2009 OWEA Biosolids Specialty Workshop

December 10, 2009

Exploring the Feasibility of Biosolids to Energy

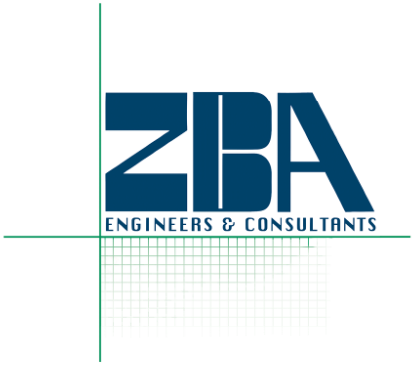
Presented by: Kevin Rhodes, P.E.

Agenda

- A primer on renewable energy
- Review the results of a feasibility study of this technology
- Contact information

Background

- Woolpert acquired ZBA in May 2004
- ZBA became the Energy Utilities Group
  - Energy industry
  - District heating and cooling
  - Higher education market
- Volatility in the energy markets caused us to look at alternatives



Why Renewable Energy?

- Renewable Portfolio Standards are a market driver
- Some forms of renewable energy make sense
- Some renewable energy sources are sustainable, meaning you can keep on doing it indefinitely, without subsidies

Renewable Portfolio Standards

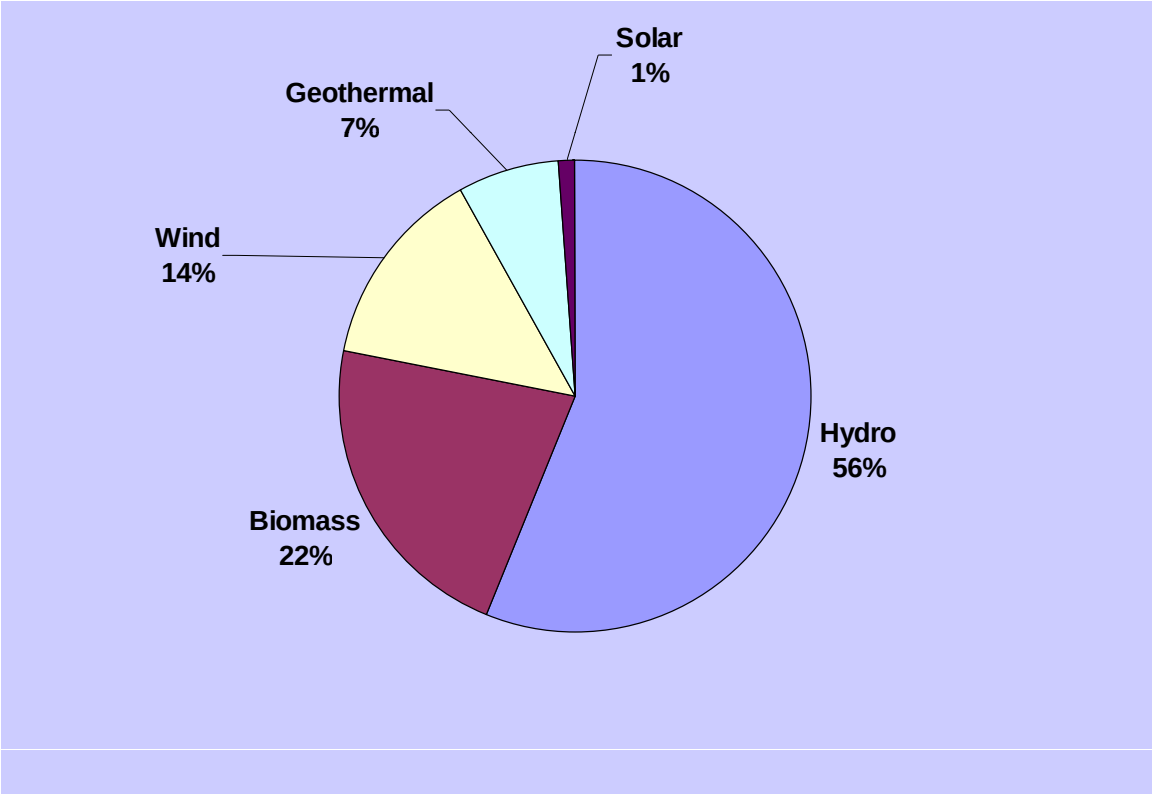
- Legislated by more than ½ of the states
  - As such, each is different
  - May soon be federally mandated
- Each mandates that by *some* date, *some* % of the electrical energy sold in the state comes from renewable sources
  - In Ohio, 12.5% renewable by 2025
  - IN NC, 12.5% renewable by 2021
- That means **2,900 MW** of *new renewable generation* in Ohio alone

Renewable Energy Certificates (REC)

- The preferred means of tracking compliance with RPS
- Each certificate represents 1,000 kWh of electrical energy from renewable sources
- RECs have a market value and may be traded “unbundled”
- Generally, RECs can be generated in states that do not have a RPS and sold into markets that do

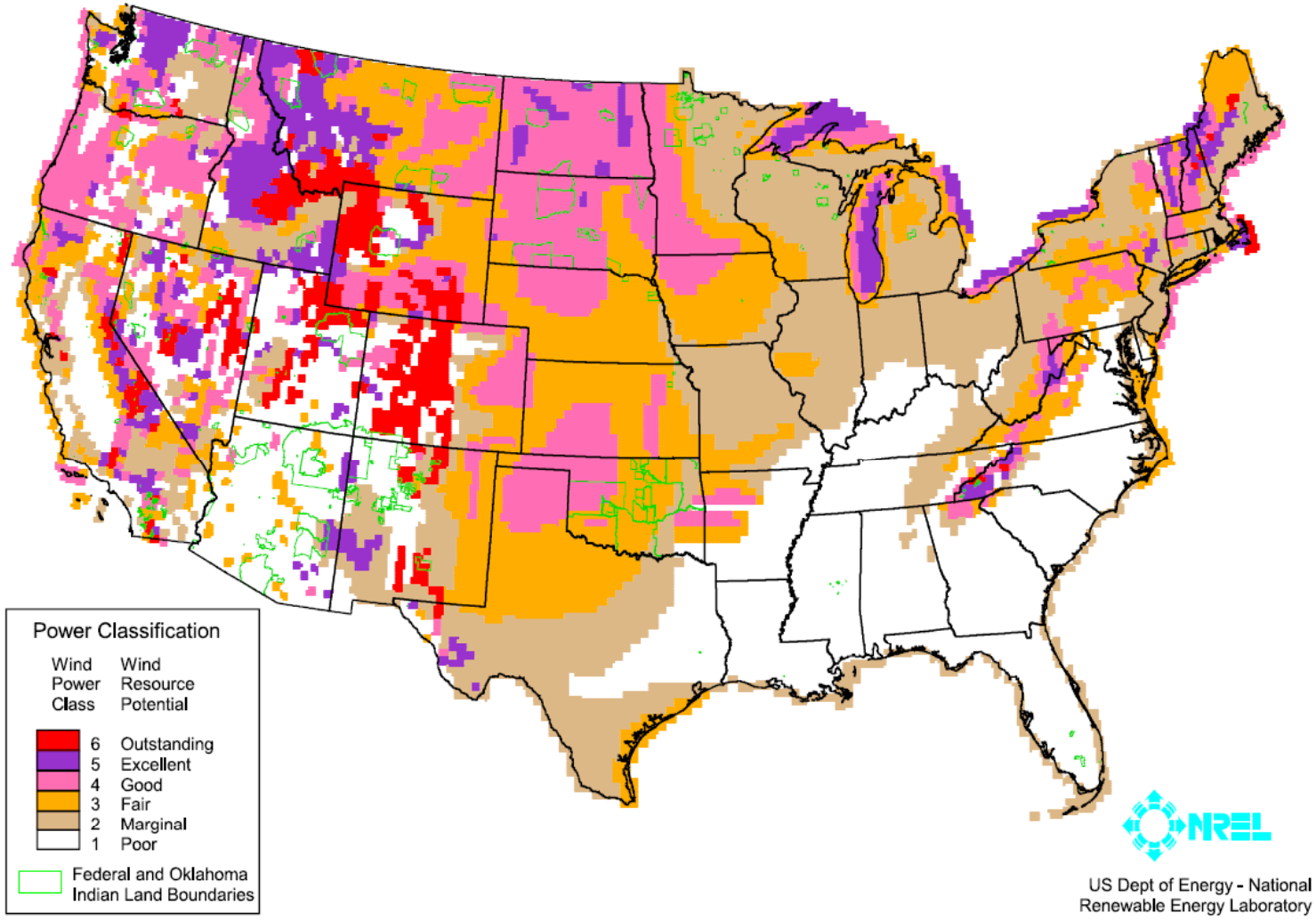
Renewable Energy's Contribution

- Approximately 9% of electricity currently generated in U.S. comes from renewable sources

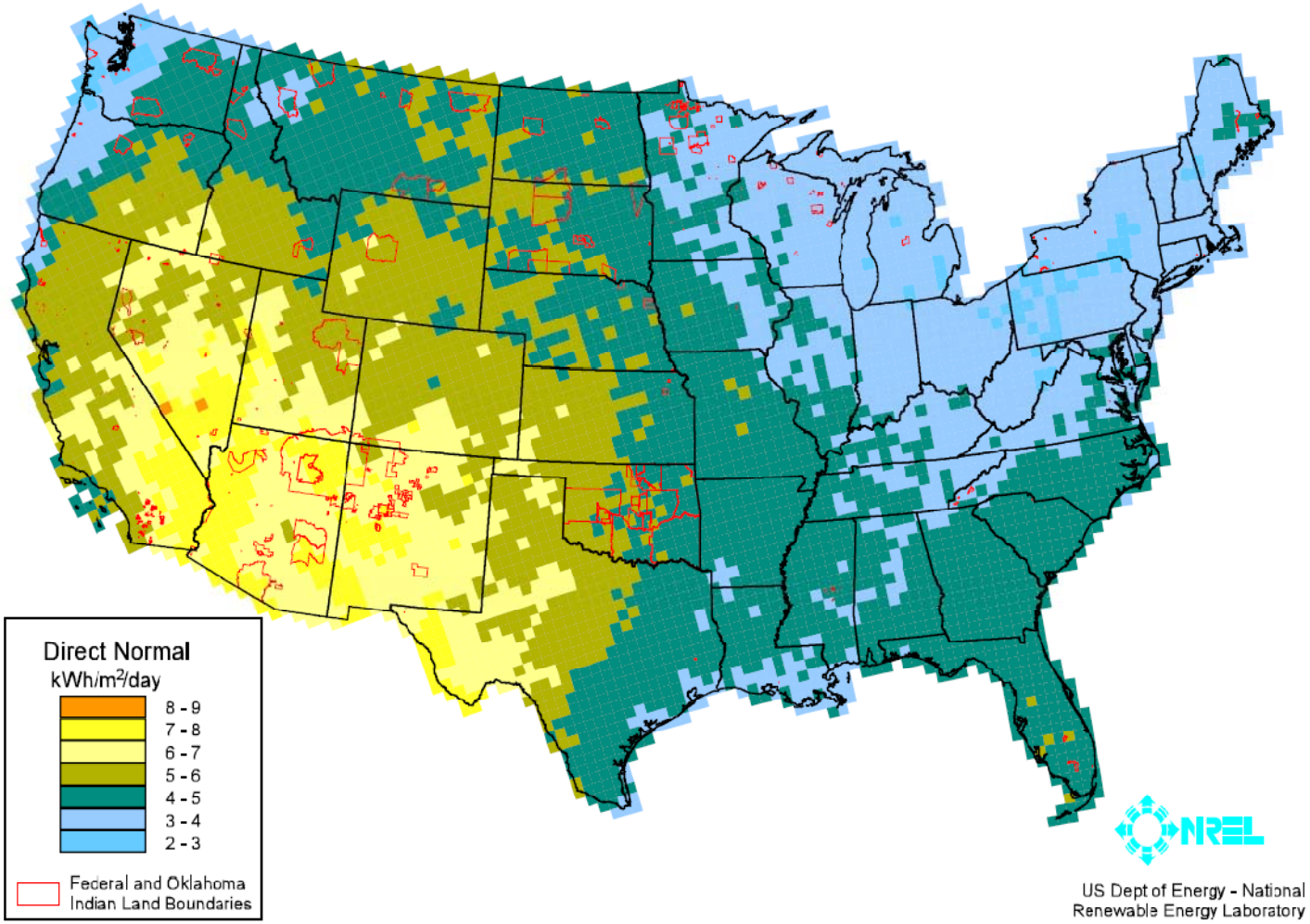


Renewables are very sensitive to geography

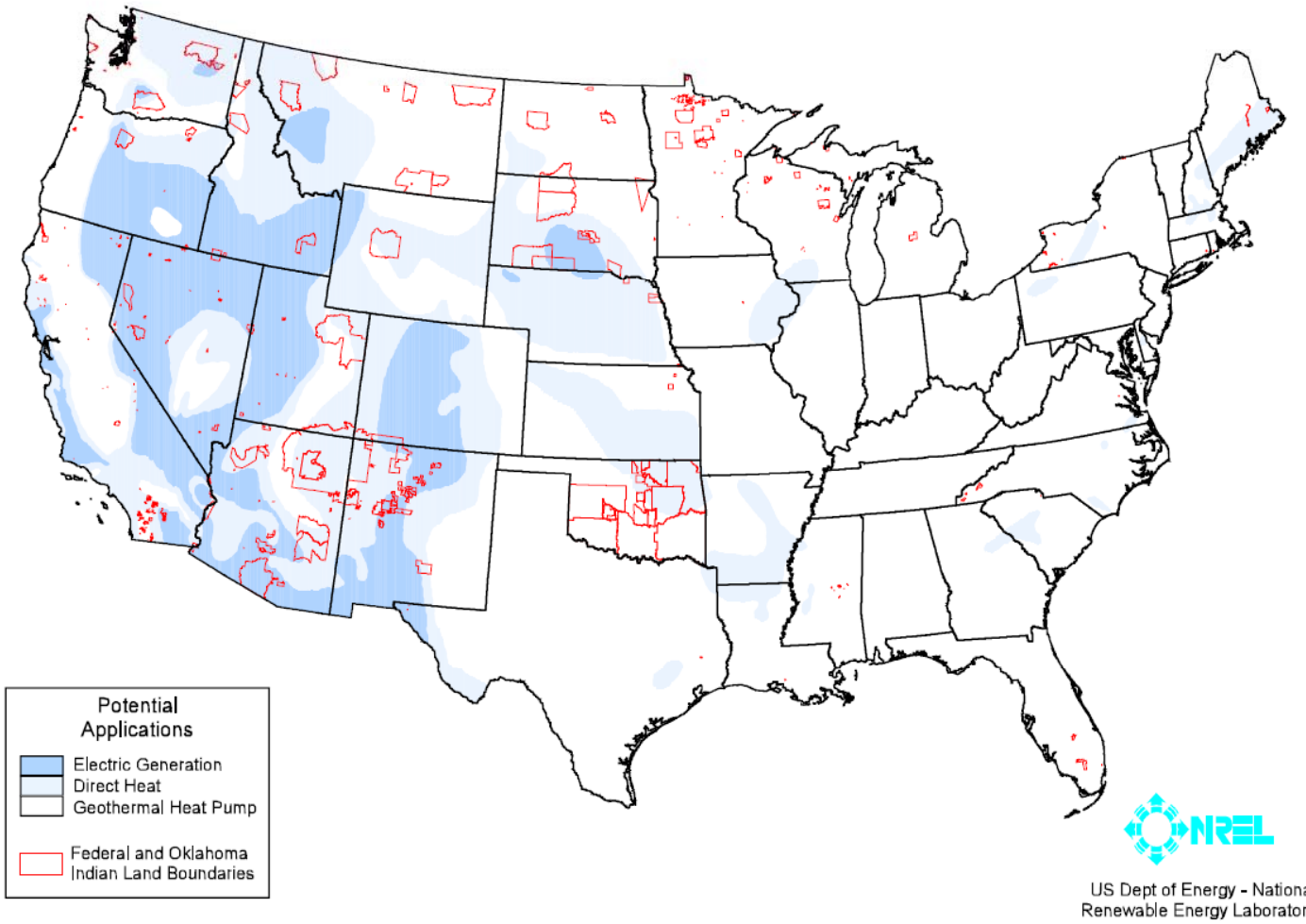
Wind Power Potential



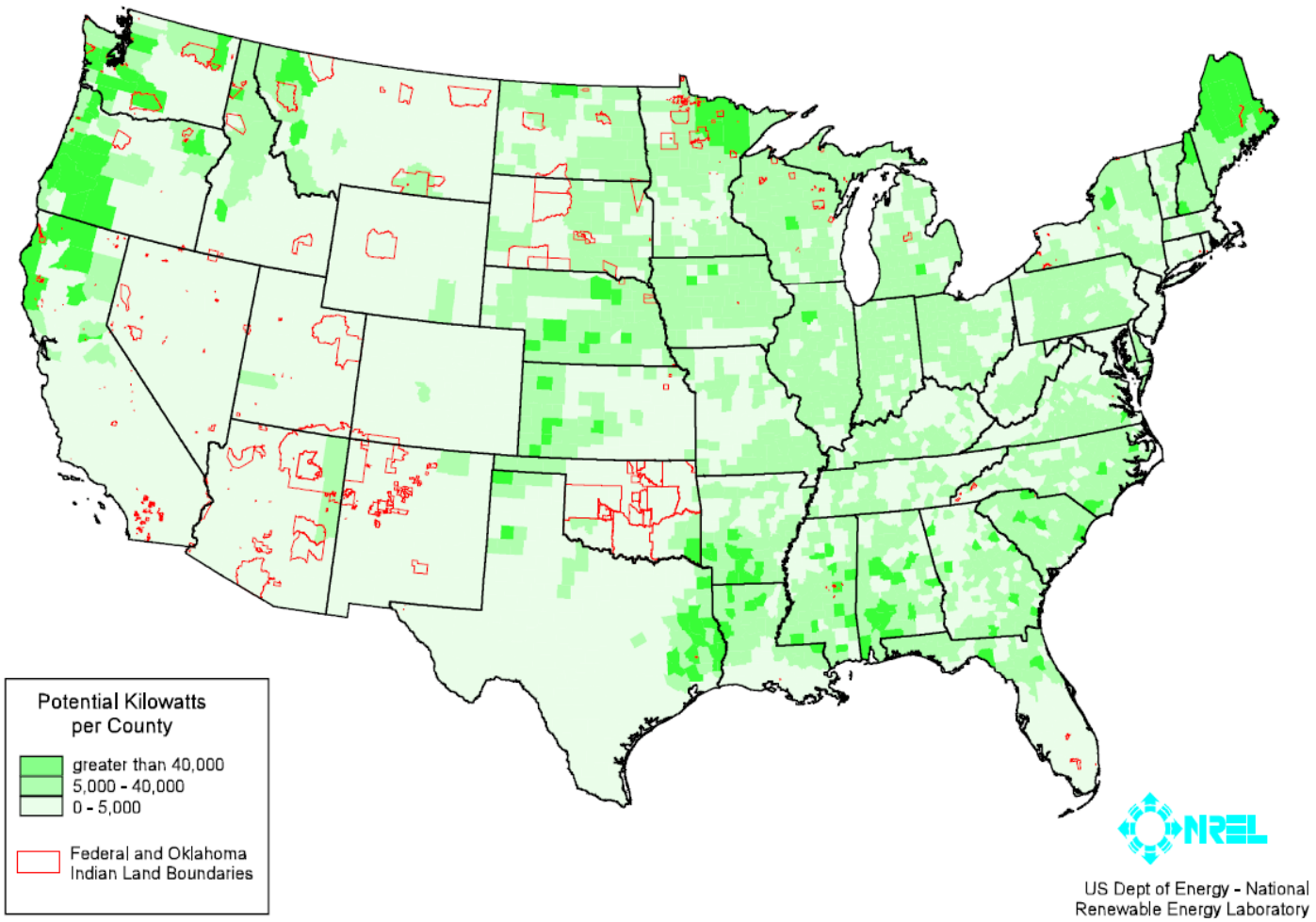
Solar Power Potential



Geothermal Potential



Biomass Potential



What is Biomass?

- Renewable organic matter within the biosphere
- Biomass waste streams
  - Wood waste
  - Agricultural waste
  - Landfill gas
  - Digester gas
  - Undigested sewage sludge (biosolids)
- Focus on inconvenient waste streams
  - Negative commercial value
  - Biosolids most inconvenient
- Our focus...**Biosolids**

Why No Respect?

- Constant, predictable source
- Uses mature technologies
- Larger population centers have:
  - Abundant fuel available
  - Robust electrical infrastructure

Case Study
Wastewater Utility

- Longstanding client
- Environmentally responsible
- Forward thinking
- Landfills their sludge

Particulars

- Utility serves a population of 250,000
- Generates 120 wet tons of sludge/day
- Disposal cost
  - Transportation $12/ton
  - Tipping fee $17.25/ton

Study Process

- Characterize waste streams
  - Is the sludge fuel?
- Develop alternatives
- Develop project costs
- Quantify savings
- Prepare net present worth analysis

Characterize Waste Streams

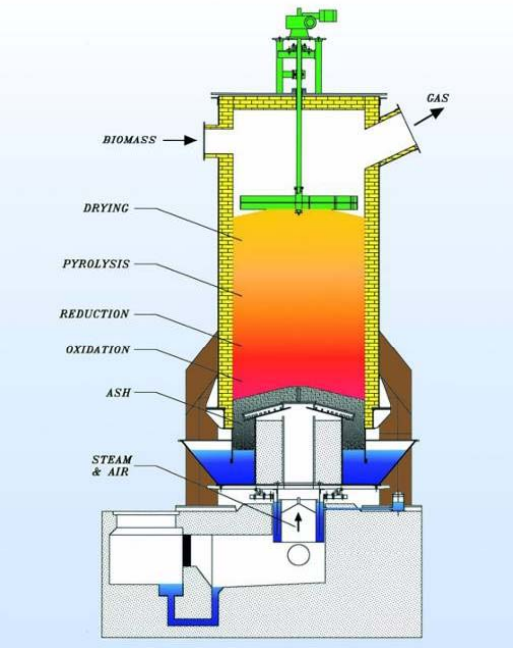
- With respect to:
  - Proximate and ultimate analysis
  - Flow
- Plant #1 biosolids
  - ~8,100 BTU/lb (dry)
  - 32% solids
  - 112 tpd
- Plant #2 biosolids
  - ~6,250 BTU/lb (dry)
  - 15% solids
  - 10 tpd

Combustion vs. incineration

- Combustion
  - The burning of fuel in the presence of heat and oxygen
  - A sustainable process, if the fuel has sufficient BTU content
- Incineration
  - Incineration is used when the “fuel” does not have sufficient BTU content
  - Auxiliary fuel is added to sustain the incineration process
  - Generally associated with the thermal destruction of:
    - Medical waste
    - Hazardous waste
  - Environmentally unfriendly

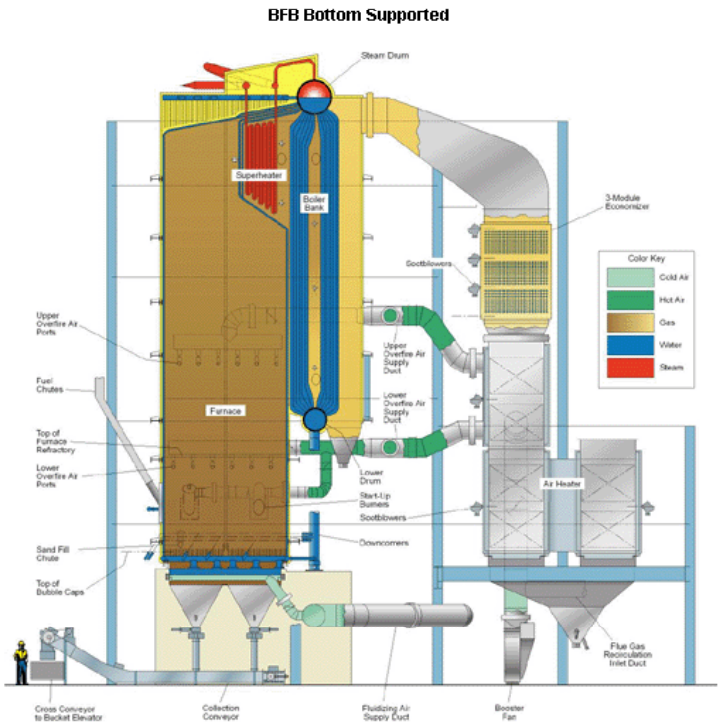
Gasification Process

- Sludge must be dried
- Subject the dried sludge to a high temp., oxygen deficient environment
- Products
  - Fuel gas
  - Sand-like ash
- Fuel gas
  - Primarily carbon monoxide and hydrogen
  - Can be combusted like natural gas
- Mature technology (>100 years)



Bubbling Fluidized Bed Process

- Further drying not required
- Sludge can be combusted directly in a Bubbling Fluidized Bed (BFB) boiler to generate steam
- Use steam:
  - To generate electricity in a condensing steam turbine generator set
  - Directly for process loads
- Mature technology (>50 years)



Fast Pyrolysis

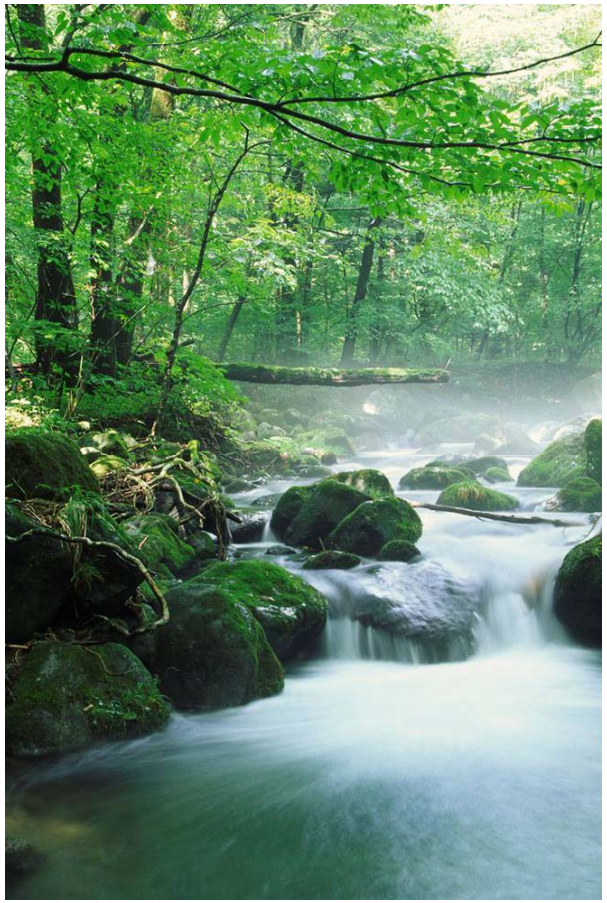
- Takes place in high temperature (500°C), oxygen ***free*** environment
- Yields “bio oil” and char
- Bio oil has 54% of the energy content of #2 fuel oil and can be used similarly to #2
- Different from petroleum based oil
- Char fuels the pyrolysis process and the remainder can be used as a soil amendment
- Pyrolysis equipment supplied in modules
- Short commercial track record

Process Alternatives and Metrics

- Bubbling fluid bed boiler and steam turbine genset
  - Initial cost $11,050,000
  - Time to positive cash flow 5.0 years
  - NPV @ 20 year horizon $15,600,000
- Two (2) pyrolysis modules/boiler/steam turbine genset
  - Initial cost $9,210,000
  - Time to positive cash flow 5.0 years
  - NPV @ 20 year horizon $13,140,000
- Two (2) pyrolysis modules with one IC generator
  - Initial cost $6,580,000
  - Time to positive cash flow 2.8 years
  - NPV @ 20 year horizon $16,910,000

Identify/Quantify Revenue Streams

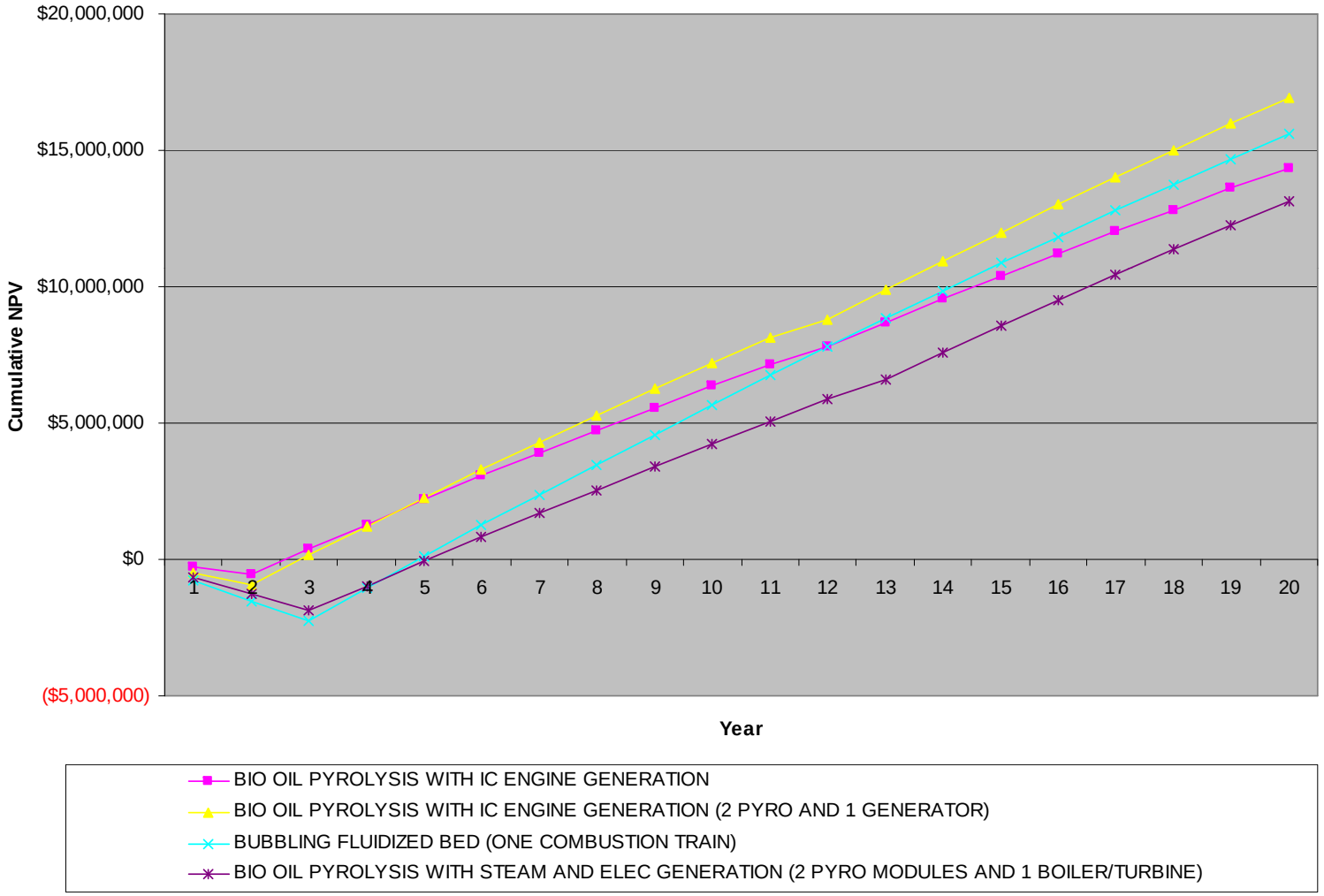
- Avoided tipping fees
- Avoided transportation costs for disposal
- Avoided electrical power purchase
- Sale of renewable energy certificates



NPV Analysis, Assuming...

- Bonding
  - 6% discount rate
  - 30-year maturity
- Inflation of CPI-U at 3.10%
- Electric at $0.07/kWh (blended rate)
- Annual maintenance at 7% of CAPEX
- 8,000 operating hours per year

NPV Chart


$20,000,000
$15,000,000
$10,000,000
$5,000,000
$0
($5,000,000)
Cumulative NPV
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Year
BIO OIL PYROLYSIS WITH IC ENGINE GENERATION
BIO OIL PYROLYSIS WITH IC ENGINE GENERATION (2 PYRO AND 1 GENERATOR)
BUBBLING FLUIDIZED BED (ONE COMBUSTION TRAIN)
BIO OIL PYROLYSIS WITH STEAM AND ELEC GENERATION (2 PYRO MODULES AND 1 BOILER/TURBINE)

Why Would a Wastewater Utility Stray From Its Core Competency?

- Perhaps the conventional paradigm in wastewater treatment needs revision
- Still left with an undesirable product that is becoming harder to dispose of
- Biosolids-to-energy extends the core competency and completes the treatment process

Key points

- What started as an energy solution became, primarily, a disposal solution
- Other sludge disposal technologies are becoming more unattractive
  - Land application is coming under more stringent regulatory pressure.
  - Landfilling is viewed as environmentally unfriendly and tipping fees are expected to rise.
  - Incineration will become a financial burden as energy prices rise.
  - Composting is resource intensive and results in a negative cash flow
- Important to consider total cost of disposal

Conversion to an energy stream that

- is sustainable
- is constant
- adds to base
- has a high capacity factor
- does not rely on a technology breakthrough
- would have been buried
- is carbon neutral

just makes sense.

Questions?

Contact info:

Kevin Rhodes, P.E.

kevin.rhodes@woolpert.com

513.527.2528 Direct

513.702.3615 Mobile