BIOMASS POWER FOR RURAL DEVELOPMENT

TECHNICAL PROGRESS REPORT

Contractual Reporting Period
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DISCLAIMER

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1.0 INTRODUCTION

The focus of the DOE/USDA sponsored Biomass Power for Rural Development project is to Develop commercial energy crops for power generation by the year 2000 is. The New York based Salix Consortium project is a multi-partner endeavor, implemented in three stages. Phase-I, Final Design and Project Development, will conclude with the preparation of construction and/or operating permits, feedstock production plans, and contracts ready for signature. Field trials of willow (Salix) have been initiated at several locations in New York (Tully, Lockport, King Ferry, La Fayette, Massena, and Himrod) and co-firing tests are underway at Greenidge Station (NYSEG) and Dunkirk Station (NMPC). Phase-II of the project will focus on scale-up of willow crop acreage, construction of co-firing facilities at Dunkirk Station (NMPC), and final modifications for Greenidge Station. Cofiring willow is also under consideration for GPU's Seward Station where testing is underway. There will be an evaluation of the energy crop as part of the gasification trials occurring at BED's McNeill power station. Phase-III will represent full-scale commercialization of the energy crop and power generation on a sustainable basis.

Willow has been selected as the energy crop of choice for many reasons. It is well suited to the climate of the Northeastern United States, and initial field trials have demonstrated that the yields required for project to succeed are obtainable. Like other energy crops, willow has rural development benefits and could serve to diversify local crop production, provide new sources of income for participating growers, and create new jobs. Willow could be used to put a large base of idle acreage back into crop production. Additionally, the willow coppicing system integrates well with current farm operations and utilizes agricultural practices that are already familiar to farmers.

There are potential environmental benefits associated with willow production. Willow crops can provide soil and water resource conservation benefits and are being evaluated as riparian buffer strips to protect watersheds. Willow may also be useful for bioremediation of contaminated sites and for beneficial uses of various organic waste streams. The Consortium is investigating the possibility of demonstrating these benefits.

For this project, willow will be grown on local acreage - within approximately 50 miles of the power stations. The willow will be harvested and delivered to either the power plant or a storage site. At the power plant, the willow will be further processed ensuring proper moisture content and sizing for firing in the power plant's boilers. Years of feedstock field testing and research by SUNY ESF and, more recently, co-firing tests and analysis at Greenidge Station are expected to reduce the learning required to optimize these processes in scale-up efforts. In addition, efforts are underway to increase the yields of U.S. clones through the native clone research and development project. The investigation of these advancements are part of this and other allied projects with SUNY ESF.

For power generation, the project will utilize commercially available equipment for co-firing dedicated feedstocks in pulverized coal boilers. An experimental project to test biomass reburn

systems for NO_X control is in the planning stages. Power generated by co-firing coal and willow offers a variety of incentives to the utilities, growers, and local economies. Co-firing biomass at existing coal-powered facilities is being considered as a technically feasible and economical strategy for SO_2 and NO_X emission reductions mandated by the Clean Air Act Amendments. Because of its low sulfur content, co-firing biomass feedstocks can improve the emission characteristics of coal-fired plants and allow generators to earn emission allowances. When used on a sustainable basis, biomass is also a near zero emitter of CO_2. Therefore, substituting biomass for coal can also reduce CO_2 emissions. Currently utilities are pursuing voluntary reductions of greenhouse gases. These reductions can be "banked," allowing power generators to hedge against future mandates regarding emission levels.

While co-firing is the Salix project's initial technology choice to build a biomass power infrastructure, Burlington Electric's participation in the Consortium is providing an avenue to test the energy crop in a prototype of future high-efficiency conversion technology. Burlington's biomass gasification repowering demonstration is the first step toward an integrated gasification combined cycle power generation system. The initial plans are to test the use of product gas in the power plant's existing boiler. Later, the product gas is expected to be used to power a combustion turbine.

1.1 Project Tasks

The specific tasks for Phase-I are as follows:

- Development of cost estimates, construction documents and site plans necessary to convert Greenidge and Dunkirk power stations to co-fire biomass fuels. Application for required environmental permits will also be completed during this phase.

- Development of detailed fuel supply plans for Greenidge and Dunkirk outlining the quantity and source of fuels to be used as feedstock. For the willow portion of the fuel supply, this would include drafting contracts, binding letters of intent, or purchase orders necessary to obtain feedstock.

- Further investigation into willow production issues such as the organization of future enterprises, cuttings sales, fuel delivery to the power plants, and ways to reduce planting, harvesting, processing, storage, and delivery costs.

- This phase will also see the expansion of willow field trials, initiation of comparative site preparation and comparative soil amendment and fertilizer studies, characterization of willow resistance to insects, and a riparian benefits analysis. The Consortium is integrating our USDA and DOE program efforts in these areas to assure the success of the demonstration.

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- The members of the development team will also be seeking product and process guarantees from equipment manufacturers. Additional effort will be directed to evaluating possible project risk sharing strategies and their impact on the team members as willow energy crops approach commercialization.

- Outreach is a vital element of the program. The Consortium continues to seek new partners in both the agricultural and power sectors.

1.2 Revised Schedule of Deliverables

Deliverable	**Original Due Date**	**Revised Delivery Date**
Design Reports		
Greenidge -	February 1997	Delivered
Dunkirk -	July 1997	2nd Qrtr 1998
Fuel Supply & Site Development Plans		
Greenidge -	January 1997	Delivered
Dunkirk -	July 1997	2nd Qrtr 1998

2.0 PROGRESS SUMMARY

During the third quarter of 1997, much of the Consortium's effort has focused on outreach activities, continued feedstock development, fuel supply planning, and fuel contract development, and preparation for 1998 scale-up activities. The Consortium also submitted a Phase-I extension proposal during this period. A few of the more important milestones are outlined below. The fourth quarter of 1997 is expected to be dominated by Phase-II proposal efforts and planning for 1998 activities.

Fuel Supply Development

- Fuel Supply Plan for Greenidge Power Station prepared and forwarded to DOE. Acreage is a combination of utility and private acreage supplemented with residue sources that NYSEG has been developing for several years.

- High mortality was encountered in Wolcott, NY at the demonstration plot due to weed competition.

- Site preparation activity continued on trial plots at Tully, Massena, Lafayette, Burlington, Wolcott.

- SoCNY RC&D and SUNY ESF staff visited Dunkirk area farmers and signed leases for 97 acres.

Power Conversion Technology Development

- NYSEG submits the Greenidge Design Report
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- NMPC is proceeding with plans to perform co-firing tests in the fourth quarter of 1997

Enterprise Development & Outreach

- Consortium members attended booths at the Empire Farm Days
- Second installment of the Willow Biomass News released
- Biomass-Bioenergy Advisory Board held at SUNY ESF in August

3.0 DETAILED TASK PROGRESS REPORTS

3.1 Task 1. Design Packages

Having completed their review of potential improvements to the Greenidge station, NYSEG has submitted a design report outlining proposed retrofits for Phase-II. The report evaluated three different power plant upgrade alternatives and suggests that retrofit of the plant should be performed with used equipment for continuous biomass co-firing operation. Plant specifications, descriptions of plant operation, and economics of the retrofit are presented in the report.

Design Packages Statement of Work

An engineering design package, environmental permits, cost estimate and construction documents, sufficiently detailed to proceed in Phase 2 with construction/operation, will be prepared. The elements of the package will be used to meet the following requirements for the Greenidge and Dunkirk projects:

- utility financial approvals for investment in facilities modifications
- permits for construction/operation
- construction bid packages and internal work orders

Conceptual designs will also be prepared for 2 to 3 additional projects (U.S. Generating,* GPU, and Burlington Electric). These projects are in the wider region represented by the Consortium partners. They will be in the development evaluation phases as Greenidge and Dunkirk Stations take the lead in commercial scale-up.

**Since the preparation of the original proposal U.S. Generating has discontinued its membership in the Consortium*

NMPC's engineering staff have made significant headway in preparing Dunkirk for co-fire tests. An injection nozzle for biomass has been procured and will be installed early in the fourth quarter of 1997. The design layout for the test system is still under review, but initial discussions with system test contracting firms have been conducted. System tests are expected to take place early in the fourth quarter.

3.2 *Task 2. Fuel Supply and Site Development Plans*

A fuel supply plan for Greenidge Station has been completed which outlines the potential acreage for willow production in the supply shed. Based on co-firing estimates for the plant and yield estimates for willow, the report estimates that 6.25% of the plant's biomass fuel needs will be met by the 500 acres planned for production in the area. The balance of the plant's biomass needs will be met using available residues which have already been contractually arranged. Clone site trials have demonstrated the importance of planting on appropriate soil and plans for planting on Greenidge acreage are proceeding.

Fuel supply and site development plans are also proceeding for Dunkirk. An evaluation of the energy crop and residue fuel supply are nearing completion and a report is being prepared.

Fuel Supply and Site Development Plans Statement of Work

A fuel supply plan will be prepared, including contracts or binding letters of intent, which provide the terms and conditions for firm costs and supply quantities of fuel for the project. The plan will also detail the responsibilities and associated costs including land preparation, planting, harvesting, processing, storing and delivery to the generating station. Contingency plans will be prepared for fuel shortages and for conversion of energy crop acreage if the business fails to materialize as planned at the end of the demonstration period. As part of this planning task two acre field trials providing region specific data to select hybrids and guide plantings will be initiated. This is necessary to ensure that the information required for crop scale up scheduled for Phase 2 is available at the earliest possible date.

Activities at the field trial sites will include site selection, preparation, planting, intermediate treatments, monitoring and harvesting. Sites will be selected to include soil types representative of those available for commercial biomass crops. Tasks will include soil sampling, fall site preparation and layout, spring planting of multiple clones in randomized-block design (double-row system of 6200-7200 trees per acre), 1st-year winter cutback (to promote multiple stem coppice), 3 years of growth (monitored for productivity & pests), and winter biomass harvest (end of year 4). Planting and harvesting of measurement plots will generally be done by hand, but, mechanized operations will be used to plant and harvest border rows whenever possible. This work will be conducted by SUNY-ESF with matching support from Consortium power companies.

3.3 Task 3. Major Equipment Guarantees and Project Risk Sharing

On going discussions are being held among the partners to establish the baseline for the agreements for Phase II.

3.4 Task 4. Power Production Commitment

NYSEG has already begun producing power at the 5% to 10% cofiring level using residue supplies. In effect, its commitment to power generation from biomass has already been demonstrated. However, as part of the Phase II proposal to DOE, NYSEG will prepare a letter of commitment to continue co-firing of biomass including feedstock produced at the willow farms for the duration of the program. NMPC will not co-fire on a continuous basis until Phase II but a

Power Production Commitment Statement of Work

NYSEG will provide a letter stating its intention to co-fire biomass at Greenidge throughout the Phase 2 Demonstration Period. NMPC will provide a similar letter of intent for co-firing at Dunkirk.

letter of commitment will be included in the Phase II proposal.

3.5 Task 5. Power Plant Site Plan, Construction & Environmental Permits Report

Power Plant Site Plan, Construction and Environmental Permits Report Statement of Work

Site plans for the Greenidge and Dunkirk Stations showing the location of existing and proposed facilities will be provided. An area map will indicate the routes to be used for fuel supply deliveries. A general arrangement of the facility including the footprint and elevations will be provided. The plans will also include a discussion of permit modifications obtained as well as traffic impact studies performed for the increase in road use by fuel supply trucks. A plan for environmental baseline monitoring and project monitoring following construction will be provided. Copies of permit modifications obtained or correspondence from the permitting agencies indicating the likelihood of success of obtaining outstanding construction permits for the project will be included.

Site plans for the co-firing retrofit of Greenidge were prepared by NYSEG and will be revised pending location of the day bin and expanded yard area for receiving biomass fuel supplies. Environmental permits for co-firing biomass at Greenidge are already in place. Emissions monitoring has already begun with the test program and preliminary air emissions results are available. SO_2 reduction have been quantified and NO_X reductions have been measured under certain feedstock and firing conditions. A report is being prepared with the Electric Power Research Institute (EPRI) that will characterize the performance of the biomass fuel ramp-up tests.

A decision about permanent facilities for GPU is not likely to occur in Phase I. GPU will need more time to evaluate the long term fuel supply situation and the perform tests with the system at Seward.

Experimental Strategies for System Evaluation Statement of Work

A plan will be prepared for experimental strategies and designs to optimize and evaluate crop production and power production. The power production studies will be carried out at Greenidge and Dunkirk. A central site for core energy crop studies will be employed to monitor and evaluate crop nutrient cycling, crop and pest management techniques, and biodiversity impacts.

The Greenidge test system is fully operational on a single shift basis and there are no outstanding permit issues. NMPC has begun to evaluate potential issues for permitting a cofiring project at the Dunkirk site including potential impacts on its ash sales.

3.6 Task 6. Experimental Strategies for System Evaluation

Site preparation continued on several sites to make ready for planting in 1998. Contact herbicide application was completed on a 1 ha site at Tully, NY which will be planted in the Spring. Herbicide effectiveness was confirmed at a site near Lafayette, NY adjacent to the 1997 willow planting.

Early season survival in the Wolcott demonstration planting averaged 78.4%. However, drought conditions combined with severe weed competition caused many of the trees to die during

August. Survival of many clones was estimated to be less than 10% during August. This planting will be treated with contact herbicide to kill all vegetation (including the trees) and replanted in 1998. Although early season tree growth appeared excellent, the pre-emergent herbicide cap appeared entirely ineffective. This first iteration of trials at the site proved without a doubt the importance of pre-emergents in establishing a healthy crop.

Studies on insect pests of willow, defoliation, and weed control techniques also continued. Research staff also noted deer browsing damage on many of the clones. The most productive clone, SV1 experienced moderate to heavy damage. Methods of reducing deer browsing damage are being investigated.

3.7 Outreach, Extension, & Technology Transfer

Numerous outreach, extension, and technology transfer events also occurred during the third quarter. A highlight of these events is provided below. Presentation materials, and newspaper articles are included in the Appendix.

In August, an international conference was hosted at the SUNY ESF on "Enhancing the Productivity and Sustainability of Short-Rotation Salicaceae." The event was jointly sponsored by the International Energy Agency and the International Union of Forest Research Organization and SUNY ESF. Forty people from seven countries attended the meeting and toured the willow biomass trials at Tully, LaFayette, and Massena. During the same week over 100 participants from another conference also toured Tully.

The second issue of *Willow Biomass News* was completed and sent out in July by SUNY ESF staff. The newsletter included a brief discussion of the following topics:

- Environmental benefits associated with willow biomass crops
- The advantages of willow as an energy crop over higher density hardwoods
- Site preparation and planting techniques for willow crops
- An announcement of the Willow Biomass Crops for Bioenergy Field Days

A complete copy of the newsletter is contained in the Appendix. In conjunction with the newsletter, SoCNY RC&D also mailed over 1800 announcements for the for the Willow Crop field days and worked closely with the Cooperative Extension in Oswego county to invite individuals across the state to participate.

The Empire Farm Days in Seneca Falls, NY is the premier agricultural production even in the state each year. Staff from SUNY ESF, Cornell Cooperative Extension, and the SoCNY RC&D talked with numerous people about the project. Several landowners expressed interest in participating in the program and have since followed up by submitting land surveys or contacting staff associated with the willow program. The people who were the most interested were non-farmers or people that owned land but did not receive the majority of their income from farming.

In August, SUNY ESF hosted a very productive meeting of the Biomass-Bioenergy Advisory Board. Key items discussed included the environmental benefits and issues related to willow biomass production, alternative uses for willow biomass crops, and methods to improve the effectiveness of the Biomass-Bioenergy Advisory board.

Media coverage about the Salix project continued to gain momentum during this reporting period. An article appeared in the September 22, 1997 issue of *The Ithaca Journal*, "Biomass fuel offers option to coal burning." This article, like all those previously published, continue to draw interest to the project from all over the state.

Several articles and news letters contributed to by Consortium members are included in the Appendix. This form of outreach continues to generate a large amount of community interest in the project. Also included in the Appendix is a report of the SoCNY RC&D's trip to Minnesota.

APPENDIX A

ARTICLES

Reprints removed

APPENDIX B

EUROPEAN TRIP REPORT

Minnesota Trip Report

Prepared by: Stacie Edick, Biomass Field Representative, SoCNY RC&D
Destination: Alexandria, MN May 26-June 1, 1997
Host Organization: WesMin RC&D and the Minnesota Wood Energy Scale-Up Project

1) Role of RC&D/DNR Forestry

The WesMin RC&D is the local coordinator and administrator of the $750,000 Minnesota Wood Energy Scale Up Project. They hold liability insurance, lease land from farmers, hire vendors to plant, cultivate, and apply herbicide to poplar crops. They write the proposals for phases of the project and disburse funds to the other partners in the project.

Other partners in the project include Champion, Boise and Potlatch pulp companies, Dept Natural Resources Forestry, US Forest Service, Northern States Power Comp., Electric Power Research Institute, and Oak Ridge National Lab.

Other related projects include a $350,000 Acceleration of Biomass Energy Development in the MN River Basin. The Joint Institute for Energy and Environment uses established models to assess social and economic impacts in counties growing and using biomass.

Hybrid Poplar Herbicide Trials are done in conjunction with US Forest Service Rhinelander, Pope County SWCD and MN Research Cooperative.

WesMin RC&D also secured funding from the Kellogg Foundation to do a business plan and feasibility study to form a cooperative. The MN Agro-Forestry Cooperative is now incorporated and publishing a newsletter.

2) Research

Herbicide: Herbicide trials are being conducted at two sites, the Rosholt Research Farm is managed by the SWCD. Research is being conducted by USFS Forestry Sciences Laboratory, Oak Ridge National Lab-BFDP and WesMin RC&D. Both pre-emergent and post emergent herbicides are being tested on a variety of clones.

Clonal: Hybrid cottonwood and poplar clones are being tested at four sites for climatic suitability, growth characteristics and disease resistance. As these clones are developed they are released to the public domain. The US Forest Service does not retain intellectual property rights.

Soil-Yeild Correlation: Bill Berguson with MN Natural Resources Research Institute is leading this study. Soil samples have been taken at several plantations and will be compared to yeilds at those sites.

Plastic Mulch Studies: Compares weed control with plastic to cultivated control. Also evaluates economic feasibility and labor requirements. Data will be analyzed by USFS Forestry Sciences Laboratory at Rhinelander, WI.

Other: Small Mammal and Bird Study, University of Minnesota. Several Research Papers have been written by Virginia R. Tolbert at ORNL.

3) Farmers/Vendors

Land is located through the CRP program, a few landowners do the cultivating and maintenance themselves. In most cases the Project provides the cuttings (which are purchased from existing commercial producers) and hires a vendor to plant them. Other vendors are hired to apply herbicide and do cultivating. The number of cultivation's is set per year and the Project covers all these expenses. If additional cultivating is required the landowner is asked to cover the expense. At the end of the project the landowner will own the crop. If there is a problem with a vendor not completing a job or doing it satisfactorily, the Project will hire another vendor to complete the work. This is at no cost to the landowner. Roughly 80% of all the expenses are covered by the project. The landowners only expense is site preparation, which runs from $35 - $50 per acre.

The land that is being used is CRP land. The landowner does not receive double income from the land because the crop is not harvested until after the CRP status expires. Several landowners have been able to get 5 year CRP extensions and have poplar planted on their land through Project funding.

4) Cropping System

The best plantations were planted on drier land, and hand planted in 8' X 8' spacing which allows for cross cultivating. This also requires fall site prep and the cuttings are planted in the same manner as willow. Cross cultivating and herbicide applications are performed as needed. Plots that were machine planted had more weed problems. The machines did not plant produce spacing consistent enough to allow cross cultivation. DNR and/or RC&D personnel visit each site once a week during establishment. Measurements are taken regularly and submitted to Don Remienschnieder at US Forest Service, who has designed data analyses model to estimate clonal specific yields.

5) Problems

Wet spring prevented early access and weed control at several sites. Some were completely replanted and others were interplanted.

Canada Thistle is a serious problem in the area. Aggressive control with cultivation is necessary. In addition to maintaining the poplar crop, Canada Thistle must be controlled to the satisfaction of the county weed inspector.

6) Market

This project was originally designed to provide wood to the power industry. Whole Tree Technology was planning to put in a 100% wood burning 100 MW electric plant but it did not happen. Northern States Power Company put in 200 acres of poplar but after a change in management they moved out of the project. This left the project with no power buyers.

However the DNR Forestry Office did a study that showed the native supply of aspen would soon become very sparse because of a lack of mature trees. This prompted the pulp and paper industry to become involved in the project. Champion has purchased several thousand acres of land specifically for the planting of poplar. Potlatch and Boise have also become involved by co-funding the clonal research being done by the US Forest Service.

7) Recommendations for Phase II of Salix Consortium's Biomass for Rural Development Project.

Use USDA's EPIC model to track willow yields by soil type, erosion information etc. This program interfaces well with other programs. It's only drawback is that it is designed for annual crops.

Use NRCS data on soil erosion by cropping practice as a basis and measure deviation from that to prove the environmental benefits of willow. Keep environmental groups informed about the project.

Select landowner and farmer participants very carefully. Use local agricultural and conservation staff to find the most successful and disciplined farmers. Site selection is important to avoid crop failure due to lack of weed control on wet sites.

8) Contacts

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