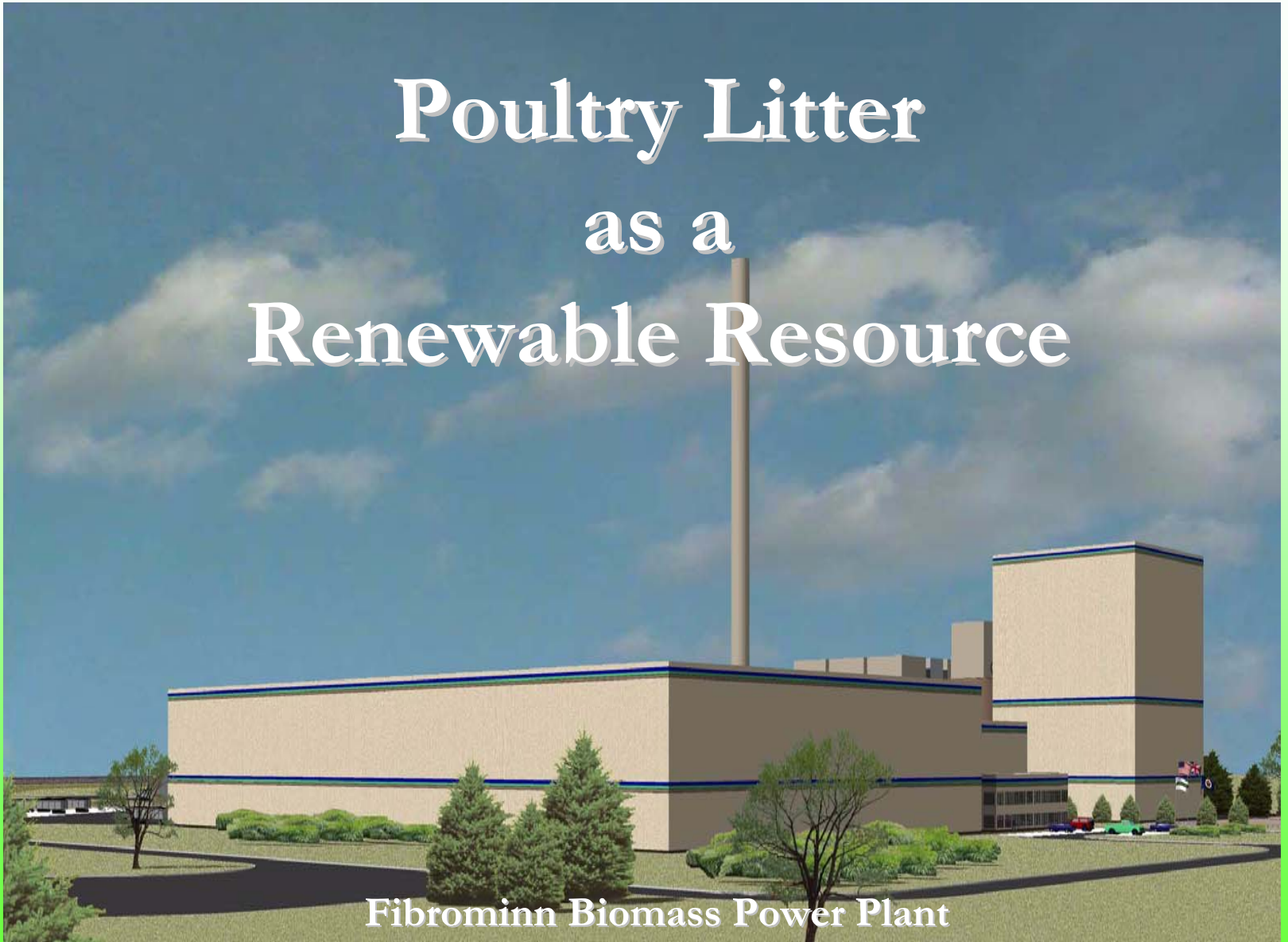


Poultry Litter as a Renewable Resource



Fibrominn Biomass Power Plant

Poultry Litter

- **Undigested Feed**
- **Water**
- **Bedding Material** ■
(wood shavings/sunflower hulls)
- **Barn Flooring Material**
- **Tramp Contaminants**

Poultry Litter

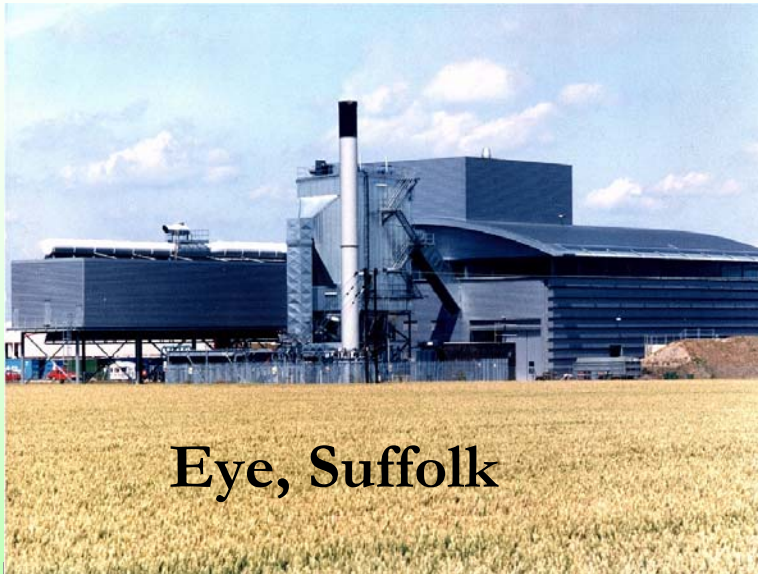
Renewable Resource

- Energy Resource
- Nutrient Resource
- Rural Economic Resource
- Environmental Resource

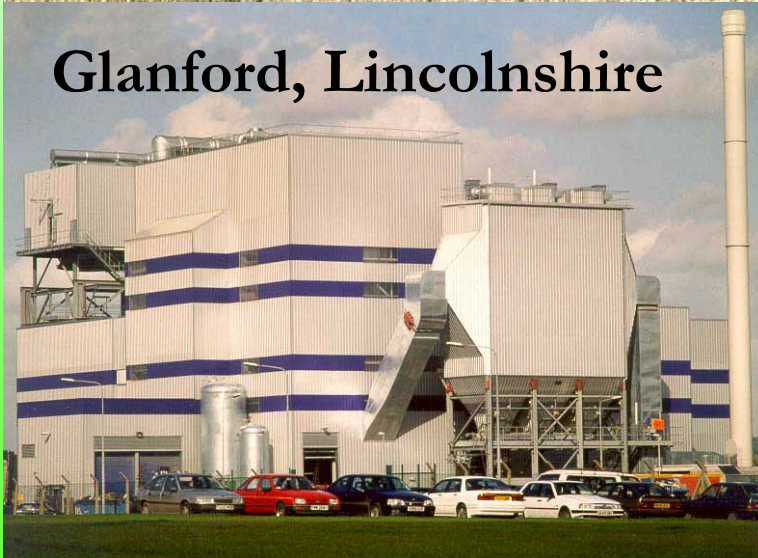
The Fibrowatt Story

- **Founded as a family owned business in 1988**
- **Developer, owner and operator of the world's first three poultry litter fueled power stations in the United Kingdom**
- **Twelve years of valuable operating experience**
- **Utilizing 825,000 tons of poultry litter per year to generate 500 million kWh of electricity**
- **Sale of 370,000 tons of ash as a nitrogen-free ash rich in potash and phosphate. UK brand name is "Fibrophos"**

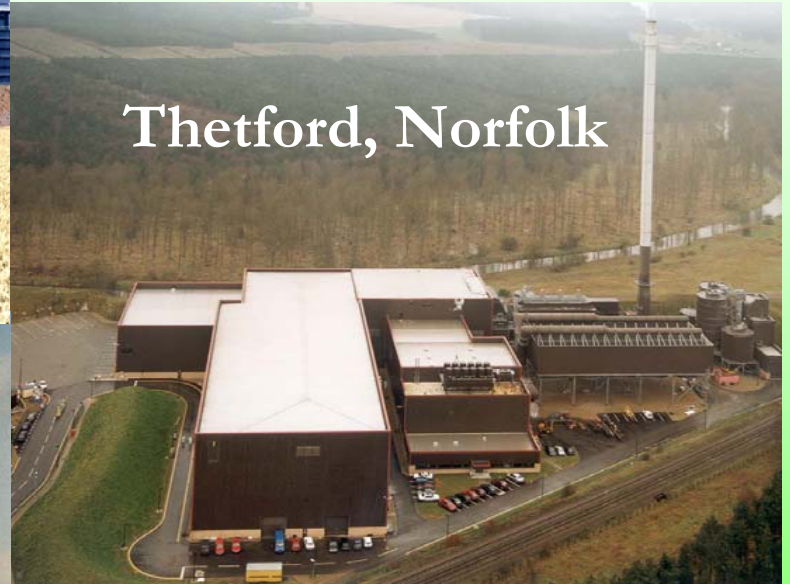
Fibrowatt's Existing Plants



Eye, Suffolk

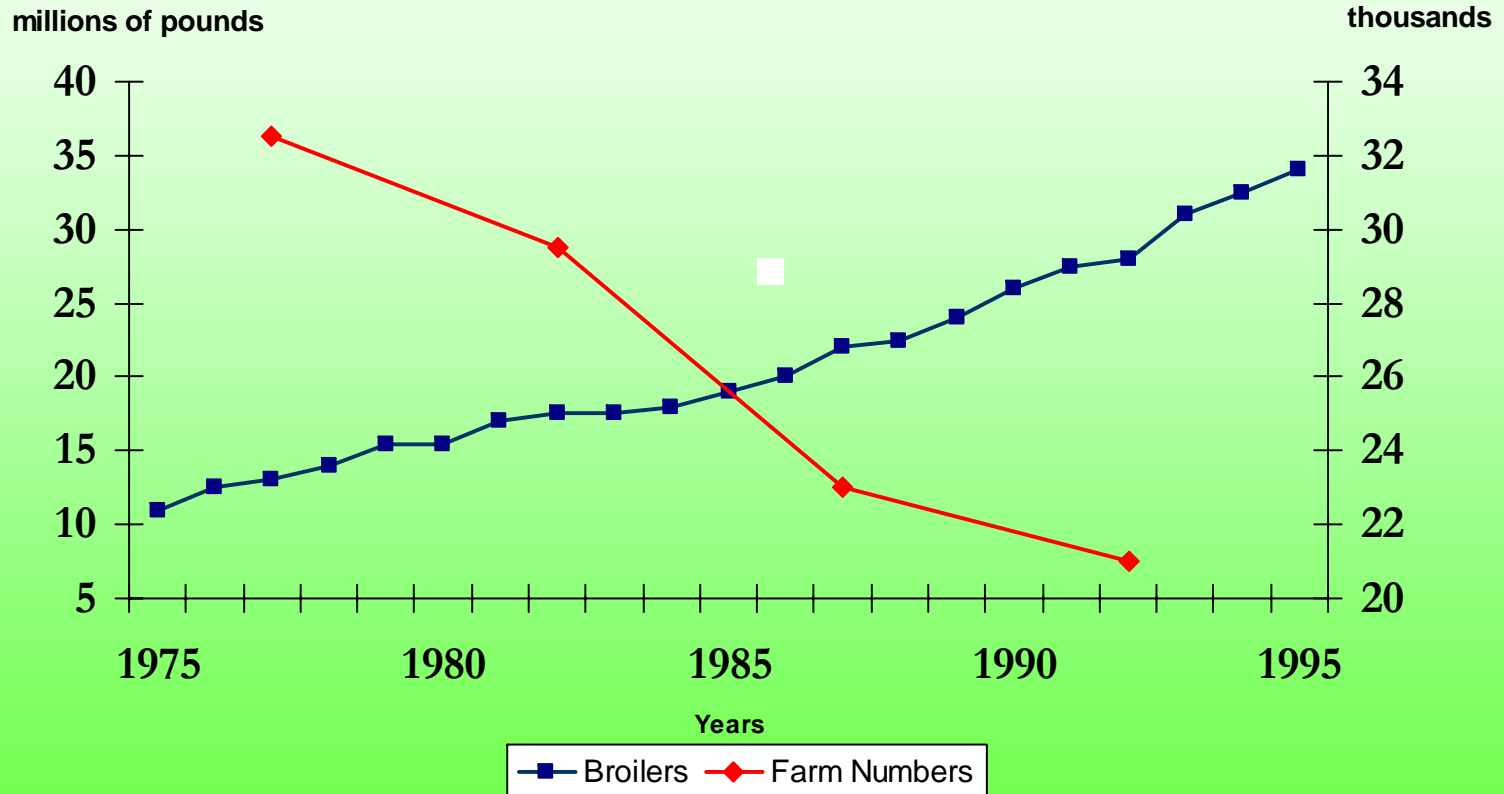


Glanford, Lincolnshire



Thetford, Norfolk

US Broilers vs Farms



Poultry Litter Stock Piles



Why Minnesota?

- Poultry Industry Support
- Minnesota Legislature Support
(Biomass Mandate)
- Fuel Availability
- Benefits to Minnesota

Our Fuel Producers



Litter to Electricity

How it Works

- **On the farm:**
 - Coordinate barn cleaning with poultry farmers
 - Barn cleaning flexibility is not tied to land application cycles
 - Fibrominn transport of litter in covered trucks using set routes
 - Careful attention to industry biosecurity concerns
- **Fuel reception:**
 - Receipt according to fuel quality
 - Sampling and analysis (moisture and ash)
 - Negative pressure in fuel hall prevents odor and dust from escaping
 - Litter delivery trucks cleaned prior to site departure

Litter Load-out



Fuel Delivery



Fuel Trucks Unloading



Sample Moisture Analysis





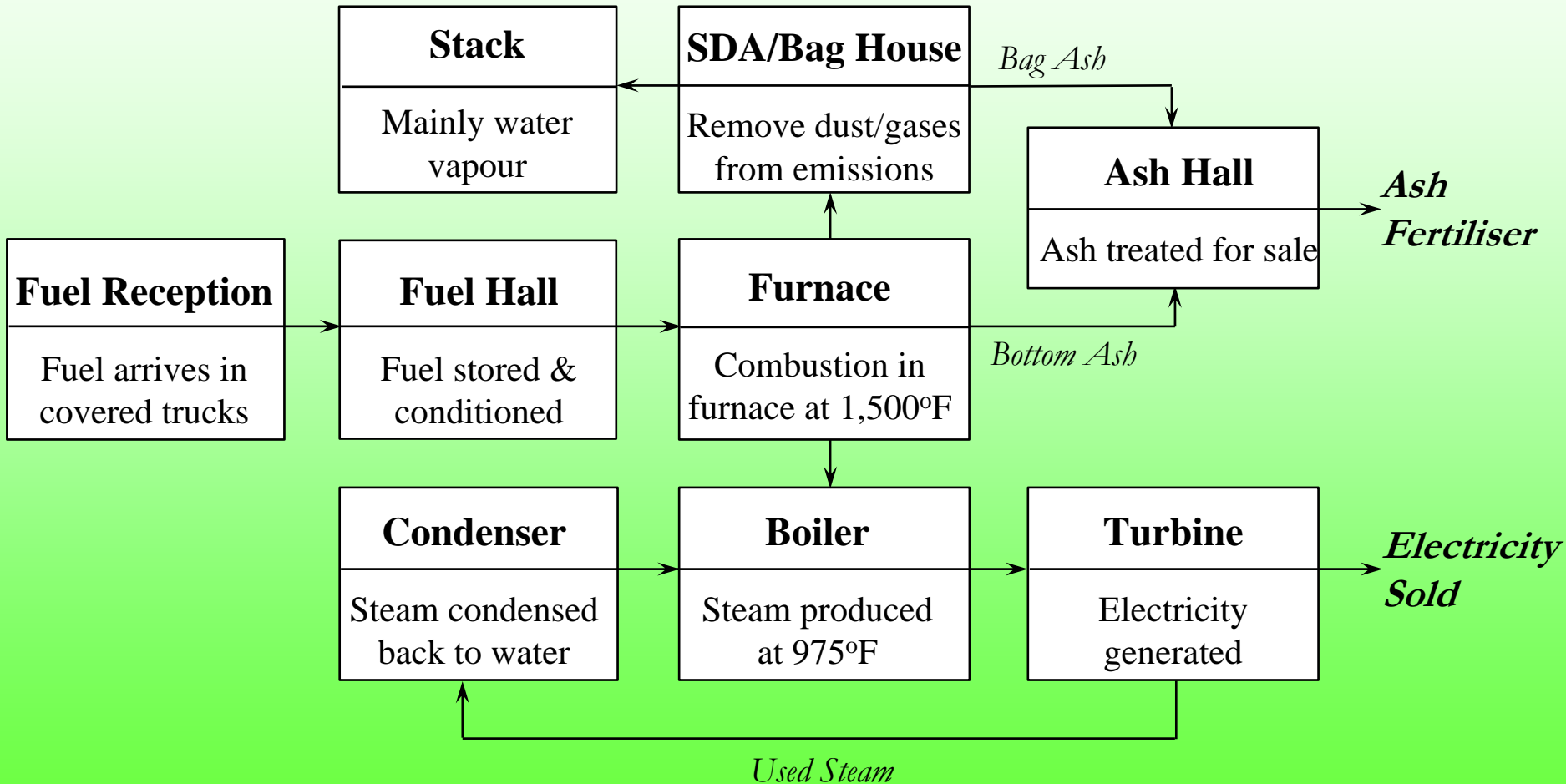
Truck Washing in UK

Litter to Electricity

How it Works

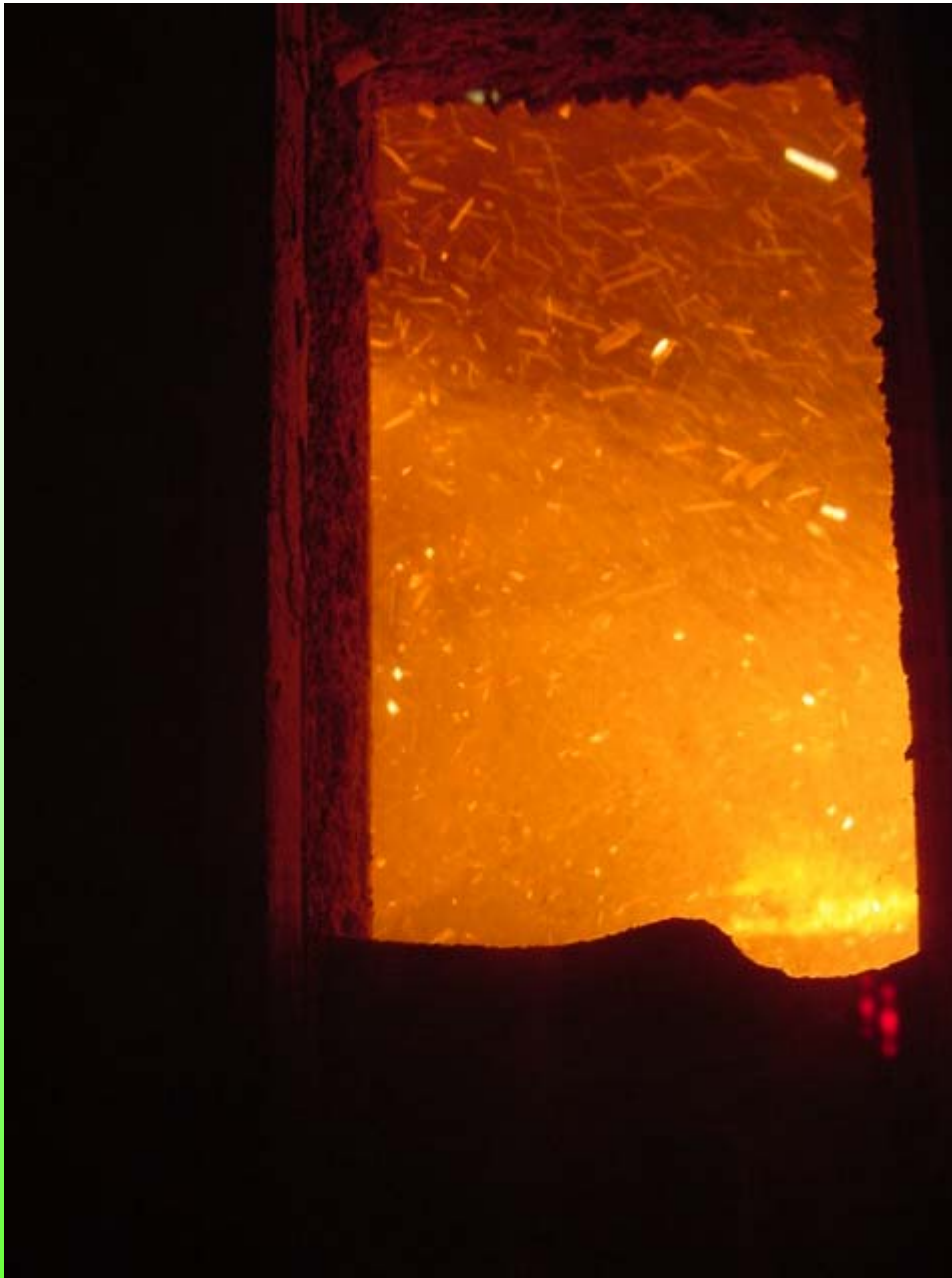
- **In the plant:**
 - Good combustion characteristics
 - Steam production to drive turbine generator for electricity sale
 - Ash managed for product quality
- **Ash By-product Generation**
 - Fibrominn**
 - Ash recovery
 - Processed to meet particle size specifications
 - Fertilizer Company**
 - Screening and blending to meet target market
 - Final production and quality control
 - Product storage, transport and commercial distribution

How it Works



Thetford Fuel Hall





**Poultry
Litter
Really
Does
Burn!**

Fuel Supply Development

- **Fibrominn has been active in the Benson Minnesota area for over three years working with the farmers and poultry industry**
- **A majority of the poultry litter fuel is under contract or available on a spot market basis**
- **Extensive sampling program completed to confirm expected fuel quality (poultry litter and secondary biomass)**
- **Various secondary vegetative biomass materials currently being evaluated**

Poultry Litter as a Fuel

Litter Fuel Quality

- **Moisture**
 Typical: 35% - 40%
 Range: 20% - 60%
- **Ash**
 Typical: 12% - 15%
 Range: 8% - 22%
- **Higher Heating Value (btu/lb)**
 Typical: 3,500 – 4,000
 Range: 2,400 – 4,800
- **Sulfur**
 Typical: 0.3% - 0.4%
 Range: 0.2% - 0.7%
- **Chlorine**
 Typical: 0.3% - 0.4%
 Range: 0.2% - 0.7%

Fuel Comparison

	Moisture	Ash
• Coal	10%	8.0%
• Wood	50%	0.5%

	Sulfur	Chlorine
• Coal	2%	nil
• Wood	0.02%	nil

	Higher Heating Value
• Coal	8,000 – 12,000
• Wood	3,000 – 6,000

Poultry Litter Fuel Challenges

- High moisture/moisture variation
- High ash content/flue gas ash loading
- Fuel compression in storage
- Supplier management
- Truck transport/seasonal limitations
- Robust boiler capabilities required
- We provide a service vs. purchase a fuel

The Greenhouse Gas Advantage

- **Greenhouse gas reduction**
 - Through a biochemical reaction nitrous oxide (N_2O) is produced when excess litter is applied to the ground
 - Methane (CH_4) and carbon dioxide (CO_2) is generated during decomposition when litter is stockpiled
 - The proposed plant avoids 283 tons of N_2O emissions
- **Over 90,000 tons of equivalent CO_2 emissions are avoided**
 - N_2O has 341 times the heat trapping potential as CO_2 as a greenhouse gas

The Greenhouse Gas Advantage

- **CO₂ emissions from a poultry litter plant are recycled**
 - Equal amount of CO₂ absorbed during feed and bedding growth
- **A poultry litter power plant will not contribute further greenhouse gas emissions as compared with fossil-fuel fired power plants**
 - Can replace 300,000 – 700,000 tons CO₂ per year

Litter Ash Composition

- **Aluminum** (as Al_2O_3) 1.5% - 2.5%
- **Calcium** (as CaO) 18% - 22%
- **Iron** (as Fe_2O_3) 1% - 2%
- **Magnesium** (as MgO) 4% - 6%
- **Phosphorous** (as P_2O_5) 18% - 25%
- **Potassium** (as K_2O) 15% - 20%
- **Silicon** (as SiO_2) 10% - 20%
- **Sodium** (as Na_2O) 3% - 6%
- **Sulfur** (as SO_3) 3% - 6%

Source of Ash

“Basically what the birds eat”

- **Ash in turkey litter**
(Nutrients primarily from corn and soybeans)
- **Lime reaction products**
- **Unreacted lime**
- **Ash in secondary biomass**

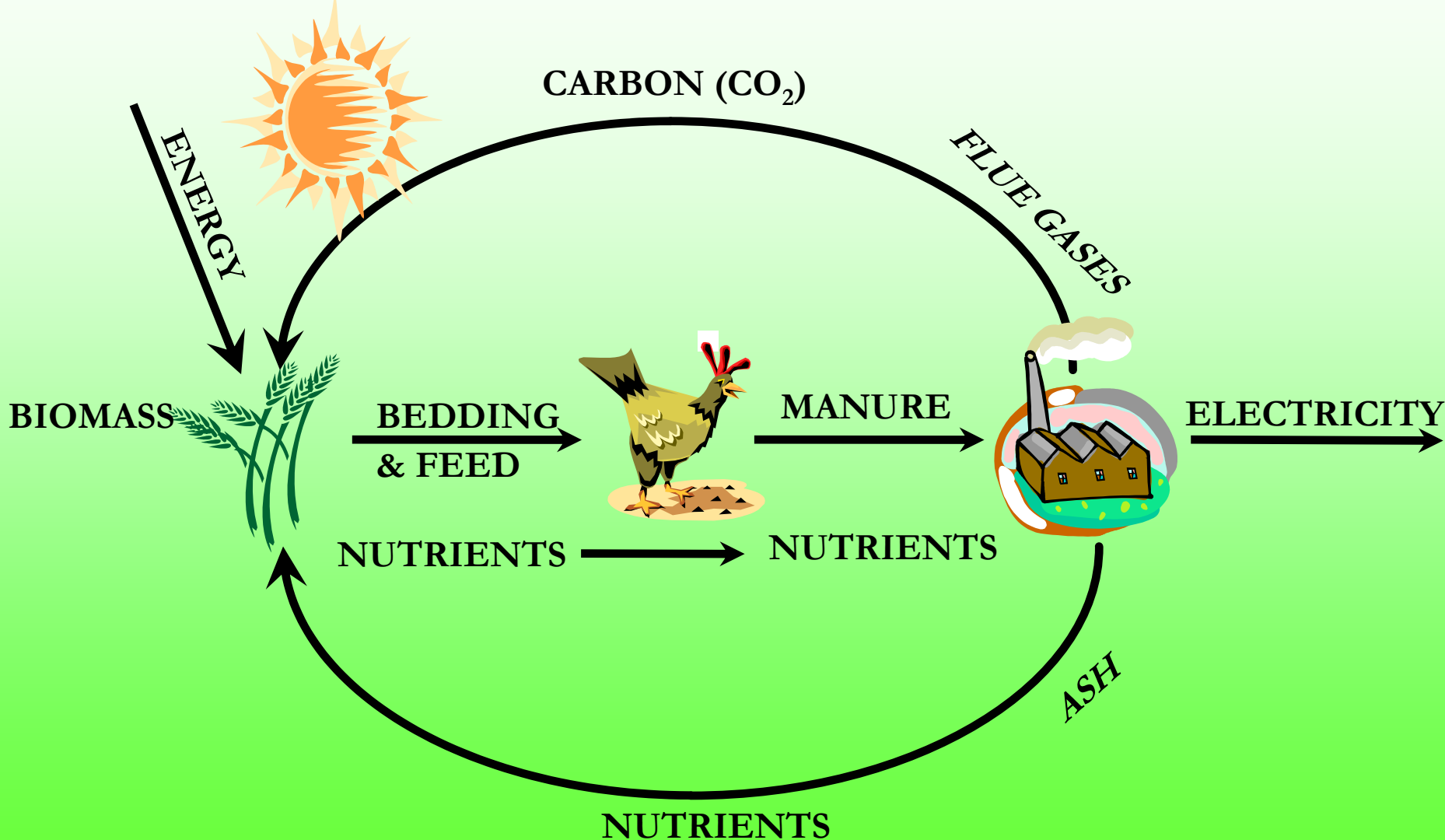
Ash By-Product Composition

- Phosphorous (as P_2O_5) 18.1% (13% - 23%)
- Potassium (as K_2O) 13.5% (8% - 20%)
- Sulfur (as SO_3) 5.1% (4% - 6%)

Ash By-Product Benefits

- Nitrogen-free fertilizer
- Concentrated nutrient value
- Secondary nutrient recycling
- Micronutrient recycling
- Slow release characteristics
- Material handling benefits
- Liming value (although below agronomic rates)
- Economic benefits (Minnesota retains revenue)

Renewable Resources



Poultry Litter to Power

- Proven, large-scale manure management option
- Year round alternative to stockpiling and land application
- Avoidance of watershed impacts for purposes of non-point source programs
- Multi-media benefits of technology (air, water, waste)
- Greenhouse gas advantages
- Clean, renewable power production

Poultry Litter to Power

Benefits

- Benefits agriculture
- Benefits poultry industry
- Benefits rural development
- Benefits communities (odor, nuisance)
- Benefits environment (watershed, air, greenhouse gases, TMDL)
- Benefits distributed energy generation
- Benefits sustainable development
- Solves problems in an innovative and integrated way

BROILER PRODUCTION BY STATES NUMBER RAISED (000), 1999

