

ANIMAL AND POULTRY WASTE-TO-ENERGY

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Animal Populations in North Carolina (per day):

- a. Dairy cattle (all ages): ~120,000**
- b. Beef cattle (all ages): ~900,000**
- c. Swine (all ages): ~10,000,000**
- d. Broilers: ~100,000,000**
- e. Turkeys: ~17,000,000**
- f. Hens and breeders: ~15,000,000**

Approximate Manure Production by Animals and Poultry
(pounds per day)

	<u>Per head</u>		<u>Dry Solids</u>
	<u>wet</u>	<u>dry</u>	-----
a. Dairy cattle:	85	10	1,200,000
b. Beef cattle:	60	7	6,300,000
c. Swine:	9	0.8	8,000,000
d. Broilers:	0.14	0.035	3,500,000
e. Turkeys:	0.5	0.13	2,200,000
f. Hens and breeders:	<u>0.2</u>	<u>0.05</u>	<u>750,000</u>
	Total Dry Solids:		22,000,000

Some Energy Equivalents from Animal Waste Production in North Carolina

Weighted average BTU value of animal waste: ~6500BTU/lb dry solids
(Range is from about 5500-7200 depending on species)

Total heat equivalent of daily manure solids (BTU): ~143,000,000,000

Potential electricity from biogas from animal waste (kW-h/day): 8,400,000
(Based on 17,100 BTU/kW-h)
(assumes 25% conversion)

Waste Production and Potential Fuel, United States

(all values in millions)

<u>Parameter</u>	<u>Dairy</u>	<u>Beef</u>	<u>Hogs</u>	<u>Poultry</u>	<u>Urban</u>
Dry tons/yr	40	13	8	20	32
Fuel, gal/yr	5000	1600	1000	3100	4000

Some Methods for Energy Recovery from Animal Waste

Anaerobic digestion (mesophilic:41-104F; thermophilic:104-131F)

Thermal oxidation/gasification

Direct combustion

Liquid fuels (ethanol from gasification, etc)

Plasma arc fuel cell gas (H₂, CO)

Aerobic composting with heat recovery

Other?

TECHNOLOGIES UNDER CONSIDERATION AT NC STATE WITH ENERGY RECOVERY

- **In-ground ambient temperature anaerobic digester / energy recovery / greenhouse vegetable production system**
- **High temperature thermophilic anaerobic digester (TAnD) energy recovery system**
- **Belt manure removal and gasification system to thermally convert dry manure to a combustible gas stream for liquid fuel recovery (ethanol)**
- **Micro-turbine co-generation system for energy recovery**
- **Combined in-ground ambient digester with permeable cover / aerobic blanket - BioKinetic aeration process for nitrification-denitrification / in-ground mesophilic anaerobic digester system (this project represents 3 farm sites)**
- **Solids separation / gasification for energy and ash recovery centralized system (this project represents 3 farm sites)**
- **Orbit/HSAD system (anaerobic digestion)**
- **BioClean system (anaerobic digestion)**

Waste-to-Energy Issues

- **Form of capture of energy (biogas, gasification products, etc)**
- **Form of use of energy (space heating, hot water, drying, electricity, marketed compressed gas, transferred gas, etc)**
- **Regulations, policies, etc. (voluntary? portfolio requirements? etc).**
- **Marketing or off-set process (purchase price, net metering, setback costs, baseline or peak/off peak use, supply reliability, etc.)**
- **Capital cost and payback**
- **Operation and maintenance**
- **Other?**

- **It is possible to recover energy from animal waste!**
- **We need to do it whenever economically and operationally feasible!**