UNC Energy Services

Energy Supply Alternatives

Carolina North

Introductions

- Carolyn Elfland – Assoc. VC for Campus Services
  - Introduction
- Jim McAdam – Manager, Chilled Water Systems
  - Heat Pump Technology & Distributed Solar
- Phil Barner – Capital Program Manager
  - Landfill Gas & Wood Products
- William Lowery – Senior Engineer, Cogeneration Systems
  - Animal Waste & Carbon Capture

Carolina North Goals

- Cost
- Reliability
- Land use
- Aesthetics
- Carbon
- Offsite / Distribution Requirements
- Operation & Maintenance
- Resource Conservation
- Pedagogical Opportunities
- Health & Wellness

Purpose of Presentation

- Energy Supply Alternatives, not choices
- Opportunities & Hurdles
- Key variables
  - Building mix/typology
  - Energy density
  - Competing goals

Heat Pump Technology

Water to Water Heat Pumps

Current Cooling Methodology

Heat Gain

Standard Chiller

Heat Rejected

59 F

5 Units

95 F

Electricity In

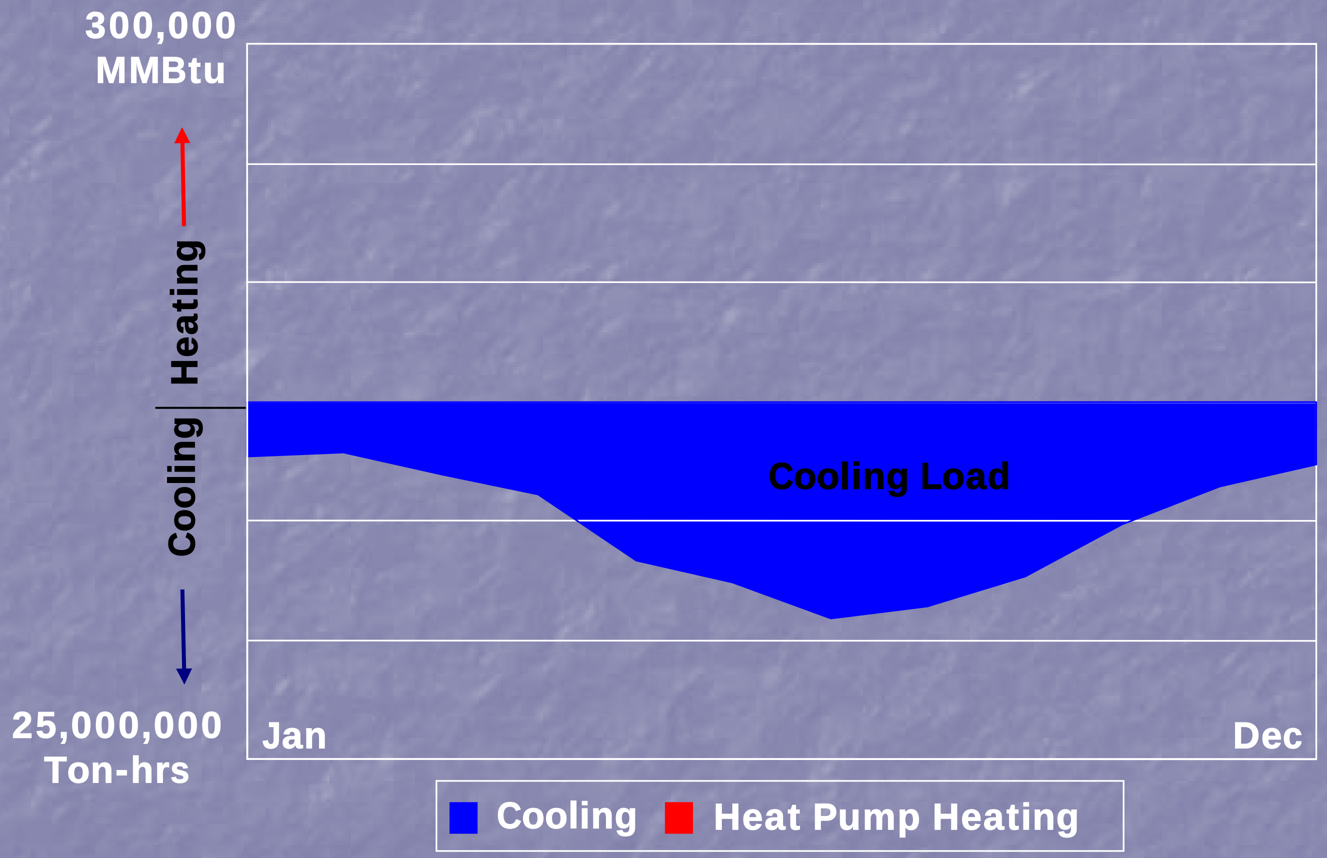
1 Unit

Water In

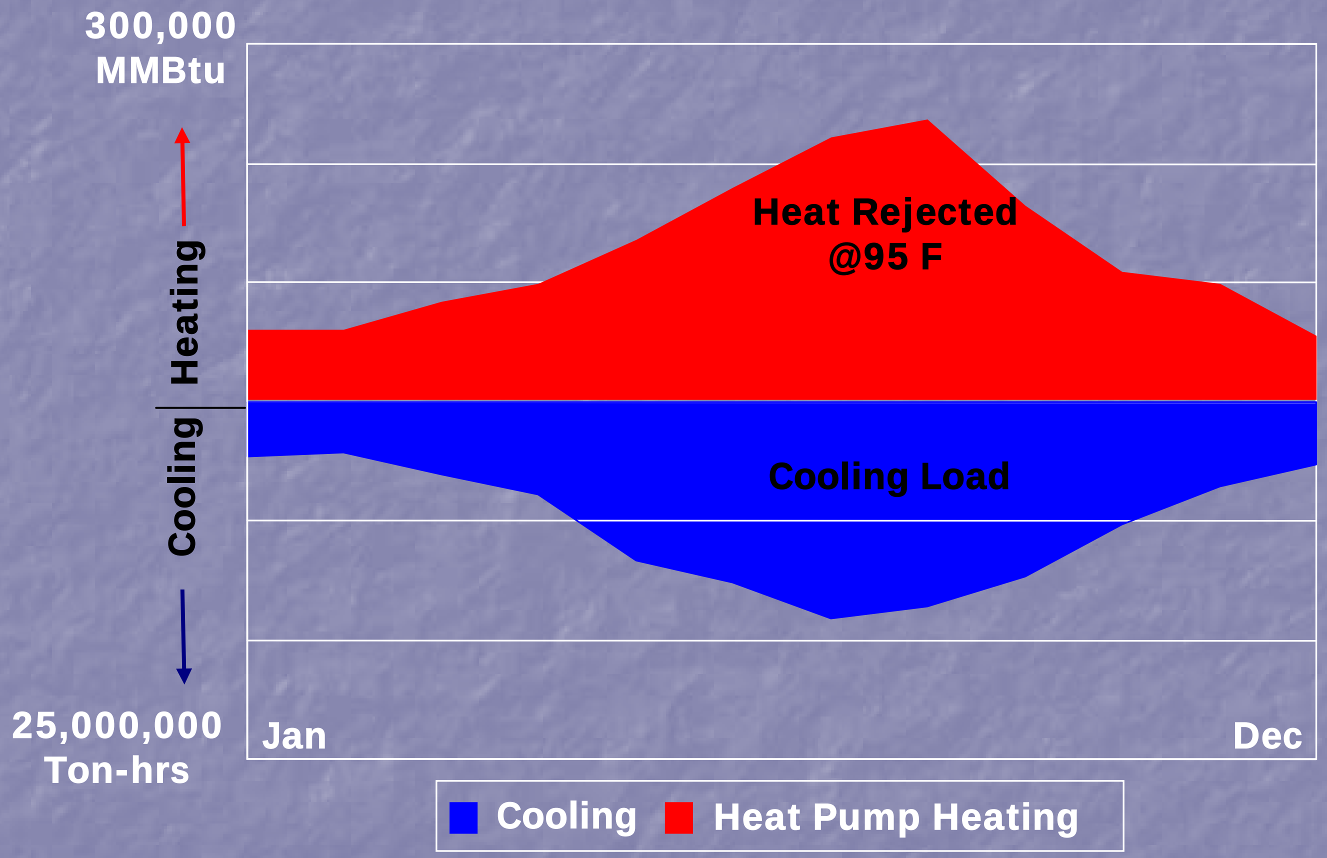
The advantage of chillers

1 Unit bought = 5 Units of useful work

Main Campus Load Profile



Main Campus Load Profile



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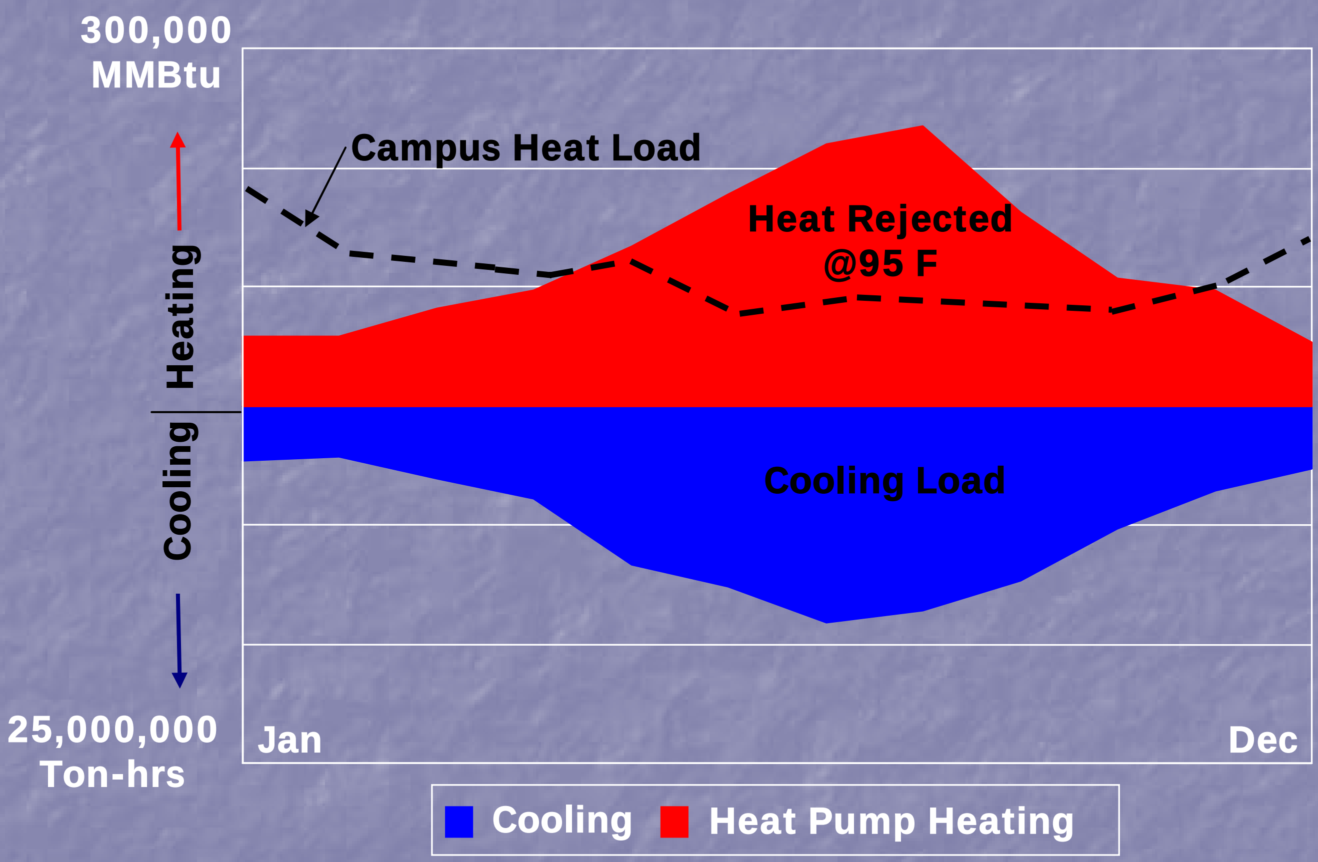


Heat Pump Opportunity

Heat In

“Heat Pump” Chiller

Useful Heat

59 F

5 Units

150 F

7 Units

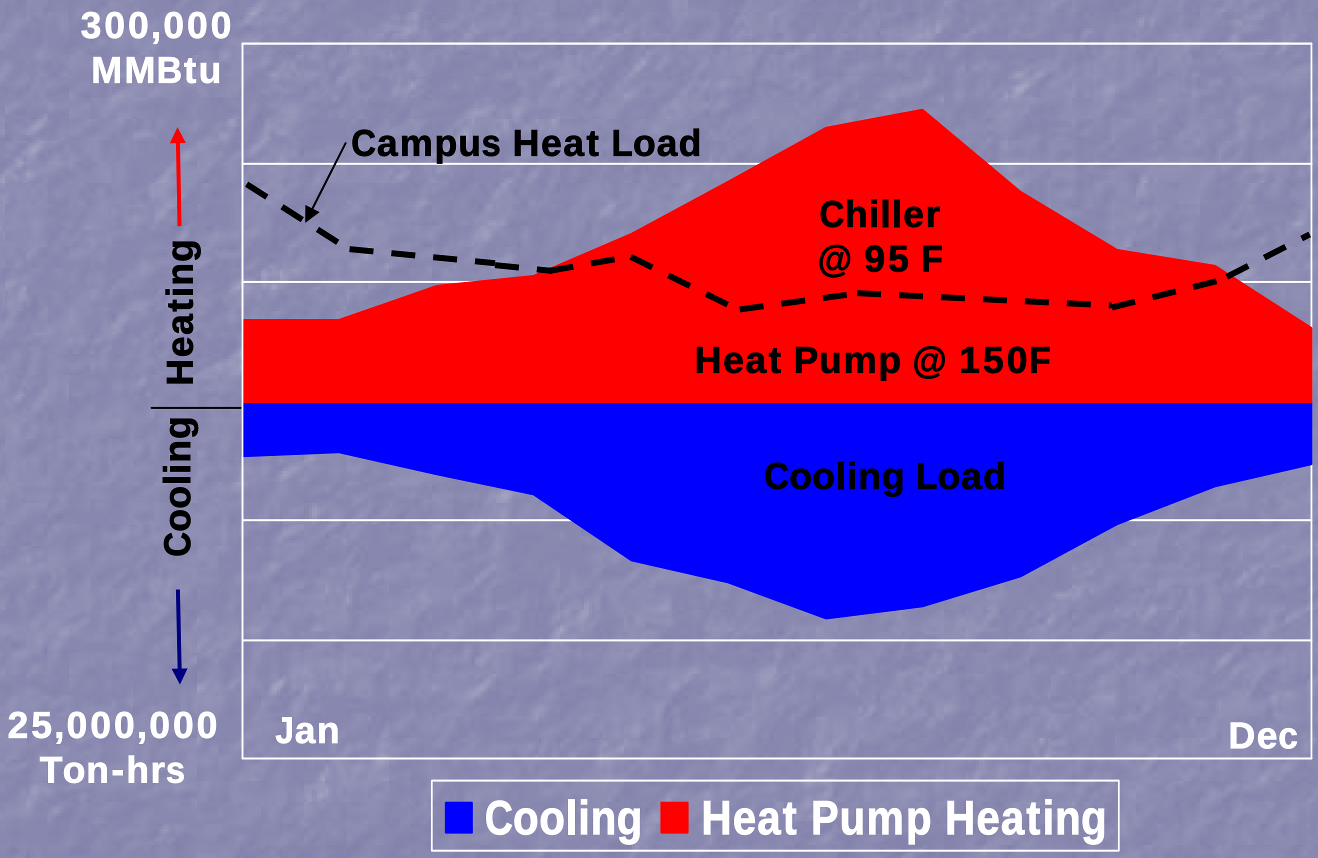
Electricity In

2 Units

The advantage of this....

2 Units bought = 5 + 7 Units of useful work

Main Campus Load Profile



Production Costs

ASSUMPTIONS

2MW Heat pump, 40F CWS, 155F HWS

24/7/365 operation

Gas = $8/MMBtu

Electric = $0.07/kWh

Water = $5/1,000 gal

	Heat Pump	Gas Boiler + Chiller	Gas Cogen + Chiller
Gas	$0	$1,752,000	$2,657,000
Electric	$1,290,000	$554,000	($126,000)
Water	$0	$130,000	$158,000
Annual Cost	**$1,290,000**	**$2,436,000**	**$2,689,000**
$/MMBtu (heating and cooling)	**$4.16**	**$7.81**	**$8.63**
CO_2 (ton/yr)	**10,377**	**17,277**	**14,621**

Heat Pump Technology

Requires coincident Heating & Cooling

This seems illogical – So why do we do it??

Heat Pump Technology

Answer: Dehumidification & Reheating

Chilled Water

(from Chiller Plant)

Steam

(from Cogen Plant)

Outside Air

Cold Air

55 F

Condensate

68 F

Tempered Dry Air

Heat Pump Technology

Answer: Data Centers need cooling all winter...

Chilled Water

(from Chiller Plant)

Electricity

(for Servers)

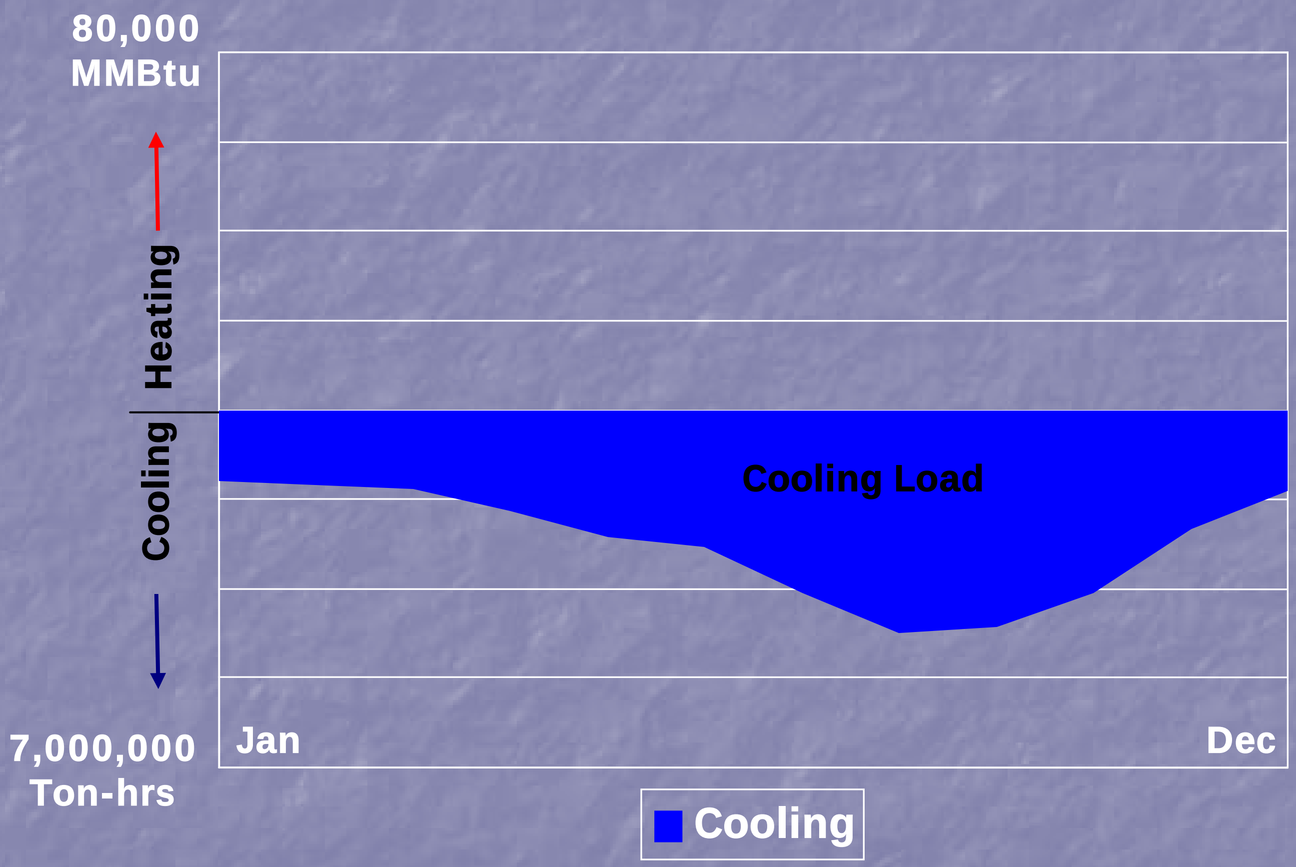
Recirculated Air

Cold Air

55 F

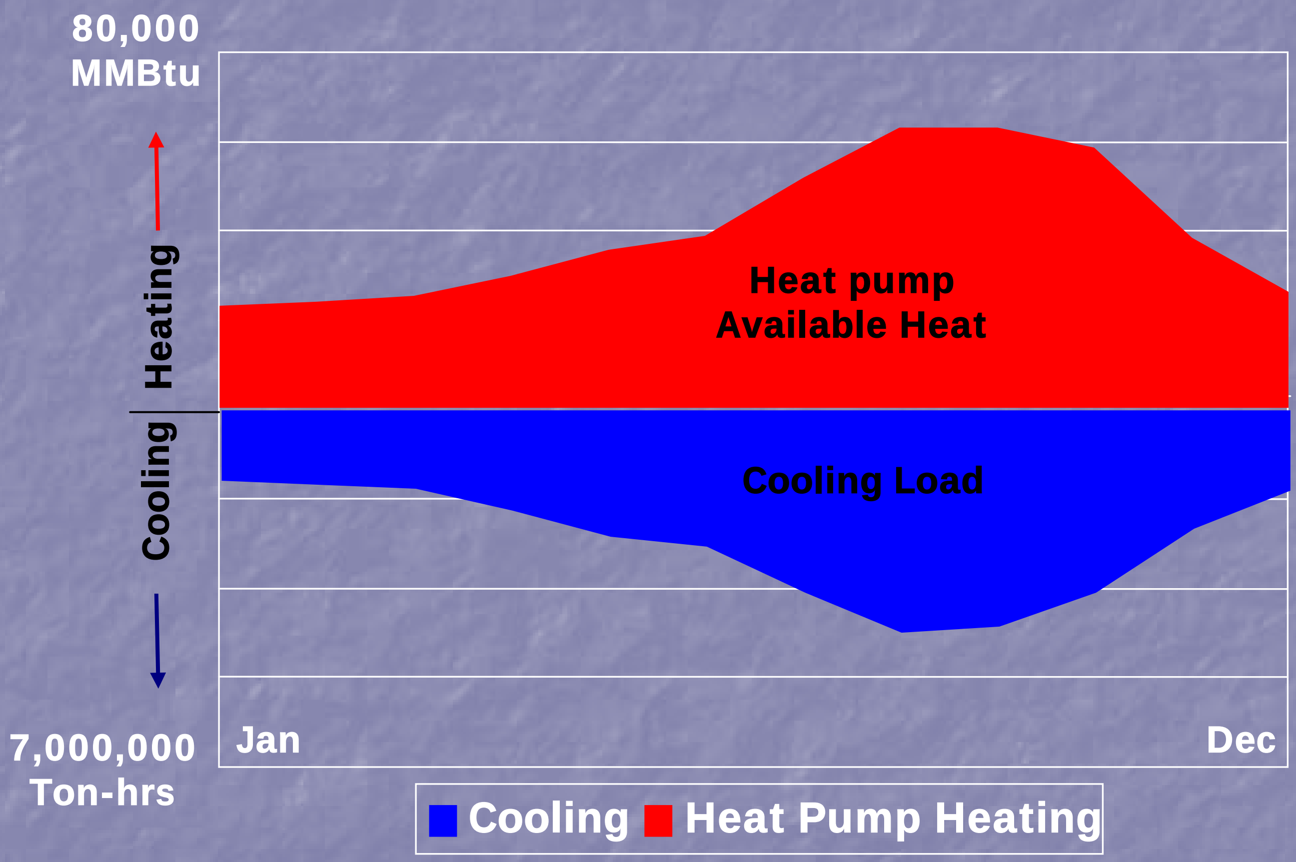
Potential Carolina North Load Profile

(1.5M sqft, 5MW RENCI)



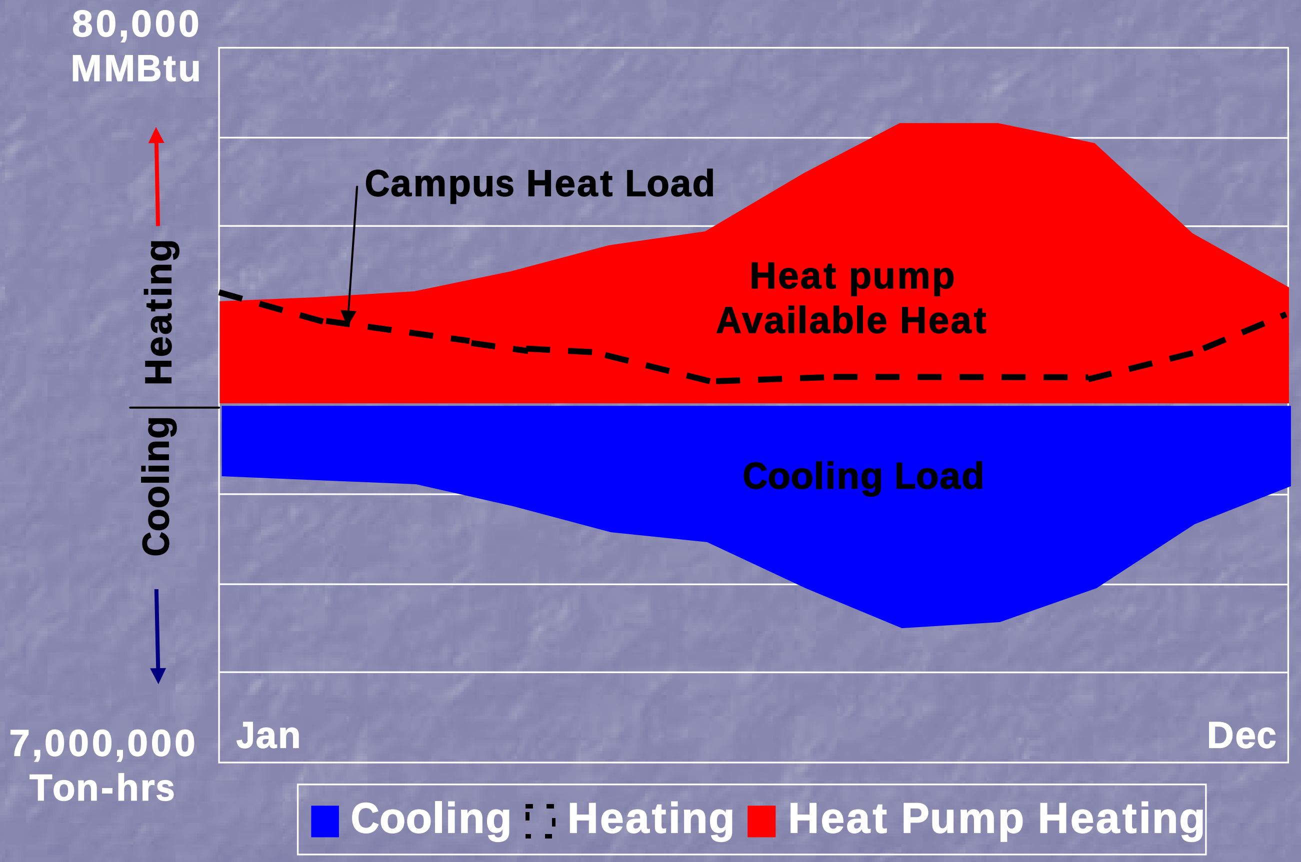
Potential Carolina North Load Profile

(1.5M sqft, 5MW RENCI)



Potential Carolina North Load Profile

(1.5M sqft, 5MW RENCI)



Heat Pump Technology

Opportunities

- Allows “Waste = Food” to work campus wide
- Inexpensive heat ($0 extra cost is possible in summer)
- Cooling tower water savings (30-50%)
- Reduced combustion-based heating
- Reduced CARBON emissions
- Proven technology in use today
- Low capital cost
- Good bridge solution for initial phase

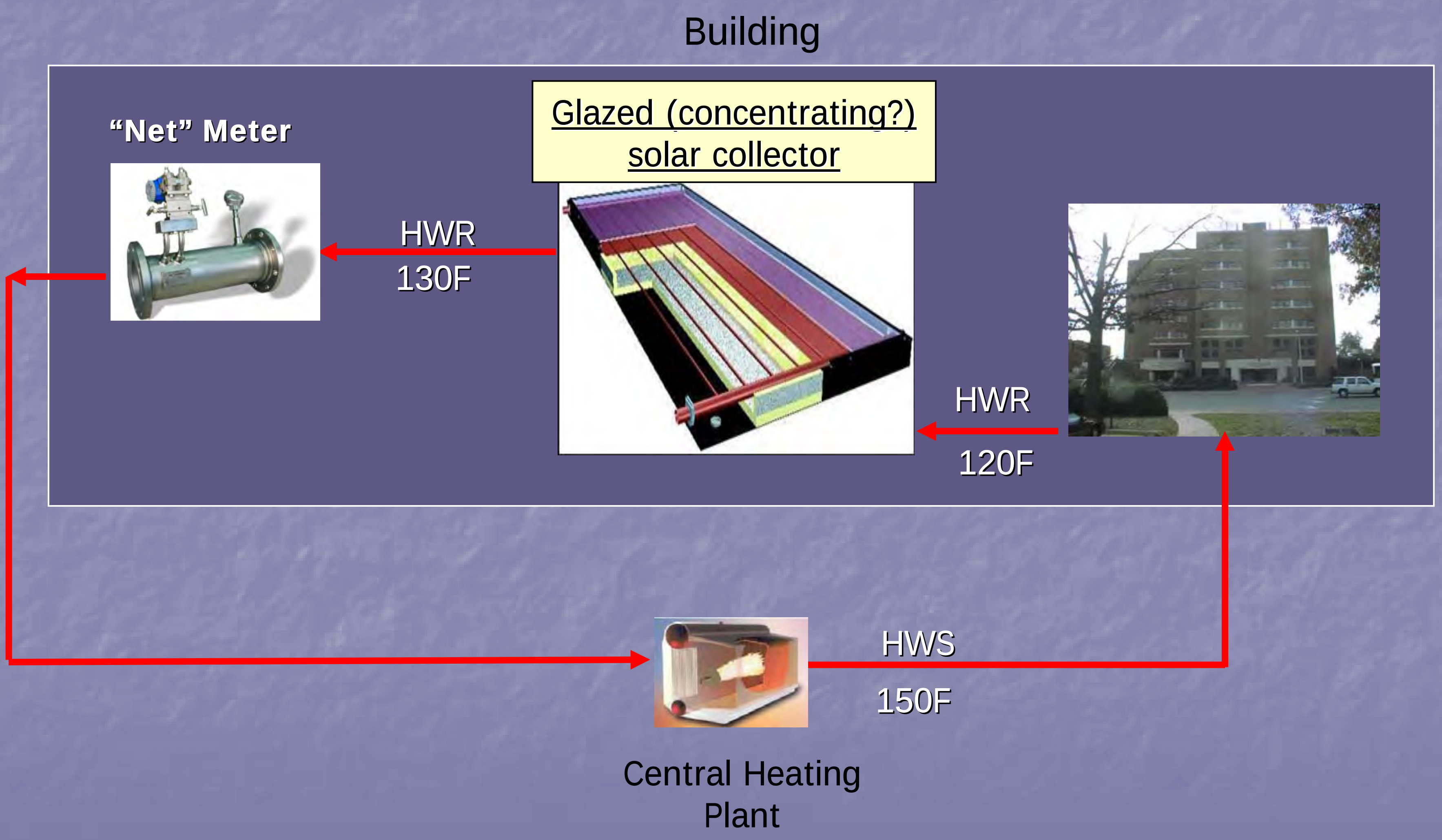
Heat Pump Technology

Barriers / Risks

- Electric rate sensitivity
- Reliance on Duke Energy
- Carbon offsets required to achieve carbon neutral goal
- Requires hot water distribution system, not steam
- Serves same heat load that is needed for Cogeneration

Distributed Solar Technology

Distributed Solar Technology



Distributed Solar Technology

Solar Assisted Heat Pump

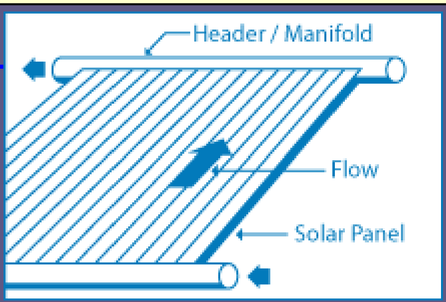
Building

"Net" Meter

CWR
65F

Bare tube solar collector

Cheapest AND Most Efficient



CWR
55F

"Heat Pump"

CWS
42F

HWS
150F

Solar Derived Btus

Cost = $6/MMBtu

Gas = $8/MMBtu

Distributed Solar Technology

Opportunities

- Solar is 100% renewable and available onsite
- Grid connection lowers installed cost and maximizes economic benefits
- All solar energy is used and no local storage is required
- Potential to finance significant building-level renewables with utility rate

Distributed Solar Technology

Barriers / Risks

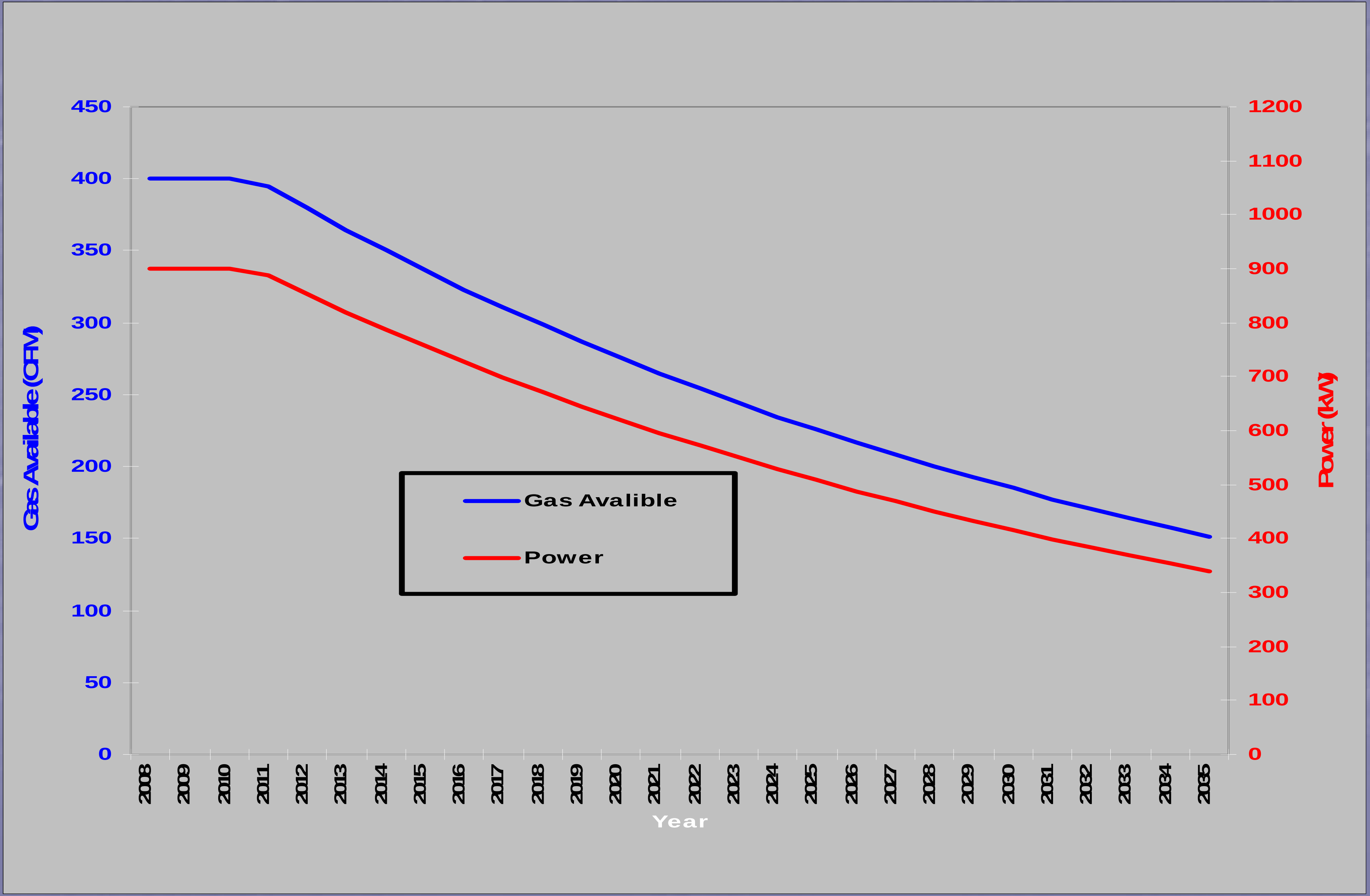
- Possible central plant/grid disruption
- Interconnections standards needed
- Metering complexity

Landfill Gas

Landfill Gas

- Orange County Eubanks Road Landfill
- ~ 2 miles from Carolina North Site
- Capacity to produce 0.75 MW of power and heat 100k to 200k GSF of building space
- Source will diminish over time with peak output around 2010

Landfill Gas



Wood Waste

Wood Waste

- Use Urban Waste Wood and Forest Residue from ~ 50 mile radius
- Combustion Technology well understood
- Gasification possibility
- Intermediate to Long Term Solution, depending on supply

Wood Waste

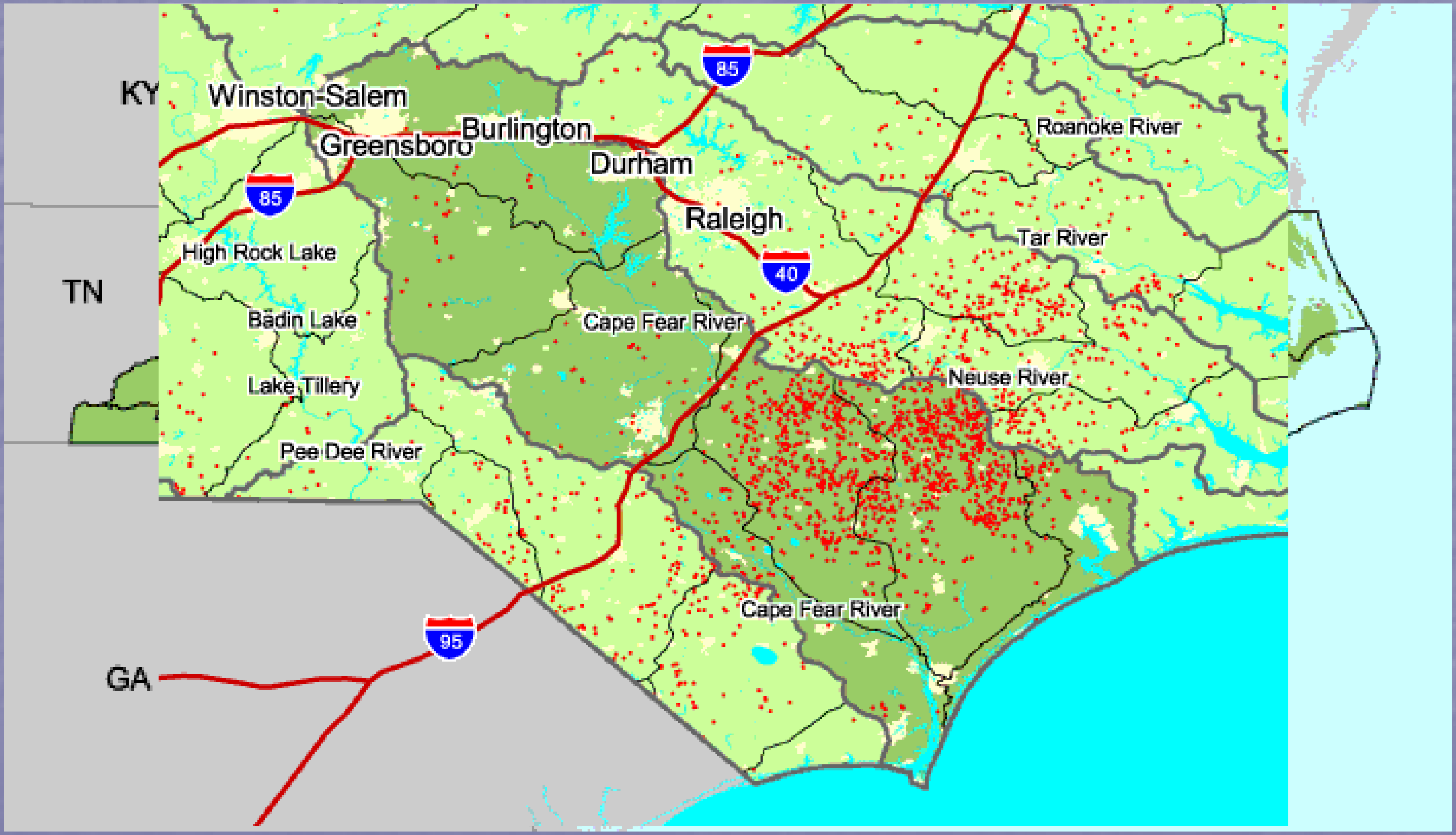
- Requires Large Fuel Handling and Preparation area – Can be Offsite
- Local Supply (~50 mile radius) required
- Local Supply appears adequate

Animal Waste

Hog Waste

- Mid 80's: over 15,000 farms, 2.4 million hogs
- Mid 90's: 3600 farms, 8 million hogs
- Currently: 2400 farms, 10 million hogs
- Second leading producer behind IOWA (16 million)
- 11 lbs of manure per hog per day
- 4000 to 6000 Btu / lbm (when fresh ☺)

Hog Waste


KY
TN
GA
Winston-Salem
Greensboro
Burlington
Durham
Raleigh
85
85
40
95
High Rock Lake
Badin Lake
Lake Tillery
Pee Dee River
Cape Fear River
Roanoke River
Tar River
Neuse River
Cape Fear River

Hog Waste Solids

Hog Waste Solids

Opportunities

- Renewable source of energy located in NC
- Mitigates other environmental problems
- Legislative incentives
- Boost to economically depressed portion of the State

Hurdles

- Lots of solids handling, energy, effort to create pellet
- Expensive, specialized boiler technology for clean burn
- Solids handling at the boiler facility, before and after the combustor
- Storage degrades the Btu content

Hog Waste Biogas

Hog Waste Biogas

Typical Biogas

Methane, CH_4	55 – 75%
Carbon Dioxide, CO_2	25 – 45%
Nitrogen, N_2	0 - 0.3%
Hydrogen, H_2	1 – 5%
Hydrogen sulphide, H_2S	0 – 3%
Oxygen, O_2	0.1 - 0.5%
Ammonia, 2 NH_3	0 – 2%

Hog Waste Biogas

Hog waste Biogas

- 60% Methane, 40% CO_2
- 0.4% Hydrogen Sulphide
- 0.5% Ammonia
- 100% Saturated Moisture Content

Hog Waste Biogas

Gas Advantage (over solid waste)

- No solids handling off the farm, final solids as fertilizer
- Clean burning, commercial product
- Lots of standard equipment can use the fuel
- Storage and delivery is well understood
- 75 MW of gas, possibly more with superbugs

Hurdles

- Get the waste to centralized large scale digesters
- Farms could us much of the gas onsite if done at each farm
- Supply goes away if industry goes away

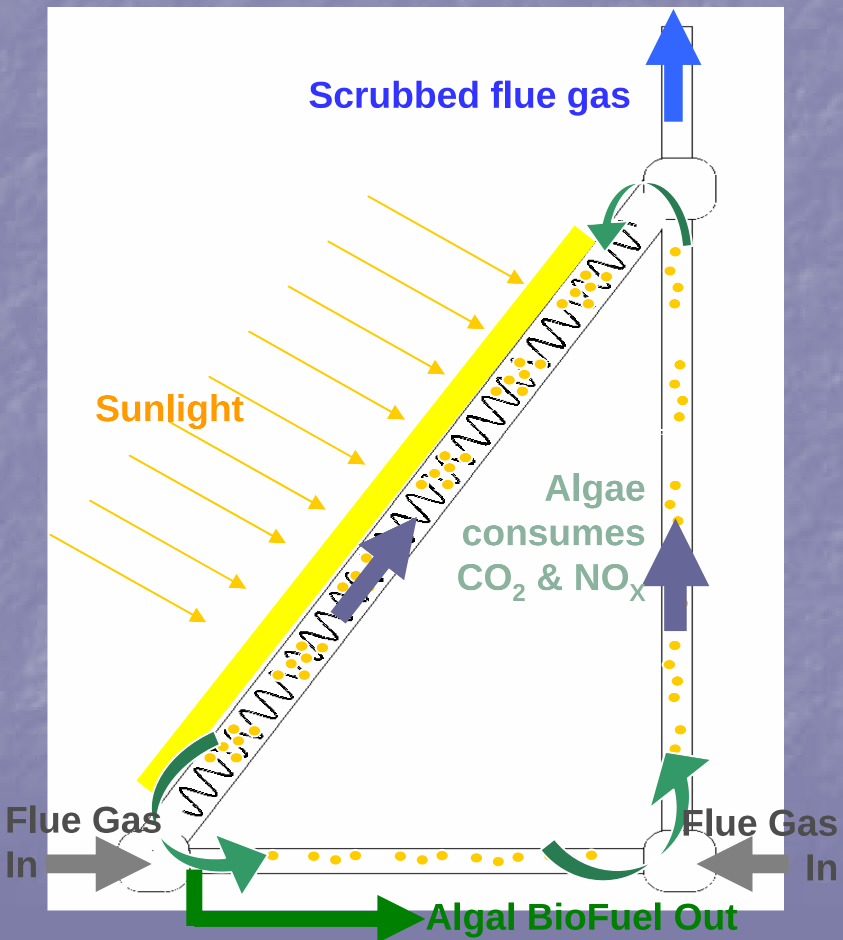
Carbon Capture

Carbon Capture

- Mid 70’s to Mid 90’s DOE studies algae for fuel production
- Identifies 300 varieties of green algae and diatoms
- Best ones blue-green algae 50% oil by weight
- Concluded 15,000 gal / acre of biodiesel is possible

Carbon Capture

Green Fuel Technologies (Cambridge Mass.)



Carbon Capture

Green Fuel Technologies (Cambridge Mass.)

- Small scale pilot project
- Capture average 86% NOx
- Capture average 50% of CO_2, peak capture of 82%
- Sequester or produce fuel
- Estimated 1000 MW plant – 40 million gal. of biodiesel and 50 million gal. of ethanol are possible

- Requires 2000 acre farm next to plant

Carbon Capture

Greenshift Corporation (New Jersey)

- Algae based filter
- Prototype handles 140 cubic meters of flue gas per minute
- 3 megawatt power plant

Thank You for Your Time !

- Questions ???