Using Short Rotation Woody Crops for Bioenergy in North America

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Scientists from the USDA Forest Service, Northeastern Research Station and Lake States Forest Experiment Station (LSFES), began breeding poplars in the 1920s and 1930s, respectively, to select favorable genotypes for pulpwood. In 1973, an oil embargo by the Organization of the Petroleum Exporting Countries prompted the LSFES to research the efficacy of short rotation woody crops for bioenergy, specifically to identify productivity limits by testing numerous species and varieties, while focusing on agricultural-type inputs. Given their high-energy content, increased yield, fast growth, and adequate disease and pest tolerance and/or resistance, poplars exhibited the greatest potential for bioenergy. Currently, there are more than 75,000 acres of poplars in North America, with most being used for pulpwood and other wood products. In addition, given their elevated water usage, fast growth, and deep root systems, poplars have been used for environmental benefits such as phytoremediation and agroforestry. Furthermore, the increased prices of oil, natural gas, and gasoline in the last year have made energy crops a free-market reality. Decades of poplar research and development have contributed to an increasing interest in using poplar biomass for electricity and poplar cellulosics for ethanol.

A biomass project using poplar as a renewable and sustainable supply of green energy has been implemented by the Public Utilities Commissions of Hibbing and Virginia, Minnesota, as a result of an $80 million power purchasing agreement from Xcel Energy (Fig. 1). In 1994, the Minnesota State Legislature required Xcel Energy to produce 150 MW of renewable generation, of which 35 MW needs to be closed loop (grown specifically for power generation). The planned overall fuel mix is 75% harvest residue and 25% dedicated energy crop (40,000 acres of poplar). The project has a predicted $1.2 billion economic impact.

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Figure 1. Laurentian Energy Authority biomass electricity plant

Using cellulose for energy is gaining support because of a mandate in the Energy Policy Act of 2005 to produce 7.5 billion gallons of ethanol by 2012, which is an increase of 3.5 to 4.0 billion gallons from recent ethanol levels. Current corn production cannot sustain this level, given that 4 billion gallons of ethanol would consume 71% of the corn exported from the United States last year. Thus, to avoid a "fuel versus food" moral issue, alternative energy crops should be considered. Poplars are an ideal potential source of cellulose because they are carbon accountable, meaning they have a better input/output energy balance than most other crops. In addition, demonstrated yields up to 7 dry tons per acre per year can supply enough poplar biomass from 11.4 million acres to produce 4 billion gallons of ethanol per year. How-

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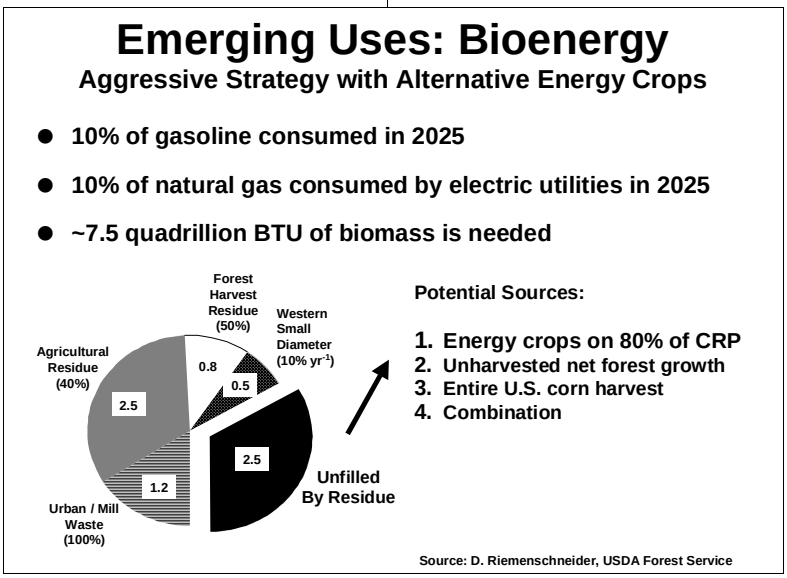

Figure 2. Hypothetical Bioenergy Strategy

A Short History of Chip Harvest Regulation in Vermont —

Peter Condaxis, Regulatory Forester, Ryegate Power Station, Vermont

In the mid-1970s the outlook for energy production was very similar to what we are experiencing today: rising fossil fuel prices and a keen interest in replacing traditional fuels with alternatives for power generation. In 1976, the city of Burlington, Vermont identified the need for additional electrical generation and began investigating ways to meet this need. City planners settled on the idea of constructing a wood-fired electrical generating station. Wood was a local, abundant, renewable resource and the harvest of low-grade material was seen as a way to improve forest management in the region. A bond issue received strong support for the concept of wood-fired generation; however, there was great concern regarding sources of wood fuel and potential negative impacts on the forest resource. Some groups and individuals were convinced that the shade trees in downtown Burlington would be harvested, and eventually Chittenden County would be clearcut in order to "feed the beast." Posters went up around the city picturing a landscape of tree stumps with a bold headline: "THE CHIP PLANT IS COMING."

Clearly Burlington Electric Department (BED) needed a way to mitigate these concerns. In 1979, BED hired NESAF member Bill Kropelin to address the public's concerns and Vermont's Act 248 regulatory process. Working with State agencies, natural resource organizations and individuals, Bill developed the "Harvesting Policy for Whole Tree Chipping Operations in Vermont." This document states that BED will only accept chips from harvesting operations in Vermont certified by a professional forester as meeting the criteria of "good forestry practice." These criteria include appropriate erosion control measures, visual quality considerations, protection of archeological sites, application of Forest Service silvicultural guides, and protection of wildlife and fish habitats. BED was required to hire a forestry staff to implement the Harvesting Policy; the Vermont Department of Fish & Wildlife (VT F&W) was to have regulatory review of all proposed chip harvests to evaluate impacts on deer wintering areas, wetlands, or the habitat of endangered species ("the three criteria"). BED foresters were to prepare a "Chip Harvest Notification" that was provided to VT F&W biologists for review; the biologists could approve the notification as sent, require modification if the proposed harvest negatively impacted the three criteria, or refuse approval if negative impacts could not be mitigated by a change in the harvest plan.

The Harvesting Policy was submitted as part of BED's Act 248 permit application, accepted by the Vermont Public Service Board and incorporated into BED's chip procurement methodology. In 1982-83, BED hired NESAF members Bill Samal, Betsy Lesnikoski and Peter Condaxis to complete the forestry staff and implement the Harvesting Policy in the field. Since fuel chip purchases for the McNeil Generating Station began in 1983, all Vermont chip harvests have gone through the notification/approval process with VT F&W, and BED foresters have been "on the ground" working with chip harvest contractors to insure compliance with the Harvesting Policy. It should be noted that the Policy does not apply to wood chips that go to markets outside Vermont.

In 1989, the developers of Ryegate Power Station in Ryegate, Vermont incorporated essentially the same Harvesting Policy in their Act 248 permit application and it became part of Ryegate's procurement policy. Peter Condaxis was hired by Ryegate Power in 1992 and has been responsible for implementing Ryegate's Harvesting Policy. While not a perfect system, the Harvesting Policy has provided a method to insure sound forest management and protection of wildlife resources on most chip harvest operations in Vermont for the past 23 years.

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ever, despite the potential to expand the resource base to marginal agricultural land, the availability of such biomass is questionable. An aggressive bioenergy strategy considering 10% of both gasoline and natural gas consumed in 2025 would require 7.5 quadrillion BTU of biomass (Fig. 2). Of the current supply, only 5 quadrillion BTU would be supplied by the combination of 100% of urban and mill waste (1.2), 40% of agricultural residue (2.5), 50% of forest harvest residue (0.8), and 10% per year of western small diameter biomass (0.5). Thus, 2.5 quadrillion BTU of necessary biomass are unfilled by residues, but they could be filled by the entire United States corn harvest, all of the unharvested net forest growth, energy crops on 80% of available Conservation Reserve Program lands, or a combination. The "fuel versus food" dilemma and likely public outcry against harvesting native forests for energy will push the burden towards energy crops. Forestry and forestry research will be an increasingly important source of feedstock development and dissemination to help the nation meet its rising energy demands.