

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

## **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)**

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

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# **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 (H<sub>2</sub>, 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!**