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Providence, RI
August 9-12, 2009

Biomass Technology Overview and Update

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Deployment and Industry Partnerships
National Renewable Energy Laboratory

Presentation Overview

- Update on commercial status of biomass conversion technologies
- US EPA/NREL biomass resource assessment tool

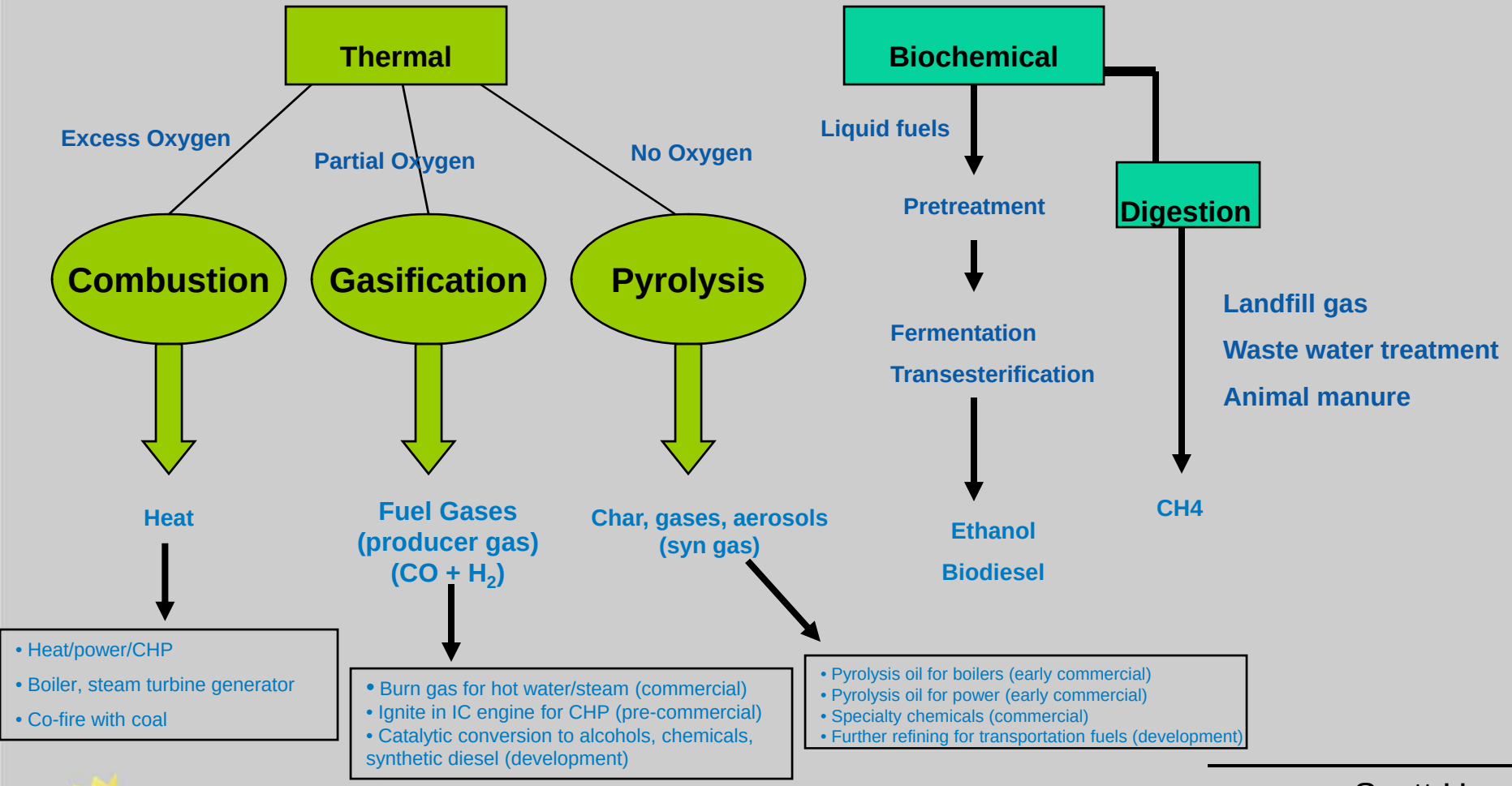
Disclaimer

Mention of a company or a process in this presentation does not constitute a recommendation or endorsement by NREL or the U.S. Department of Energy

New Report

- *A Market Assessment of Biomass Gasification and Combustion Technology for Small and Medium-Scale Applications*
- Developed at request of Clean Energy States Alliance
- Assess commercial status of small-scale biomass gasification and combustion systems
- Focus on ~ 5 MW (50 MMBtu/hr) and less, not residential
- Applications are for power, heat or CHP
- Appendices contain manufacturer database

Biomass Energy Pathways



Combustion Technologies

- Grate stokers or fluidized bed
- Almost all commercial systems are combustion
- Thermal-only systems typically have best economics
- Efficiencies in 15% – 35% range for power only, (60%-70% CHP)
- Emissions control needed, requires water for steam cycle support
- Power: 1-110 MW (average is ~20), 500+ facilities in U.S
  - Installed costs $2,500 - $5,000/kW
  - Smaller systems (< 10 MW) still have poor economics
  - Cost of energy = $0.06 - $0.16/kWh

Small-scale Commercial Systems

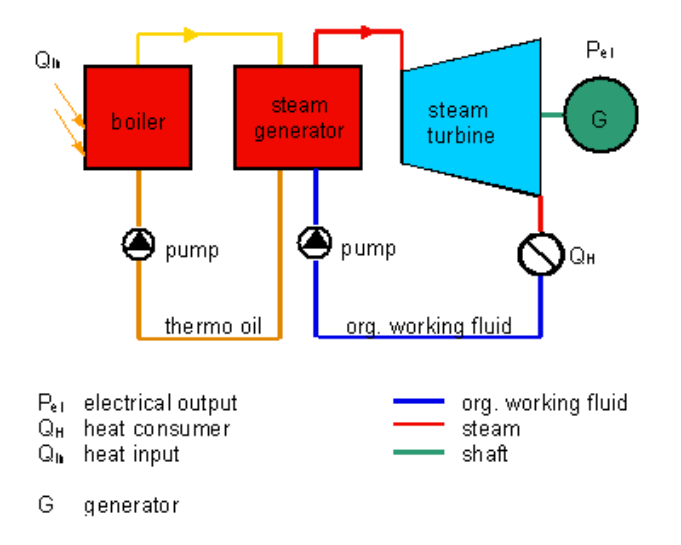
- Majority of installed small-scale biomass systems use combustion technology to make hot water or steam
  - or “close-coupled” gasifiers (gasifiers with immediate oxidation – burning - of gas)
- Wood is the primary resource (chips and pellets)
- Usually hot water or low pressure steam
- Some CHP systems, but most are thermal only
- Numerous vendors and support network

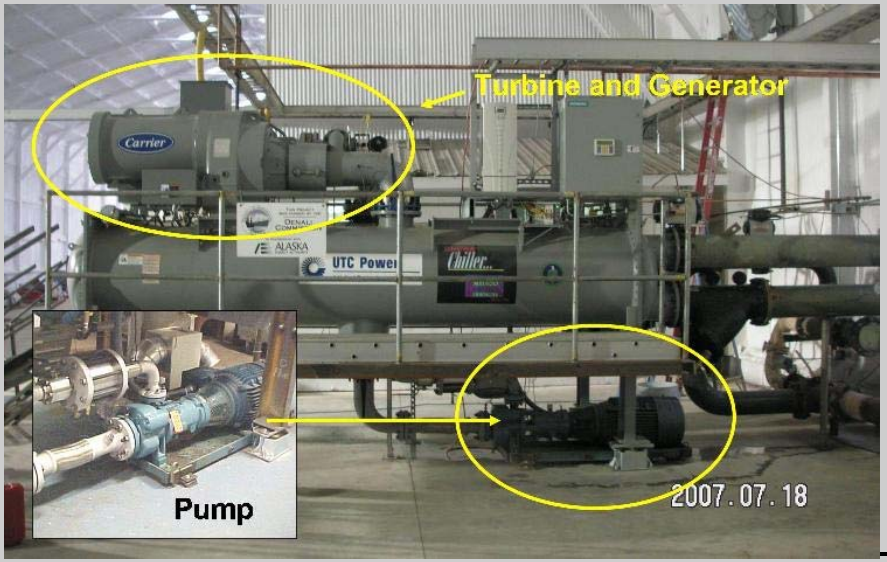
Pellet Boiler for Thermal Energy

- Harney Hospital, Burns, Oregon
- Thermal Eff. – 85%
- KÖB – shipped in container and connected in 2 days
- Commercial technology
- $250,000 cost, saving $37,000 per year
- 750 ft^2 footprint

ORC Biomass System

- Uses low temperature hot water (as low as 165 F) to heat a working organic fluid with low boiling point
  - This fluid then runs a turbine
- All components are commercial, but systems have not been put together in U.S. (Europe has)





400 kW Geothermal ORC unit at Chena Hot Springs, AK

European Technologies Making Their Way Here

- Froling, Tarm - (Bioheat USA)
- Uniconfort - (AES/Wichita Burners)
- KÖB - (A3 Energy Partners)
- Osby-Parca - (Forest Energy Corporation)

Biomass Gasification

Photo courtesy Nexterra

Photo courtesy ChipTec

- Pre-commercial, early demo
- Potentially better suited to small scales (100 kW and up)
- Potential to be more efficient than combustion, 30%- 40%
- Manages mineral matter
- Gas ($CO + H_2 + CH_4$) can be used in boilers, IC engines, gas turbines, steam turbines or to make liquid fuels
- Installed Cost $3,500/kW and up
- Reduced water usage
- LCOE - $0.15 - $0.20^{+}

Close-coupled Gasification

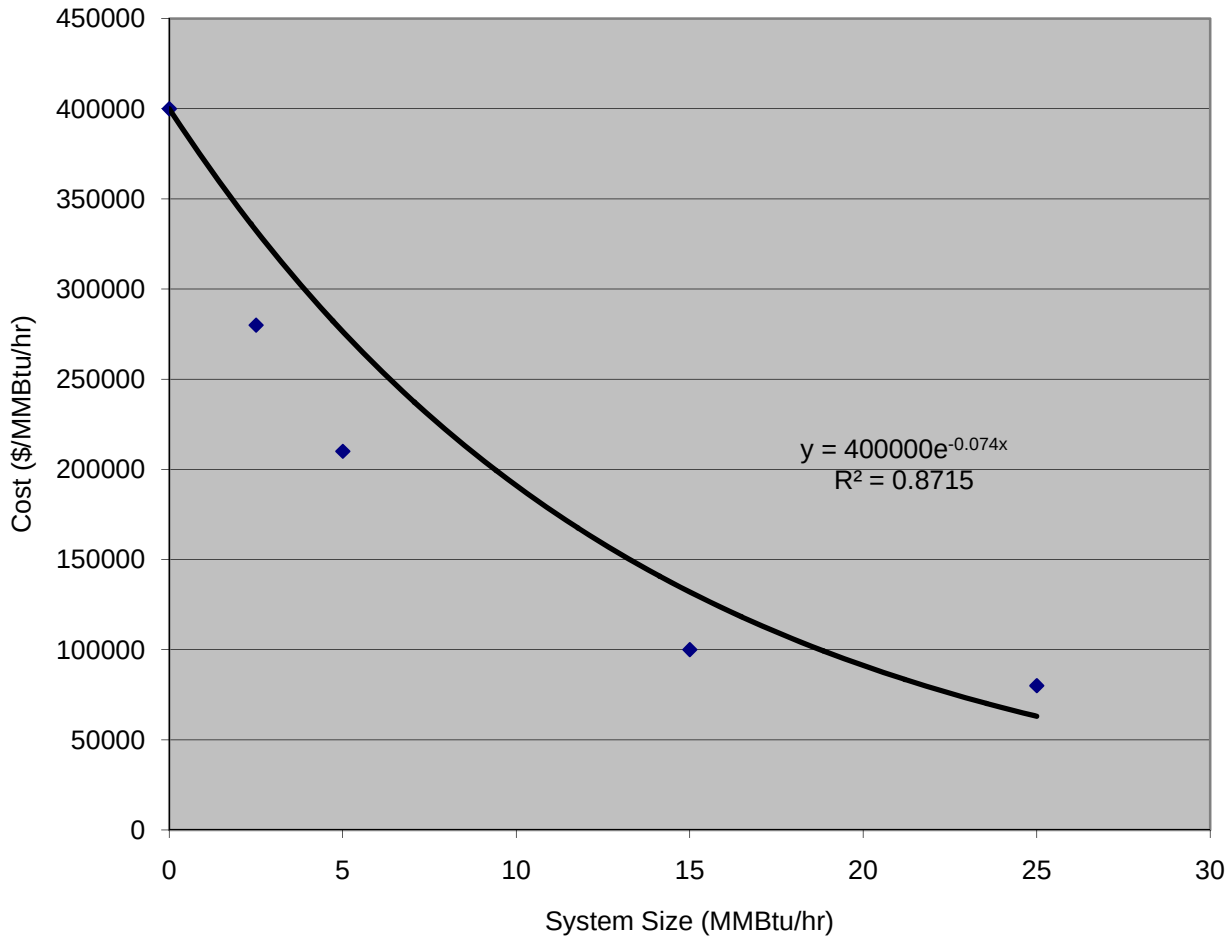
- Chiptec “close-coupled” gasifier
  - (gas is combusted to make steam for a turbine)
- Commercial technology, hundreds of thermal only systems
- North Country Hospital, VT
  - 265 kW CHP system
  - 500 Hp, 300 PSI Hurst boiler
  - Cost $2 million, saving $250,000/year

Nexterra Gasifier

- Several thermal systems installed
- System ordered for Oak Ridge National Labs (thermal only for now)
- Commercializing 2 MW gasifier power system
  - coupled to GE Jenbacher engines

Plant at University of South Carolina. Source: Nexterra/Johnson Controls

Estimated Costs for Biomass Thermal Systems

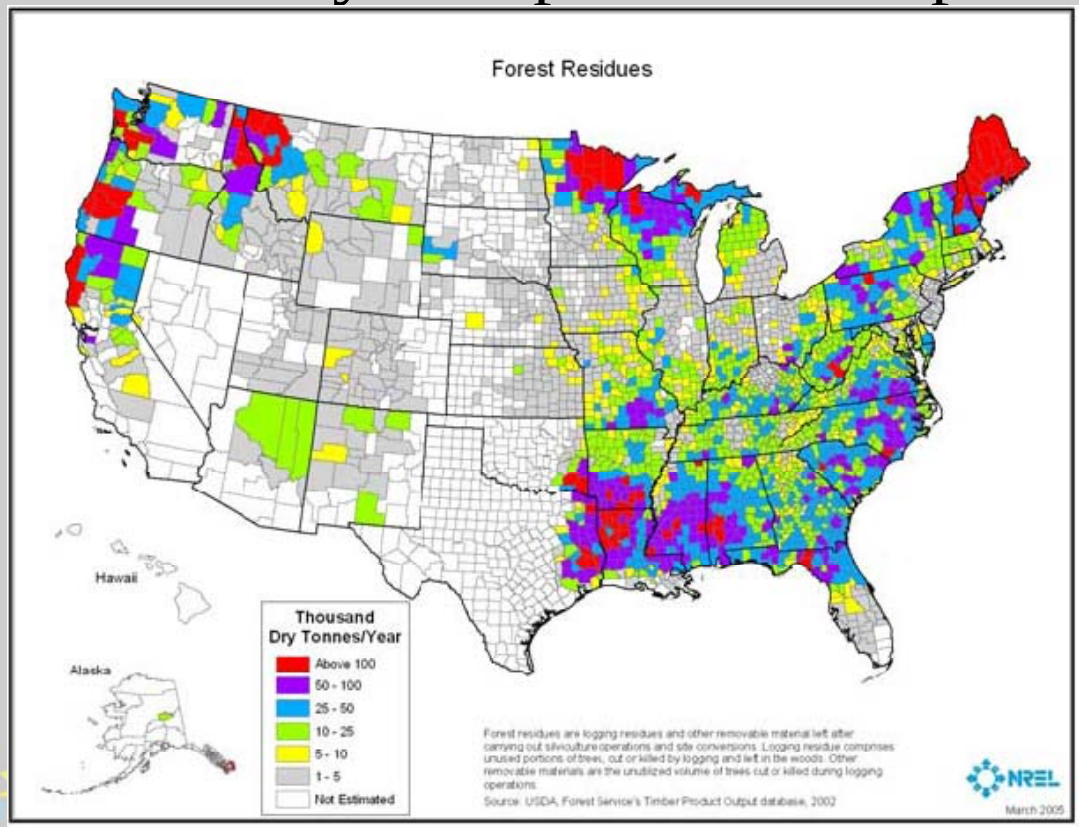


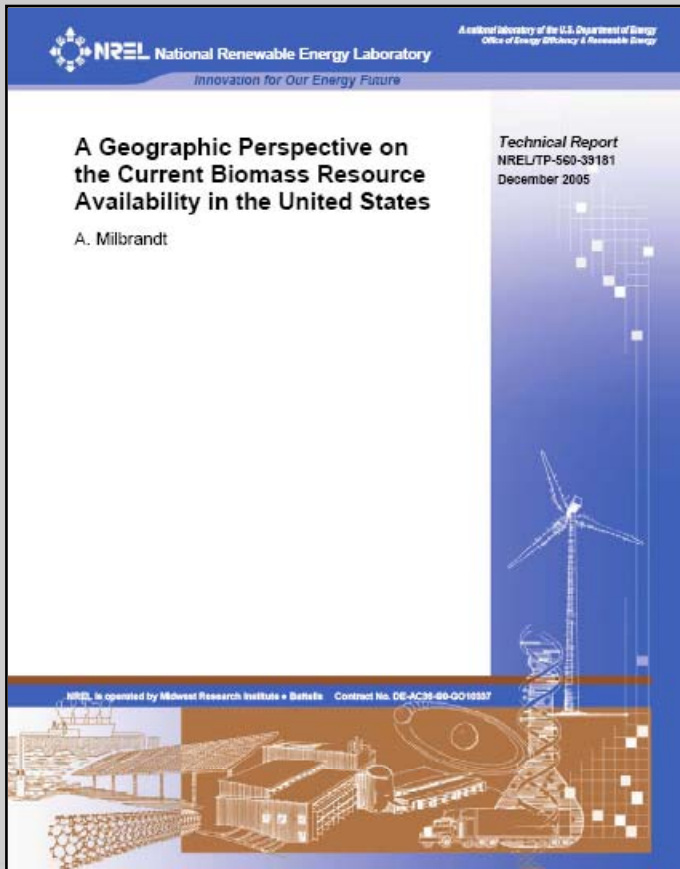
New Biomass Assessment Tool

- Funding provided by U.S. EPA, Region 6, Blue Skyways Program
- NREL developed the data, GIS platform and programming
- Additions/updates slated for FY 2010

Previous Efforts

- Data sets scattered across multiple agencies
- State and county totals, maps as pictures
- No analysis capabilities for public





Biopower Assessment Tool

http://rpm.nrel.gov/biopower/biopower/launch

- Visualization and analysis of biomass resources on a local basis
- Initial screening tool to identify and evaluate sites for potential biopower development opportunities

<u>Does not take the place of an on-the-ground detailed assessment and analysis</u>

Biomass Data Layers (2007 Data)

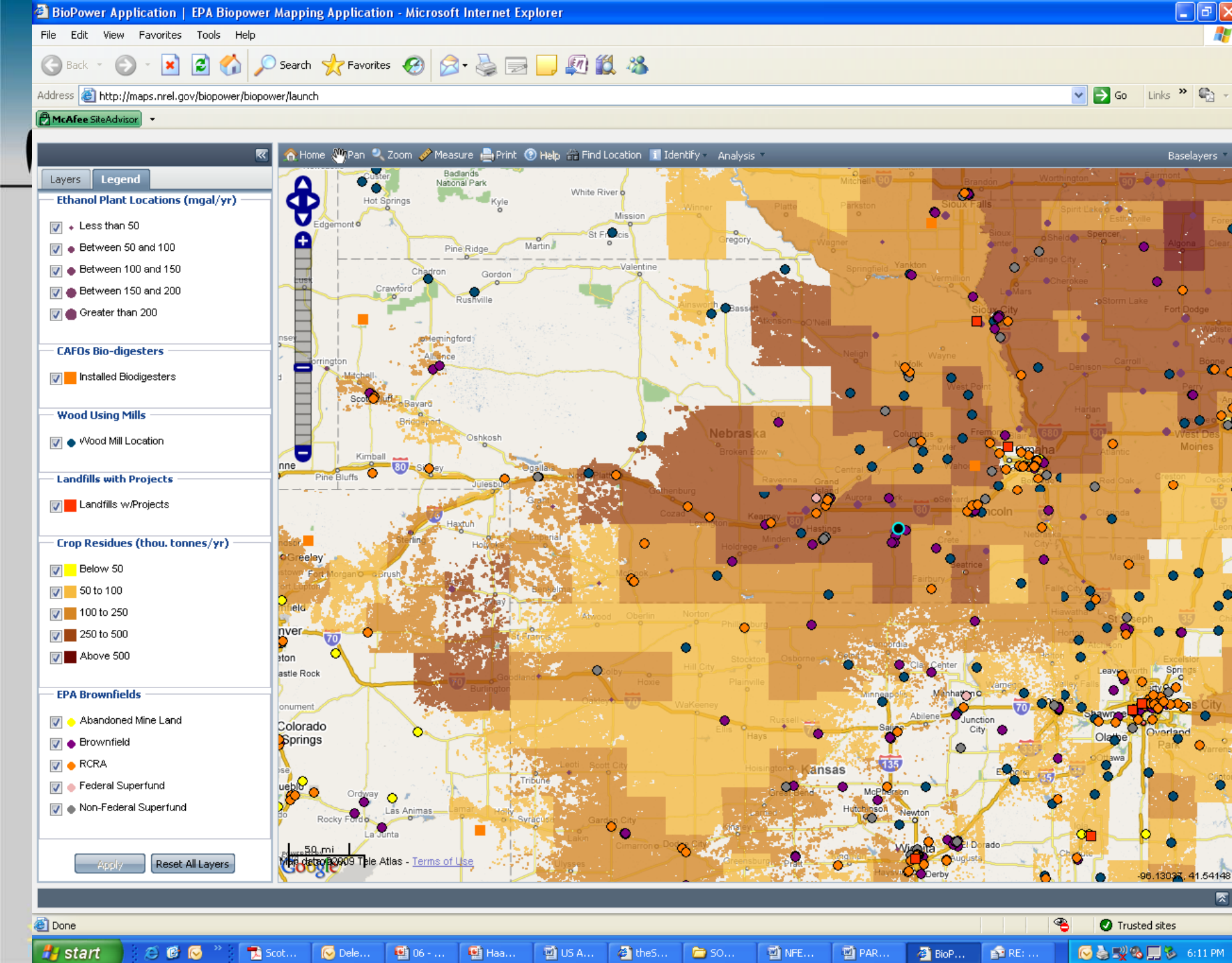
- Crop residues (county level)
- Livestock manure (county, USDA)
- Wastewater treatment plants (points, county, EPA)
- Landfills (points, EPA)
- Forest residues (county, USFS)
- Primary and secondary mill residues (county, NAICS code)
- Urban wood waste (county, based on population)

Full methodology documented in:

A Geographic Perspective on the Current Biomass Resource Availability in the United States, A. Milbrandt, 2005.

Other Layers

- Sawmill locations
- Electric and natural gas rates (county level)
- Biomass facility locations
  - Biomass power, ethanol, landfill gas to energy, manure to energy
- Fossil fuel power plants
- Wind, solar resource layers
- Alternative fuels filling stations
- EPA Brownfields sites
- Transportation networks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McAfee SiteAdvisor
Home Pan Zoom Measure Print Help Find Location Identify Analysis Baselayers
Layers Legend
Ethanol Plant Locations (mgal/yr)
Less than 50
Between 50 and 100
Between 100 and 150
Between 150 and 200
Greater than 200
CAFOs Bio-digesters
Installed Biodigesters
Wood Using Mills
Wood Mill Location
Landfills with Projects
Landfills w/Projects
Crop Residues (thou. tonnes/yr)
Below 50
50 to 100
100 to 250
250 to 500
Above 500
EPA Brownfields
Abandoned Mine Land
Brownfield
RCRA
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Non-Federal Superfund
Apply
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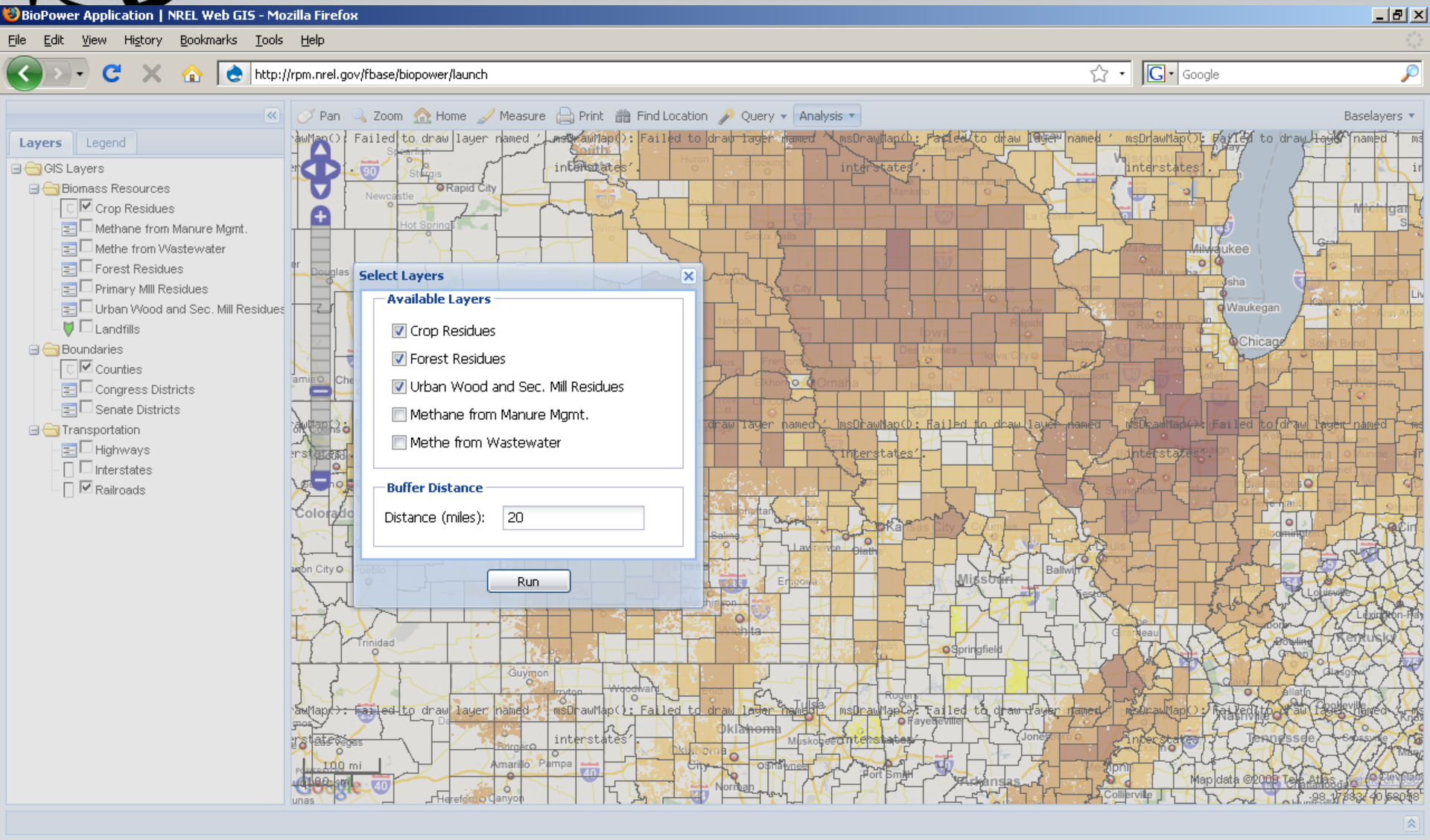
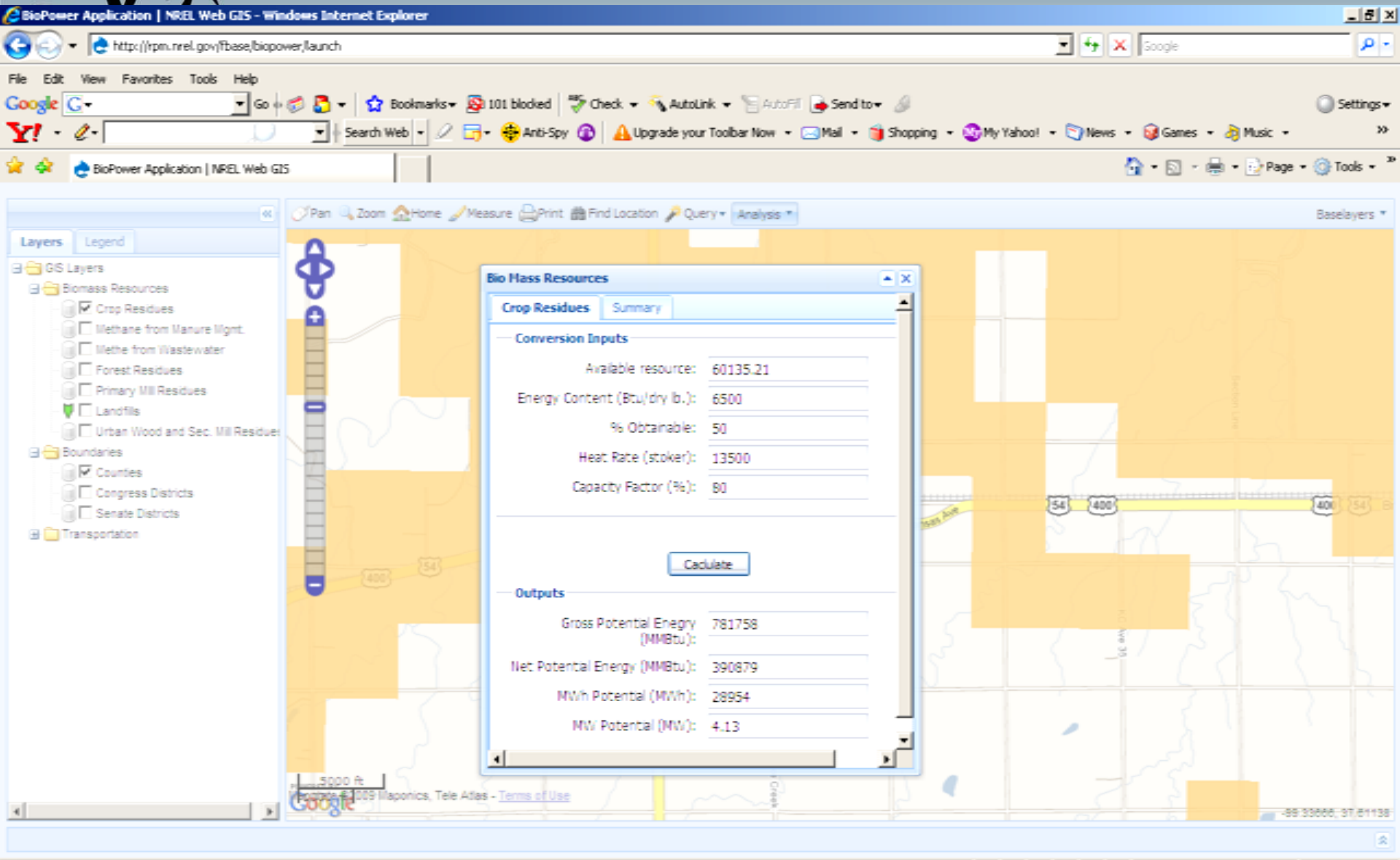


Functionality



Summary

- Biomass technologies are proven and commercially available, financeable
  - Combustion; close-coupled gasification
- Emerging technologies promise new opportunities
  - Gasification and direct use of gas in IC engine or gas to liquids
  - Pyrolysis liquids to transportation fuel
- Biopower mapping application can assist with screening and identification of potential sources of biomass
  - Does not take the place of opening the phone book

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