO_2 emissions from the manufacturing of fertilizers and a reduction in CO_2 emissions due to an offset in fossil fuel consumption for electricity and heating.

4. Challenges and/or priorities to greater methane recovery and use

The major barrier to greater methane recovery and use is financial in nature. Start up costs for anaerobic digesters in Canada that are a part of the ECoAMu program have ranged from $2 to 8 million CN depending on size and complexity of the project. This cost has been borne by a combination of public (federal, provincial and municipal governments) and private monies. The high cost of start-up discourages most parties from attempting to adopt anaerobic digestion, despite a general high level of interest in this technology in the farming community. Further challenges exist in terms of expertise, reliability and parts required to operate an anaerobic digestion system.

The biggest challenge facing Canadian energy policy is balancing the need to reduce greenhouse gas emissions with the need to maintain energy production and exports and meet growing consumption.

5. Current cooperation among countries or non-governmental organizations

There are no formal agreements between Canada and other countries or NGOs, however there is an informal flow of information between scientists and research institutions at an international level. One Canadian company – Enerkem Inc – has been successful in exporting its gasification technology to the United Kingdom, where it will establish a 10 MW plant in East London. Enerkem Inc. has been supported for the past four years by the ECoAMu program to test and demonstrate their gasification of straw and straw and municipal solid waste technology at a plant in Sherbrooke Québec.

6. Country priorities

The Government of Canada is developing environmental legislation for reducing air pollution and greenhouse gas emissions to deliver clean air, clean water and clean soil. Canada's Clean Air Act will establish a regulatory framework for the first time to deal with both air pollution and greenhouse gases from the federal level.

The Government of Canada promotes the development of a sustainable renewable energy industry in Canada through investments in renewable energy systems and by providing information on renewable energy technologies. As a part of this act, Canada is aligning its environmental policy-making with economic and market forces to protect the environment and promote the development of green technologies. In support of the future competitiveness and prosperity of the agriculture sector, the Government will invest in ongoing measures, including new investments in biomass science and funding in support of a biofuels strategy, and new programming to support the agri-food industry in developing new market opportunities. Natural Resources Canada (NRCan) delivers several initiatives to encourage the development and use of emerging renewable energy sources and technologies, among them are Renewable Energy Deployment Initiative (REDI), Wind Power Production Incentive (WPPI) and Government Purchases of Electricity from Renewable Resources (PERR). Furthermore, there are several federal programs that support the development of anaerobic digestion technology including ECoAMu, Environmental Technologies Assessment for Agriculture, Technology Early Action Measure, Industrial Research Assistance Program, Sustainable Development Technology Canada and the Green Municipal Fund.

7. Conclusions and observations

Canada, like most industrialized countries, currently uses only a small amount of non-hydroelectric renewable energy. Renewable energy remains a growth market, with installed capacity expected to double over the next decade in Canada. Most renewable options are expected to be competitive with grid power in Canada by 2013, especially if supported with effective incentives. Programs and policies to foster renewable energy development vary widely across the country and are a function of industry structure, ownership of generation assets, market size, and political leadership.

Methane capture and use is a new and diverse area in which the Canadian agriculture sector and rural Canadians can generate revenue while reducing net GHG emissions,

realizing co-benefits such as improved air quality and contributing to national energy security.

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Appendix I

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