DOE OFFICE OF INDIAN ENERGY

Foundational Courses
Renewable Energy Technologies
BIOMASS

Presented by the National Renewable Energy Laboratory



U.S. DEPARTMENT OF ENERGY | Office of Indian Energy

Course Outline

What we will cover…

- About the DOE Office of Indian Energy Education Initiative
- Course Introduction
- Resource Map & Project Scales
- Technology Overview(s):
  - Siting
  - Costs
- Successful Project Example(s)
- Policies Relevant to Project Development
- Additional Information & Resources

Introduction

The U.S. Department of Energy (DOE) Office of Indian Energy Policy and Programs is responsible for assisting Tribes with energy planning and development, infrastructure, energy costs, and electrification of Indian lands and homes.

As part of this commitment and on behalf of DOE, the Office of Indian Energy is leading *education* and *capacity building* efforts in Indian Country.

Training Program Objective & Approach

Foundational courses were created to give tribal leaders and professionals background information in renewable energy development that:

- *Present foundational information on strategic energy planning, grid basics, and renewable energy technologies;*
- *Break down the components of the project development process on the commercial and community scale;*
- *Explain how the various financing structures can be practical for projects on tribal lands.*

NREL's Presenter on Biomass is

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Introduction to Biomass Energy

- Biomass heating and electric power is a form of renewable energy generation
- Considered carbon-neutral in the near-term
- It's a base-load (dispatchable) source of power and heat
- Intermediate products include pellets and torrefied biomass

Source: NREL/PIX 16161

Intro to Biomass, continued

- Reliability and cost of biomass supply is critical
- Commercial, proven technologies
- New, highly-efficient technologies making headway in U.S. and around the world

Biomass Heat Exchanger
NREL/PIX 03447

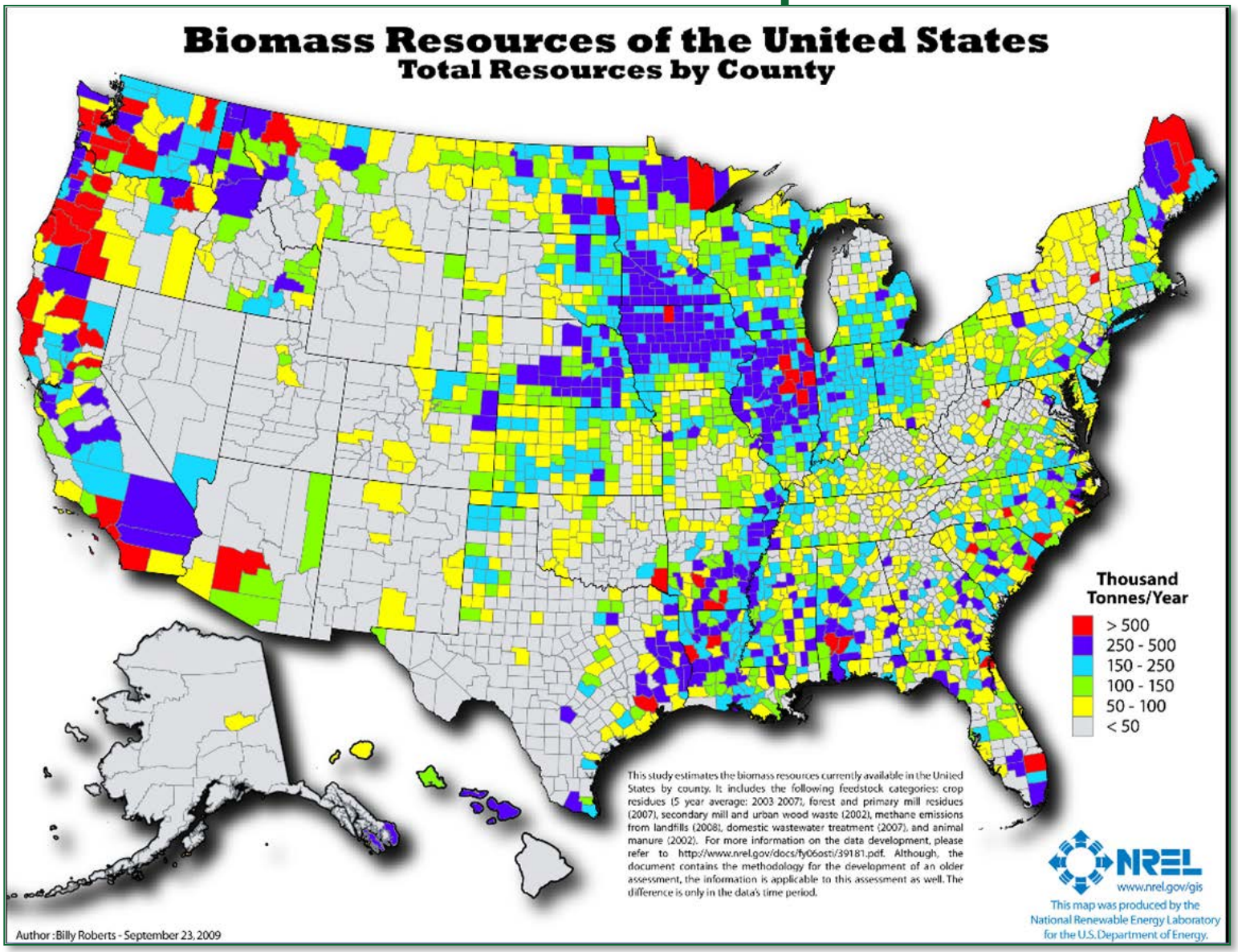
High-Level Biomass Resources Maps

The most important factor in the success of a biomass facility, of any type, is the availability of appropriate resource

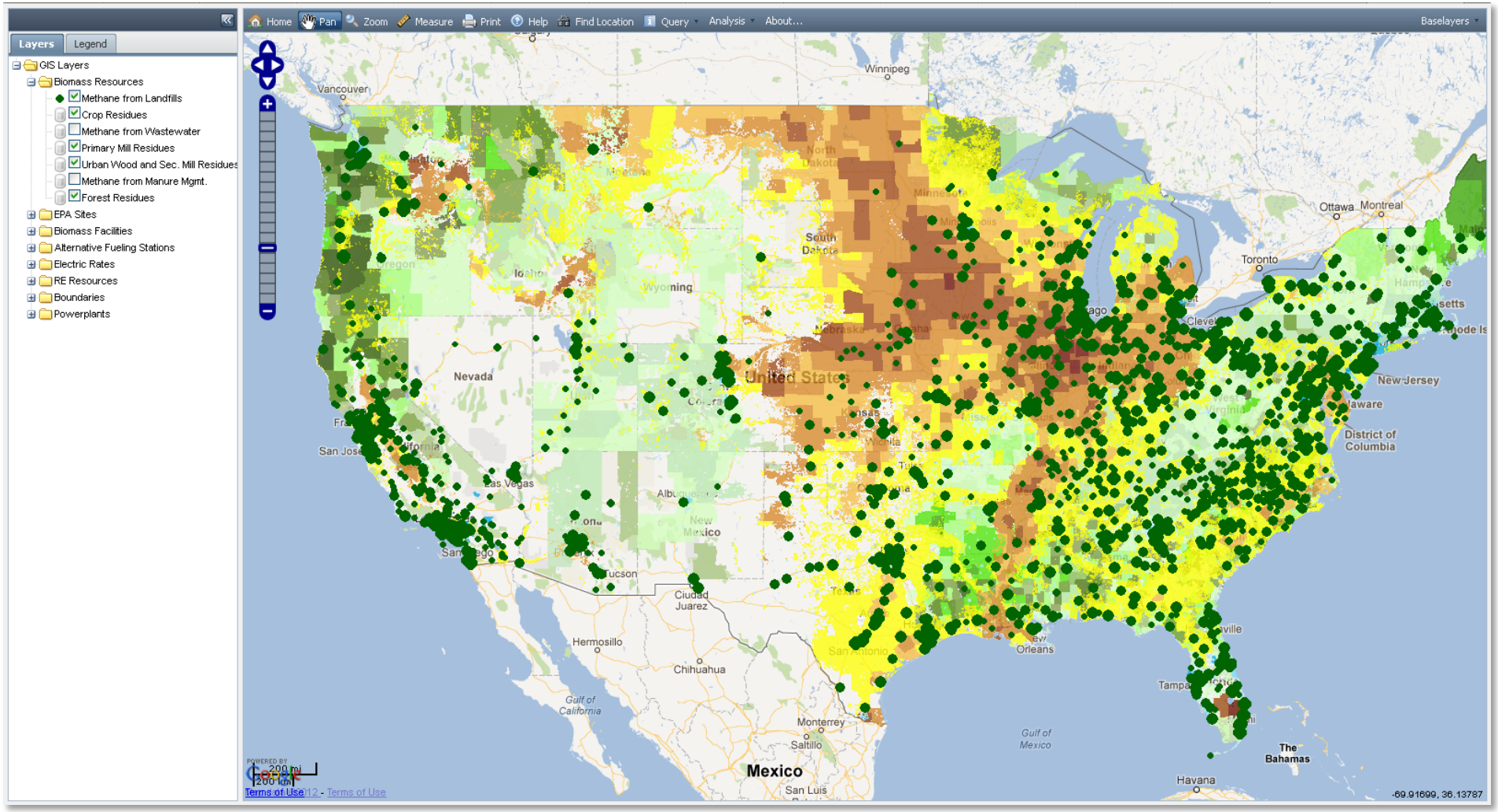
For a high-level assessment of resources, the following tools can be used:

- NREL geographic information system (GIS) maps: www.nrel.gov/gis/maps.html
- State and national level maps
- Biomass interactive atlases:
  - rpm.nrel.gov/biopower/biopower/launch
  - maps.nrel.gov/biomass

Biomass Resource – GIS Map



Biomass Resource – Biopower Atlas



Commercial or Community Scale?

Heating

~ 1.5 million British thermal unit (Btu)/hour and larger

- Hotel
- School
- Casino
- Recreation center
- Office building
- Multi-resident district heating system

Electricity

~1 megawatt (MW) to 10 MW

- Lumber mill
- Village power
- Casino

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Technology Overview

Primary uses:

- Facility heating
- Electric power generation
- Combined heat and power (CHP)

"Biomass" includes, but is not limited to:

- Wood from various sources
- Agricultural residues
- Animal and human waste
- Municipal solid waste and landfill gas

Range of Bio-Energy

Biomass Feedstock

- Trees
- Grasses
- Agricultural Crops
- Residues
- Animal Wastes
- Municipal Solid Waste
- Algae
- Food Oils, Waste Oils

Conversion Process

- Combustion
- Gasification
- Pyrolysis
- Co-firing
- Enzymatic Fermentation
- Gas/liquid Fermentation
- Acid Hydrolysis/Fermentation
- Trans-esterification

Products

Fuels
- Ethanol
- Biodiesel
- "Green" Gasoline & Diesel

Power
- Electricity
- Heat

Chemicals
- Plastics
- Solvents
- Chemical Intermediates
- Phenolics
- Adhesives
- Furfural
- Fatty Acids
- Acetic Acid
- Carbon Black
- Paints
- Dyes, Pigments, and Ink
- Detergents
- Etc.

Food and Feed

Photos left to right: NREL/PIX 05086, 12481

Biomass Project Feasibility

Depends on:

- Availability and cost of each type of biomass (chip, pellet, or logs)
- Competing fuel cost (e.g. fuel oil, natural gas, etc.)
- Thermal peak and annual load
- Building size and type
- Space availability
- Operation and maintenance staff availability
- Local emissions regulations

Biomass Performance Characteristics

- Typical biomass boiler operating on fuel with a moisture content of 40% has a net efficiency of about 60%-65%.

- Efficiency influenced by:
  - Moisture content of the biomass
  - Combustion air distribution and amounts (excess air)
  - Operating temperature and pressure
  - Flue gas (exhaust) temperature

Commercial Technologies

Source: NREL/PIX 06656

- Combustion/steam turbine
- Efficiencies in 15% – 30% range power only, (60%-70% CHP)
- Stokers and fluidized bed
- 500+ facilities in U.S.

Emissions

- Air emissions from a biomass system depend on:
  - System design
  - Fuel characteristics
  - Operation and maintenance factors
- This table shows typical emissions for a biomass heating system (based on Chiptec gasifier data) operating on 40% moisture content pine (pound [lb]/green ton)

Constituent	PM10	NOx	VOC	CO
Typical biomass system emissions [lb/green ton burned]	2.1	2.8	0.6	1.7

Biomass Costs - Electric

- Installed costs $1,900 - $5,500/kilowatt (kW)
- Larger systems (>5 MW) have better economics
- LCOE = $0.08 - $0.20/kilowatt-hour (kWh)
- A typical biopower scale for a tribal or community application would probably be about 10 MW, and cost ~$40 M
- LCOE could be $0.10 - 0.12/kWh
  - This strongly depends on feedstock cost

Biomass Costs - Thermal

- Heating plants: average $350,000 per MMBtu/hr (*), with smaller plants having a higher cost intensity than larger ones
- Operation and maintenance costs include:
  - Fuel
  - Labor (2-5 hours per week, including fuel ordering and a daily walk-through)
  - Repair and replacement of mechanical parts
  - Ash disposal

(*) MMBtu is one million British thermal units

Biomass in Kodiak, AK

Homeland Security

- Wood pellets in Coast Guard boilers in place of expensive fuel oil
  - Source of pellets: wood waste and second-growth trees from Tongass National Forest
- Benefits
  - Reduce fuel costs
  - Improve operations and resiliency
  - Support energy independence
  - Foster environmental stewardship

Source: The U.S. Department of Homeland Security

NREL Renewable Fuels Heating Plant

NREL recently installed a biomass heating plant to provide heat to the research buildings.

- 9 million Btu/hr system
- Tied into an existing hot water distribution system
- Designed to displace a significant amount of natural gas use at the NREL campus in Golden, Colorado
- Cost was $3.3 million

Source: NREL/PIX 16579

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State Biomass Policy

- Renewable Portfolio Standards:
  - 30 states have enacted a Renewable Portfolio Standard (RPS) within which some kind of biomass is eligible. Mostly electric power, but some states include thermal
- As with biofuels, many biopower incentives have been passed on a state level to encourage biopower production

- For information on your state: http://www.dsireusa.org

Federal Biomass Policy

- Relevant Federal Legislation
  - USDA Farm Bill
  - Healthy Forests Initiative
  - U.S. Energy Initiative
  - National Energy Policy Act of 2005 (http://www1.eere.energy.gov/femp/regulations/epact2005.html)

What we covered…

▪ About the DOE Office of Indian Energy Education Initiative	√
▪ Course Introduction (Takeaways)	√
▪ Resource Map & Project Scales	√
▪ Technology Overview(s):	√
- Siting	√
- Costs	√
▪ Successful Project Example(s)	√
▪ Policies Relevant to Project Development	√
▪ Additional Information & Resources	

Useful Resources

RESOURCE	NREL GIS maps: www.nrel.gov/gis/maps.html rpm.nrel.gov/biopower/biopower/launch maps.nrel.gov/biomass
TECHNOLOGY	• Woody Biomass Utilization Desk Guide (www.forestsandrangelands.gov/Woody_Biomass/documents/biomass_deskguide.pdf)
POLICY	A supply chain analysis framework for assessing state-level forest biomass utilization policies in the United States (www.sciencedirect.com/science/article/pii/S0961953410002540)

Thank You & Contact Information

For More Information:

DOE Office of Indian Energy

Website: www.energy.gov/indianenergy

Email: indianenergy@hq.doe.gov

NREL Technology Websites:
www.nrel.gov/learning/re_basics.html

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INFORMATION ON THE CURRICULUM PROGRAM & OFFERINGS

Curriculum Structure & Offerings

Foundational Courses

- Overview of foundational information on renewable energy technologies, strategic energy planning, and grid basics

Leadership & Professional Courses

- Covers the components of the project development process and existing project financing structures

Foundational Courses

Energy Basics

- Assessing Energy Needs and Resources
- Electricity Grid Basics
- Strategic Energy Planning

Renewable Energy Technology Options

- Biomass
- Building Heat and Hot Water
- Geothermal
- Hydroelectric
- Solar
- Wind

All courses are presented as 40-minute Webinars online at
www.energy.gov/indianenergy