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Electric Power from Poultry Waste is Not Green

In 2006 Fibrowatt LLC announced plans to construct up to three poultry waste burners in North Carolina. We asked: Is there a need for such facilities? What would be the impact on air quality? What are the alternatives?

Fibrowatt, LLC presents its poultry waste energy facilities in Great Britain as good examples of its technology and sponsored tours to the plants in the towns of Thetford and Eye. Following this lead, we gathered data from Britian's Environmental Agency to get a better idea of what is released from the smokestacks at those sites. Also, we obtained the air pollution permit for Fibrowatt's first US poultry waste burner in Benson, Minnesota, which operates under the name Fibrominn, and compared it to the draft permit for Duke Energy's newest coal-fired electric plant in Cliffside, North Carolina.

Poultry Waste Burning: A Solution Looking for a Problem

Poultry manure is rich in nitrogen, potash and potassium. This relatively dry litter is an excellent fertilizer, and farmers spread it on agricultural lands.

> Data from the Maryland Cooperative Extension manure testing program indicate that poultry litter averaged 3.522% nitrogen, 2.971% phosphorus, and 2.343% potassium during the period 1995-2001, the most recent period for which data are available. These estimates indicate that each ton of poultry litter contains 70.44 pounds of nitrogen, 59.42 pounds of phosphorus, and 46.86 pounds of potassium. [1]

A 2002 University of Maryland study concluded that application to farmland provided the ***highest economic value to local farmers*** while proposals to burn litter to generate electricity represented a negative value.

> Electric power generators would not be able to afford to pay a positive price for poultry litter because electricity produced using poultry litter under these technologies is expensive relative to the alternatives available. The capital and operation and maintenance costs alone amount to between 5.1 and 8.4 cents per kilowatt-hour. Ash sales should bring in only between 0.7 and 1.3 cents per kilowatt-hour, while cleanout and transport costs amount to between 2.0 and 2.3 cents per kilowatt-hour. The before-tax net cost of producing electricity thus ranges between 5.1 and 9.5 cents per kilowatt-hour, far more than the wholesale price of electricity on the Delmarva Peninsula even with a renewable energy tax credit. [2]

Fibrowatt claims to solve the problem of poultry waste by burning litter to produce electric power. But the nitrogen which is essential for plant growth becomes a problem when burned. Oxides of nitrogen (NO_x) created by combustion are the principal cause of ozone pollution which leads to severe, life-threatening health problems such as asthma and other pulmonary diseases. This is a fundamental drawback which the best pollution control devices may only mitigate.

Poultry Litter versus Coal-fired Power Plants: An Air Pollution Comparison

To determine the impact of poultry waste power plants on air quality, we gathered data on actual air emissions from a poultry waste-fueled plant as reported by the operator. [3] Table 1 lists some of the major pollutants and annual emissions from the 38.5 megawatt plant in Thetford, UK which uses poultry litter for fuel.

Table 1. Annual Air Pollution Totals from Poultry Litter Power plant

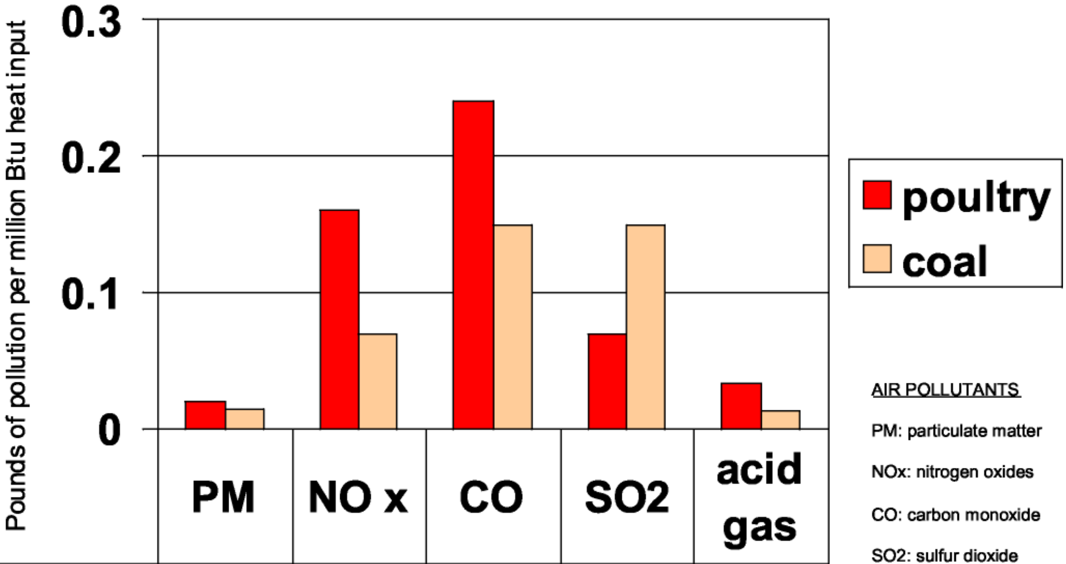
Pollutant	**Air Emissions 2004**
Carbon Dioxide	455,006 tons
Carbon Monoxide	258 tons
Sulphur Oxides (SO2)	351 tons
PM10	23 tons
Nitrogen Oxides (NO2)	619 tons

In Thetford's annual emissions report we see that a relatively small power plant emitted substantial levels of pollution and greenhouse gas. Carbon dioxide emissions, which contribute to global warming, were nearly half a million tons. In a previous report on poultry waste burning [4] we found that in 2004 this plant emitted three times as much nitrogen oxide per megawatt as Duke Energy's Buck Steam plant operating near Salisbury, NC. Fibrowatt countered that the comparison was unfair because the Buck plant only operated at 38% capacity that year. But even at this reduced rate, the aging Buck plant would have generated over three times the maximum output of the Thetford plant for less than three times the NOx.

Next, we compared permit limits on emissions of particulate matter, nitrogen oxides, carbon monoxide, sulfur dioxide and acid gases from a recently opened poultry waste power plant in Minnesota with a coal-fired power plant proposed by Duke Energy in North Carolina. These plants are representative of the latest developments in technology and pollution control.

The pollution data in Figure 1 is taken from the state air permits for the two plants. The graph illustrates the relative air pollution impacts of power plants powered by poultry litter compared with boilers fired by coal. In our comparison, we utilized heat input in millions of BTUs (mmBTU) as a common denominator. This is the typical method for regulating electric generating plants in North Carolina, Minnesota and most other states. The sources of emissions data used in this graph are included as Attachments A and B. When the targets of the NC Clean Smokestacks Act are reached in 2009, coal-fired electric power plants in North Carolina will emit less than half the nitrogen oxides per mmBTU compared to the 50-megawatt Fibrominn poultry-powered plant in Minnesota.

Figure 1. Air Pollution from Electricity Generated by Poultry Waste and Coal



	PM	NO x	CO	SO2	acid gas
poultry	0.02	0.16	0.24	0.07	0.034
coal	0.015	0.07	0.15	0.15	0.013

AIR POLLUTANTS

PM: particulate matter

NOx: nitrogen oxides

CO: carbon monoxide

SO2: sulfur dioxide

Acid gas: hydrochloric acid and sulfuric acid

Power plants in this comparison

Fibrominn, Benson, Minnesota

Fibrominn Biomass Power Plant, Benson, Minnesota, Permit No. 15100038-004
Pollution control devices: baghouse/spray dryer, selective non-catalytic reduction

Fibrominn is a 50-megawatt electric power plant in Benson, Minnesota. It is the only such plant operating in the United States. The primary fuel (75%) is turkey and chicken litter. The balance of the fuel includes agricultural wastes and wood chips. The volume of litter burned at the Minnesota plant is expected to total 700,000 tons per year. Steam generated from burning poultry litter will be used to run a turbine and produce electricity. Minnesota Pollution Control Agency issued an air permit for the Fibrominn Biomass Power Plant in compliance with MR 7007.1150 and 1500 air pollution control requirements which conform to federal emission limits. The plant began operating in 2007.

Duke Energy, Cliffside, North Carolina

Duke Cliffside Coal-fired Power Plant Unit 6, Cliffside, North Carolina, Permit No. 04044T
Pollution control devices: low-NOx burners, Selective catalytic reduction, Electrostatic precipitators wet/dry, flue-gas scrubber

On March 21, 2007 Duke Energy was granted a Certificate of Public Convenience and Necessity from the North Carolina Utilities Commission for modifications of its Cliffside Steam Station for a new 800-megawatt advanced coal-fired electric power plant. Duke states it will meet all federal and state requirements including the 2002 Clean

Smokestacks Act. North Carolina Division of Air Quality has completed a permit review for Duke Energy's new Cliffside Unit 6 which is expected to come on line in 2011. The permit would meet all 15A NCAC 2D air pollution control requirements which comply with federal emission limits

Both the Fibrominn and the Cliffside power plants were subjected to preconstruction New Source Review under the federal Clean Air Act. Both meet federal requirements for best available control technology (BACT).

As yet, no poultry waste permit application has been submitted in North Carolina, and only preliminary meetings with the state air pollution agency have taken place. However, Fibrowatt's representatives are on record saying that the proposals for North Carolina would include plants of about 40-50 megawatts electric output.

All things considered, replacing electricity from coal with electricity from poultry litter would increase ozone pollution in North Carolina.

Poultry Waste Power Plants Are Not Carbon Neutral

The burning of poultry litter eliminates a valuable organic fertilizer which would have to be replaced by mineral fertilizers. So, in addition to the pollutants from the smokestack, one must include the energy used to produce the fertilizer replacement for poultry litter. Table 2 below [5] details the energy which is required to produce the nitrogen, phosphorus and potassium (NPK) in mineral fertilizers.

Table 2. Estimate of average energy requirements for nitrogen, phosphate, and potash (BTUs/lb).

Nutrient	**Production**	**Packaging**	**Transportation**	**Application**	**Total**	**Equivalent** [1]
N	29,899	1,119	1,936	688	33,642	0.240
P_2O_5	3,313	1,119	2,452	645	7,529	0.054
K_2O	2,753	774	1,979	430	5,936	0.042

[1] Gallons of #2 fuel oil (diesel) to produce one pound of nutrient.

Proponents of poultry waste energy plants neglect to account for fertilizers needed to replace poultry litter. The energy of production (second column) for mineral fertilizers is part of the energy debt created by burning poultry litter. In other words, burning poultry litter results in the use of fossil fuel energy to produce a replacement, creating additional air pollution and greenhouse gas emissions. Nearly 36 thousand BTUs would be wasted to produce a pound of the nitrogen, phosphorus and potassium (NPK) in mineral fertilizers.

What would be the energy impact of replacing organic poultry fertilizer with mineral fertilizers? According to Fibrowatt, approximately 3 million tons per year of poultry litter is produced annually in North Carolina. [6] Table 3 details the potential impacts of replacing poultry litter with chemical fertilizers in North Carolina.

Table 3. Annual Energy and Fuel Oil Needed to Replace NC Poultry Litter

	Content %	*Pounds/year (3 million tons litter)*	*BTU/pound (Table 1)*	*BTU/year*	*Fuel oil per pound* [1]	*Fuel oil gallons per year*
N	3.522	211 million	29899	6.32E+12	0.24	50,716,800
P_2O_5	2.971	178 million	3313	5.91E+11	0.054	9,626,040
K_2O	2.343	141 million	2753	3.87E+11	0.042	5,904,360

[1] Gallons of #2 fuel oil (diesel) to produce one pound of nutrient

The percentage of nitrogen, phosphorus and potassium (N, P_2O_5 and K_2O) in 3 million tons of poultry litter shows that about 530 million pounds of vital minerals are directly available for agricultural use. If instead 3 million tons of poultry litter were burned to produce electric power, we estimate that it would take 1.2 million barrels of diesel fuel per year to replace this organic fertilizer with chemical fertilizers.

We need clean renewable energy in North Carolina.

North Carolina is considering adding new resources for electric generation. Clean renewable sources of electric power are necessary and desirable to replace existing coal-fired and nuclear power plants. We believe the goal should be to provide improved air quality and other benefits to energy consumers and residents. But proposals for three 35-megawatt poultry waste burners in North Carolina raise serious environmental, economic and public health concerns. After careful consideration, we believe that electric power plants fueled by poultry waste have no place in a clean energy future.

Louis A. Zeller
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References

1. *Economic Value of Poultry Litter Supplies In Alternative Uses,* Erik Lichtenberg Doug Parker Lori Lynch, October 2002, Center for Agricultural and Natural Resource Policy, page 7
2. ibid, page 25
3. http://maps.environment-agency.gov.uk /wiyby/queryController? topic= pollution&ep= 2ndtierquery&lang=_e&layerGroups=1&x=585200.0&y=286800.0&extraClause=AUTHORISATION_ID ~'AP0844'&extraClause=YEAR~'2004'
4. *Fibrowatt's Proposal to Burn Poultry Litter in NC,* July 11, 2006, available at http://www.bredl.org/pdf/Report_Fibrowatt060711.pdf
5. Fluck, R.C. (ed.) Energy in Farm Production. vol.6 in Energy in World Agriculture. Elsevier, New York. pp.177-201.1992
6. Rupert Fraser, CEO Fibrowatt in the Raleigh *News & Observer*, June 18, 2007

Attachment A

Fibrominn Biomass Power Plant, Air Permit No. 15100038-003, Emission limits, page A-7
Minnesota Pollution Control Agency

What to do	Why to do it
EMISSION LIMITS Unless otherwise noted, the emission limits below apply at all times except during periods of startup, shutdown, or malfunction. Duration of startup, shutdown, or malfunction periods are limited to 3 hours per occurrence. The startup period commences when the affected facility begins the continuous burning of biomass and does not include any warmup period when the facility is combusting natural gas or propane, and no biomass is being fed into the boiler. The use of biomass solely to provide thermal protection of the grate or hearth during startup when biomass is not being fed to the boiler is not considered to be continous burning.	hdr
Total Particulate Matter: less than or equal to 0.02 lbs/million Btu heat input based on three runs that are between 60 and 120 minutes in length.	Title I Condition: 40 CFR 52.21(j), BACT emission limit Also meets the requirements of 40 CFR 60.43b(c)
Particulate Matter less than 10 micron: less than or equal to < > lb/mmBtu, based on three runs that are between 60 and 120 minutes in length. The Permittee shall propose limits after completion of the Performance Tests required below. Permit conditions below require the completion of an inital stack performance test within 180 days of initial startup, and then quarterly thereafter until the company has completed a total of five tests. The proposed emission limit shall be submitted within 45 days of the submittal of the final test results.	Title I Condition: 40 CFR 52.21(j), BACT emission limit
Opacity: less than or equal to 20 percent on a 6-minute average, except for one 6-minute period per hour of not more than 27 percent opacity.	40 CFR 60.43b(f)
Sulfur Dioxide: less than or equal to 0.07 lbs/million Btu heat input or 80% control, whichever is least stringent based on a 24-hour hour daily geometric average emission concentration or a 24-hour daily geometric average percent reduction.	Title I Condition: 40 CFR 52.21(j), BACT emission limit
Nitrogen Oxides: less than or equal to 0.16 lbs/million Btu heat input based on a 30 day rolling average. This limit applies at all times including periods of startup, shutdown, or malfunction. The 30 day average emission rate is calculated as the average of all hourly emissions data recorded by the monitoring system during the 30 day period. A new 30 day rolling average emission rate is calculated each steam generating unit operating day.	Title I Condition: 40 CFR 52.21(j), BACT emission limit, also meets the requirements of 40 CFR 60.44b(l)
Nitrogen Oxides: less than or equal to the following during any 30-day rolling average period that both biomass and natural gas/propane are burned: Eo = [(0.10*Hgo) + (0.20*Hr)]/(Hgo + Hr) where: Eo is the NOx emission limit in lb/mmBtu Hgo is the heat input from combustion of natural gas/propane and Hr is the heat input from combustion of any other fuel (biomass)	40 CFR 60.44b(l)
Carbon Monoxide: less than or equal to 0.24 lbs/million Btu heat input based on a 24-hour daily average.	Title I Condition: 40 CFR 52.21(j), BACT emission limit
Hydrochloric acid: less than or equal to 0.034 lbs/million Btu heat input or 95% control, whichever is least stringent.	Title I Condition: 40 CFR 63.43(b), MACT emission limit

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Attachment B

Duke Cliffside EGU, Air Permit No. 04044T, DAQ Review, Emissions Table 4-1, page 16

Table 4-1
Emissions – Unit 6 Boiler

Pollutant	Proposed Emission Rate		
	lb/mmBtu	lb/hour[1]	tons/year[2]
SO_2	0.15	1,177.5	5,157.5
NO_x	0.07	549.5	2,406.8
PM	0.012	94.2	412.6
PM_{10} (filterable only)	0.012	94.2	412.6
PM_{10} (filterable + condensable)	0.018	141.3	618.9
CO	0.12	942	4,126.0
VOC	0.004	31.4	137.5
H_2SO_4	0.005	39.3	171.9
Lead	0.000022	0.17	0.75

[1] lb/hour is based on heat input of 7,850 mmBtu/hr
[2] tons/year is based on heat input of 7,850 mmBtu/hr and 8,760 hours/year operation