FOREST BIOMASS: A RENEWABLE RESOURCES-BASED PRODUCT AND ENERGY PLATFORM PROPOSED BY NCSU FOR THE FUTURE GLOBAL ECONOMY

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Carbohydrates and lignin are among the most abundant chemicals on the planet which may potentially be used to produce chemicals, materials, and energy without concomitant toxic waste generation. , Only 3% of the hundreds of billions of tons of biomass on the earth is used by humans.

As opposed to many petroleum derived chemicals and energy, the carbohydrates and lignin in biomass are readily renewable, potentially inexpensive, and environmentally benign. However, the systematic, efficient utilization of this vast resource is still in its infancy. Since global air quality and climate change pressures are mounting while the availability of cheap and abundant fossil fuel becomes increasingly questionable, it is likely that any economic advantages for a petrochemical-based economy will literally evaporate within the next twenty years.

Given the abundance and chemical versatility of biomass, the US chemical industry is therefore beginning to consider it as the next generation of feedstock for the manufacturing of chemicals, materials, and energy products. This likelihood unambiguously demonstrates the need for scientific research aimed at improving the fundamental economic and environmental sustainability conversion technology for polysaccharides and lignin. *It is envisioned that within the next several decades, many of the basic commodity chemicals used to make drugs, agricultural adjutants, polymers, and fuels will almost exclusively be produced from wood, sugars, and other natural feedstocks.* However, the extent of these developments will depend on the fate of crude oil supplies, their prices, and the quality and availability of natural feedstocks. It is within this framework that the Department of Wood and Paper Science at the North Carolina State University is positioning itself to expedite this new future economy through its current efforts in forest biomass research.

The Department is currently witnessing a renaissance in the concentration area of forest products science and engineering. In addition to our traditional focus on pulping, bleaching, and paper making we are beginning to explore the possibilities of using the forest for the production of value-added chemicals and fuels. In fact, a number of efforts at our Department will demonstrate the wide scope of work done in forest biomass research. One of the unifying themes in our forest biomass research & education is the potential for redefining a pulp mill as a “biorefinery,” i.e., a conceptualized site that provides bio-based resources and energy that are usually outside the scope of traditional functions. Figure 1 illustrates this concept using a flow diagram.

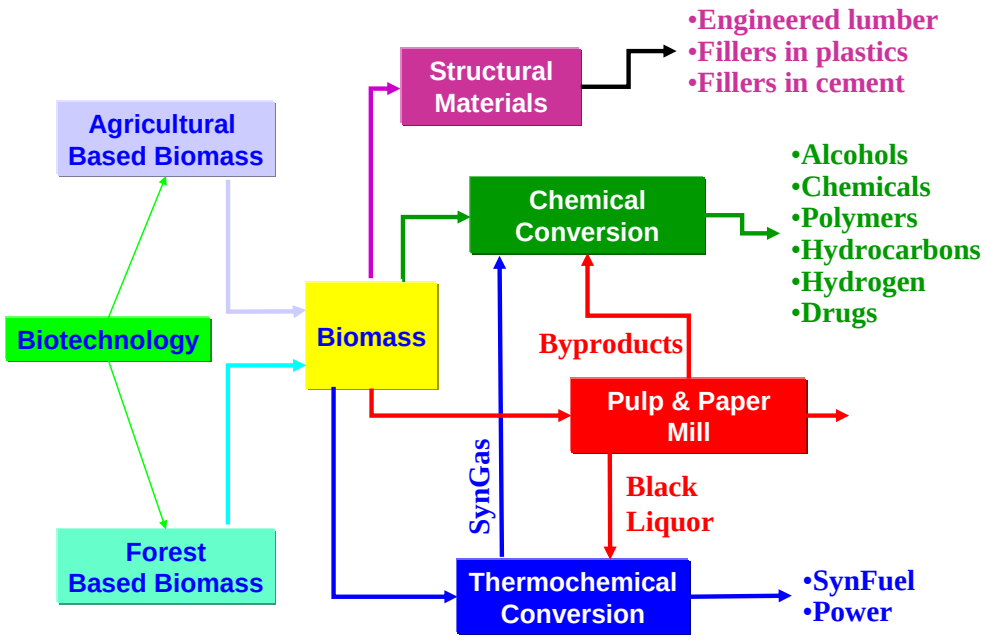

Figure 1. A flow diagram is shown above that represents the "biorefinery" concept in pulp, paper, agricultural residues, and related biomass.

The Department of Wood and Paper Science is realizing that a strong academic component must be included in any future efforts directed toward the establishment of a economy based on the biorefinery concept. The biorefinery concept is essentially self-sustainable since it produces its own energy, it virtually no environmental impacts, and it employs renewable resources. At NCSU, a strong driver to support the realization of an economy based on green science is the establishment of a forest biomass program, which will build on our strength in pulp and paper science and engineering, that encompasses work from a number of academic disciplines to address the needs of the bio-based economy. In that vein, researchers at NCSU are working together to assemble practical research projects and cooperation efforts that will eventually provide a critical mass for industrial exploration and implementation.

We envision that NCSU will tackle a broad suite of associated forest chemical, material, and energy research and educational considerations for a future bio-based economy. Some of the research areas in progress at the Department are shown below:

- Modification of Cellulosic Structures and Properties for Novel End Uses
- Modification of Lignins for Novel End Uses
- Extraction of Value-Added Chemicals from Biomass
- Bioethanol from Lignocellulosic Biomass
- Smart Polymers and Hydrogels based on Biomass
- High Performance Fiber Structural Composites

Some of the pertinent activity at the Department that has been fostering the evolution of a forest biomass program includes:

- We have begun organizing a graduate course program in biomass science & engineering

- An electronic journal entitled, “BioResources” has been founded at NCSU devoted to the dissemination of advanced applications of lignocellulosics
- A recent USDA competitive grant was awarded to us in conjunction with UT’s SunGrant Center & NCA&T to develop a postgraduate curriculum in biomass/bioenergy
- MeadWestvaco’s advanced packaging center, which is relocating to The NCSU Centennial Campus, will be closely allied with the Department as we explore new materials and processes, and valued-added products.

The future of extracting chemical, material, and energy value from forest materials and residues is very bright. It promises to be brighter with the collected academic effort at Departments such as Wood and Paper Science at NCSU that make concerted commitments to making forest biomass a robust scientific discipline. As shown by the work being done at our Department, a renewable resource-based economy is already at hand.