The North Carolina Biomass Roadmap:




Recommendations for Fossil Fuel Displacement through Biomass Utilization[1]

Abridged Version, September 2007

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[1] The unabridged version of the North Carolina Biomass Roadmap is available online at: www.engr.ncsu.edu/ncsc/bioenergy

[2] Created in 1988, The North Carolina Solar Center is part of the N.C. State University College of Engineering that works with state government and the renewable energy industry. It serves as a clearinghouse for information, provides technical assistance, education, outreach, and training.

The abridged version of the NC Biomass Roadmap includes:

I. **Background information on biomass to energy pathways**
II. **Energy use in North Carolina**
III. **Potential biomass resources available for energy utilization**
IV. **Bio-products Development**
V. **Target goals for use of biomass in the state**

I. Background

The North Carolina Biomass Council developed this Roadmap at the request of the State Energy Office to be used as a tool to assist stakeholders in planning North Carolina's future biomass utilization. The Roadmap represents the collective assessment and expertise of the North Carolina Biomass Council and is a result of numerous facilitated discussions.

For the purposes of this Roadmap, biomass is defined as "any organic matter that is available on a renewable or recurring basis, including agricultural crops and trees, wood and wood wastes and residues, plants (including aquatic plants), grasses, residues, fibers, animal wastes, and segregated municipal waste…" **Biomass can be converted into biopower, biofuels and bioproducts** through chemical and biological means or can be used to generate heat and/or electricity through direct combustion, co-firing, gasification, and pyrolysis. Figure 1 (below) outlines the dynamic nature of biomass utilization.

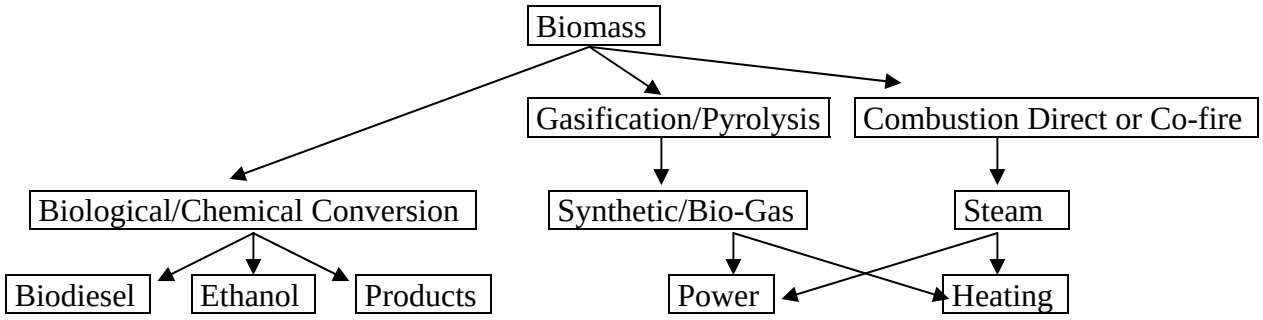

Figure 1: Avenues for Biomass Utilization

II. Energy use in North Carolina

In 2002, North Carolina consumed an estimated 2,633.8 trillion British Thermal Units (BTUs) of energy, **ranking twelfth nationally** in energy consumption. Notice from Figure 2 that **petroleum is the largest energy source consumed at 37%**, requiring the state to import 12.1 million gallons of gasoline and 4.1 million gallons of diesel fuel *per day*. Also note that North Carolina already meets 4% of its energy needs using biomass, ranking eighth nationwide in biomass utilization.[3]

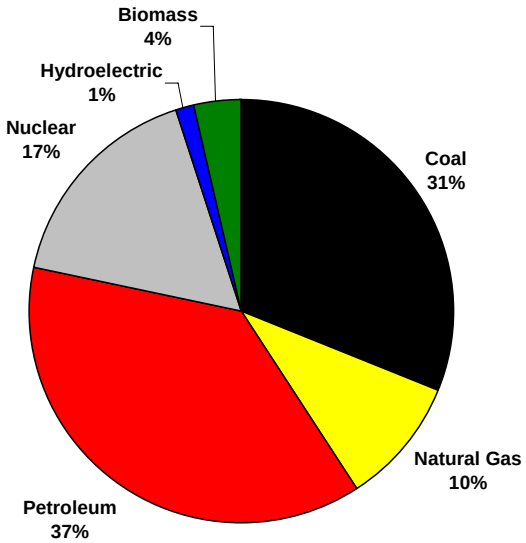

Figure 2: North Carolina Energy Consumption in 2002[4]

[3] Energy Information Administration. *Petroluem Profile: North Carolina*. Nov. 2006. http://tonto.eia.doe.gov/oog/info/state/nc.html

[4] *North Carolina State Energy Plan*. State Energy Office and ASU Energy Center. January 2005

Figure 3 shows that energy consumption in North Carolina has increased exponentially and most expect that it will continue to do so. The Integrated Resource Plan (IRP) developed by the North Carolina Utilities Commission predicts that **electricity consumption will increase an average of 1.8% per year over the next 10 years**.[5] The Energy Information Agency (EIA) predicts that national consumption of liquid fuels and other petroleum products will grow around 1% per year[6].

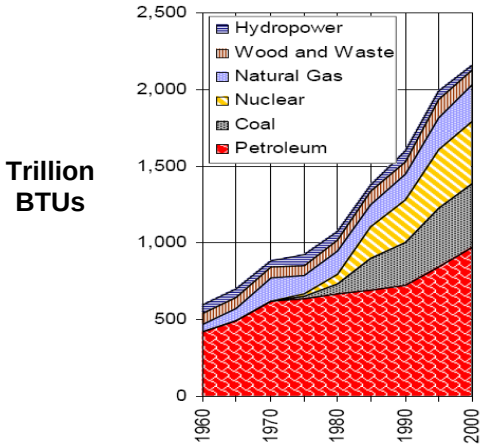

Figure 3: Past Energy Growth by Source[7]

Table 1: Potential Biomass Resources

Forest Resources: 57%
Softwood: 12%
Hardwood: 14%
Pulpwood: 31%
Agricultural Resources: 16%
Wheat Straw: 0.5%
Corn Stover: 5.5%
Corn Grain: 6%
Sweet Potato: 1%
Soybean Oil: 3%
"Waste" Resources: 27%
Yellow Grease: 0.5%
Animal Renderings: 2%
C&D Wood Waste: 6%
MSW Wood Waste: 5%
Poultry Litter: 4%
Hog Waste: 4%
Landfill Gas: 5.5%

III. Potential Biomass Resources in North Carolina

North Carolina has an abundance of untapped biomass resources that are distributed across the state. Currently, our national bioenergy policies support the resources typical of Midwestern states, but North Carolina has a very different mix of existing crops and potential biomass resources. **North Carolina has a significant amount of lignocellulosic biomass (plant fibers containing lignin and cellulose) that could be utilized**. Since North Carolina is unique in its feedstock supply, it requires a distinct approach to make use of these resources. Table 1 lists the distribution of North Carolina's annual biomass resources according to their available energy content for their most likely energy conversion. Some of these resources are currently being used in alternate markets, but could be utilized for energy without significant impact in North Carolina.

To put this annual supply of resources into perspective, Figure 4 illustrates the biomass supply in relation to North Carolina's current energy consumption. As can be seen from this chart, **North Carolina could meet an additional 10% of its current energy needs using these biomass resources**. Combined with the current biomass energy production, North Carolina could decrease its current dependence on fossil fuels by a total of 14%. Furthermore, as new dedicated energy crops such as canola, hulless barley, industrial sweet potato, switchgrass, and hybrid poplar are grown, this percentage could increase.

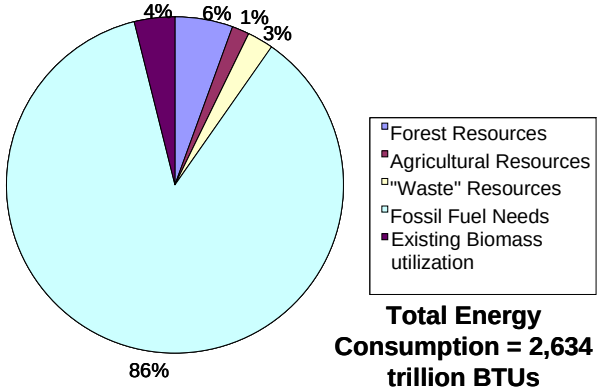

Figure 4: Potential North Carolina Energy Consumption (% BTU's)

[5] NC Utilities Commission. *Annual Report of the NC Utilities Commission Regarding Long Range Needs for Expansion of Electric Generation Facilities for Service in North Carolina.* Nov 2006. http://www.ncuc.commerce.state.nc.us/reports/lr2006.pdf
[6] Energy Information Administration. *Annual Energy Outlook: 2007*. Nov. 2006. *http://www.eia.doe.gov/oiaf/aeo/aeoref_tab.html*
[7] *North Carolina State Energy Plan*. State Energy Office and ASU Energy Center. January 2005

IV. Bioproducts Development

Some of the world's largest and most powerful chemical, energy, and food-processing companies (such as: DuPont, BP, Archer Daniels Midland and Cargill) have begun to form joint ventures focusing on bioproducts. For example, DuPont has located a plant in Kinston that produces one of its newest and most versatile bio-based polymers, Serona, which is used in the production of carpeting, clothing, and in automotive and industrial components.

Smaller North Carolina manufacturers have also proven adept at making the transition to bioproducts. For example:

- Hickory Springs Manufacturing Company in Hickory uses a soy-based polyol, in place of polyurethane, in the manufacture of its Preserve foam product.
- Twin City Knitting Company in Conover incorporates a corn-based fiber, Ingeo, in producing some of its socks. However, all of these rely on raw materials derived from food crops grown outside of North Carolina.

V. Targets for Biomass Utilization and Fossil Fuel Displacement

Biofuels Target: "10 in 10"

- North Carolina should **displace 10% of its gasoline and diesel fuel consumption by 2017** using in-state biomass resources while incorporating energy efficiency measures (i.e. increased fuel efficiency).
- It is possible for North Carolina to provide 10% of its current gasoline and diesel consumption using existing resources.

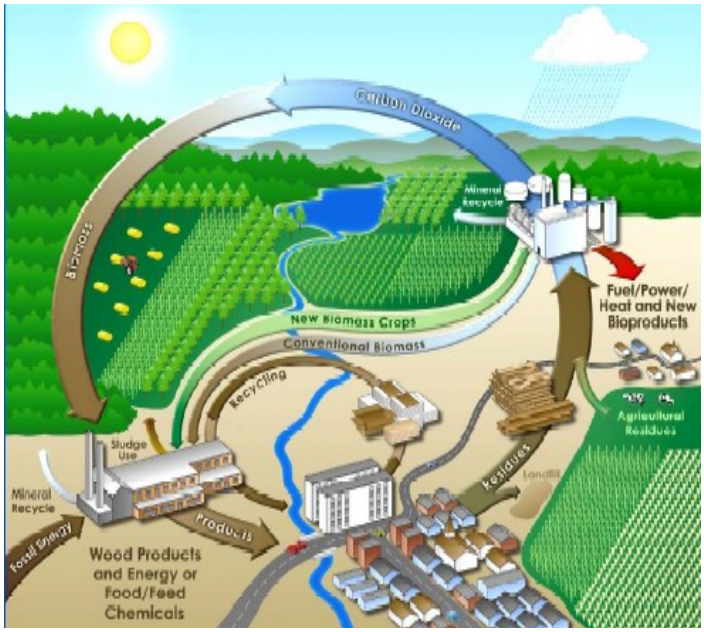

Figure 5: Biomass Energy Carbon Cycle

Biopower Target: "7 by 17"

- North Carolina should **displace 7% of its predicted power consumption by 2017** using its available biomass resources while incorporating energy efficiency measures.
- The December 2006 document, *Analysis of a Renewable Portfolio Standard for the State of North Carolina* shows this to be practical if North Carolina uses its existing resources and reduces its power demand by 14% through energy efficiency by 2017[8].
- This target will most likely be achieved in conjunction with a 10% Renewable Portfolio Standard in North Carolina that includes energy efficiency for 25% of its RPS.

Bioproducts Target: "Leader in Bioproducts Research and Development"

- North Carolina should become a leader in bioproducts research and development by 2017.
- Universities, community colleges and businesses have initiated research and development in biotechnology which positions North Carolina as a potential national leader in bioproducts R&D.

[8] *Analysis of a Renewable Portfolio Standard for the State of North Carolina*, produced by La Capra Associates, LLC in December of 2006