BIOMASS POWER FOR RURAL DEVELOPMENT

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European Trip Report

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 SO₂ 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 CO₂. Therefore, substituting biomass for coal can also reduce CO₂ 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
<u>Design Reports</u>		
Greenidge -	February 1997	Delivered
Dunkirk -	July 1997	2 nd Qtr 1998
<u>Fuel Supply & Site Development Plans</u>		
Greenidge -	January 1997	Delivered
Dunkirk -	July 1997	2 nd Qtr 1998

2.0 PROGRESS SUMMARY

During the fourth quarter of 1997 the Consortium submitted a Phase-II proposal. A few of the other more important milestones are outlined below. The first quarter of 1998 will be dominated by pre-planting activity in the spring.

Fuel Supply Development

- Visit to CAMECO facility initiates new relationship with manufacturer of heavy farm equipment
- Production of willow cuttings for spring planting continues

Power Conversion Technology Development

- Initial co-firing tests conducted at Dunkirk Steam Station
- New interest in project by product developers of an advanced grinding process

Enterprise Development & Outreach

- Trips to Europe by Consortium members allow for technology transfer and building of new relationships with equipment suppliers.
-

- Several articles, meetings, and presentations by Consortium members this quarter increase local interest in the project

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.

During this reporting period, NMPC completed preliminary co-firing tests in one corner of one of Dunkirk's boilers. The tests were very encouraging and NMPC is proceeding with plans to complete the system design. The primary purpose of the tests were to demonstrate the feasibility of co-firing at the test and collect some preliminary emissions data. Full details of the test will be presented in the Design Report scheduled for release in the 2nd quarter of 1998.

3.2 Task 2. Fuel Supply and Site Development Plans

A fuel supply plan for Greenidge Station has been completed and

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

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.

submitted. 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.

3.3 Task 3. Major Equipment Guarantees and Project Risk Sharing

A visit was made to CAMECO Industries Inc. of Thibodaux, LA along with staff from ANTARES, Niagara Mohawk, and Cornell University. CAMECO is a manufacturer of heavy farm machinery and specializes in the production of cane harvesting equipment. Their technology is very similar to some of the equipment being used in Europe to harvest willow. The tour of their production facilities and a field visit to a sugar cane harvesting, handling, and processing plant were informative. Discussions were held with CAMECO about modifying a sugar cane harvester to harvest willow biomass crops. These discussions led to the inclusion of CAMECO in the Phase-II proposal effort. Discussions with other heavy equipment manufacturers are also ongoing.

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 letter of commitment similar to the letter from NYSEG will be included in the Phase II proposal.

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.

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

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. Sulfur dioxide reductions have

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.

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 be reached 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.

The Greenidge test system is fully operational on a single shift basis and there are no outstanding permit issues. NMPC is begun to evaluating 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

Willow and poplar cutting production continued in the SUNY ESF cutting orchards. Production is expected to be completed during January 1998. Areas planted during 1997 at Tully and Lafayette, NY, and Burlington, VT were coppiced. Biomass measurements for first year growth were completed in the clone site trial at Burlington and the genetic selection trial planted at Tully in cooperation with the USDA Forest Service, Rhineland, WI.

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.

All physiological measurements were completed in the genetic selection trial established during 1997 at Tully, NY in cooperation with the USDA Forest Service in Rhineland, WI. Hybrid poplar clones were the first to shed leaves during fall 1997. The last clone to shed its leaves was a willow clone (S301), which held its leaves until late November. Leaf area and mass measurements completed during October and November 1997 fit well with the regression equations developed during summer 1997 for predicting leaf area from leaf mass measurements. End-of-season stem height, diameter, and biomass were measured on the inner four trees of every plot. Trees were placed in a drying oven for moisture content determination.

A visit was made to Burlington, VT to examine the clone site trial established there during the spring of 1997. Burlington Electric's staff have done an excellent job of using mechanical weed control methods to maintain the trial. The one weed that has persisted, horsetail (*Equisetum arvense*) should only have a limited impact on the willows. A wide range of groups visited these research plots over the summer ranging from scientists, to policy makers, to the general public. The project has also received attention in the local press. While some deer - and moose on one occasion - damage has occurred, the willows have become well established. It is suspected that the relatively high water table at this site benefitted them.

The willows will be coppiced during November.

Machine planted fall tillage and no-till plots were compared to hand-planted fall tillage and no-till plots. First year results indicate that both willow and poplar biomass production was significantly greater on the fall site preparation compared to the no till treatment. There were no significant differences in biomass production between the hand planted and machine planted plots for either site preparation. Survival in all treatments for both willow and poplar was good, exceeding 90%. The only significant difference was for willow on the no-till plots. In this trial the machine planted plots had a greater survival then the hand-planted plots ($p = .097$). In both treatments survival was greater than 90%. These results suggest that the modifications to the planting machine did improve machine performance. Efforts are underway to further improve the efficiency of the planting machine while maintaining its effectiveness.

Preliminary results from this trial further reinforce the necessity of good weed control during establishment. Clearly, these biomass crops do not compete well with weeds during establishment and production is significantly reduced. The poor success of the no-till treatment suggests that different techniques will have to be used if this approach is going to be successful on old fields. No-till approaches are particularly difficult to apply in old fields where the population of perennial weeds is very high making them difficult to control once the willow is planted. Several additional recommendations can be made based on this trial and previous experiences. For example, herbicides need to be applied earlier in the summer in order to more effectively kill established vegetation, especially in fields where there is a heavy population of perennial weeds. An early application of herbicides also provides an opportunity for additional weed control if necessary. Additionally, the use of cover crops after fall site preparation or waiting until spring to plow and disk a site is recommended.

A decision was made to eliminate the current clone site and demonstration areas at Wolcott, NY. Mortality at this site was high because of severe weed competition. An adjacent field will be planted in 1998. Final survival and height data were collected from the clone site-trial at Wolcott. Survival averaged 49.3%, and ranged from 69.6(S19) to 28.7%(PUR34).

Site preparation was completed on sites near Tully (1 ha) and Lafayette (2 ha), NY for planting in spring 1998. Site preparation continued for plantings at Wolcott, (2.4 ha), Sheridan (27 ha) and Leon, NY (15 ha). All sites will be disked immediately before planting in spring 1998 as per normal procedure. Weed control was completed where appropriate in the alternative site preparation study at Lafayette, NY.

Efforts continued to secure more land for willow bioenergy plantings. Site visits were completed with three landowners in western New York (approximately 80 ha total) and one landowner in central New York (8 ha). Suitable sites will be prepared during summer 1998 and planted in spring 1999. Contract negotiations are currently ongoing. Early snow caused two other site visits in central New York to be postponed.

Willow breeding plans for January 1998 were completed. Intraspecific F1 hybrids will be produced using native willows collected during 1995 from across New York and Pennsylvania. Parents were selected based on stem diameter, height, and stem number measurements completed during November 1997 in the native willow cutting orchard at Tully, NY. Eight male and eight female parents will be mated using an incomplete diallel design for a total of 40 crosses. A visit was made to the New York Department of Environmental Conservation Saratoga Tree Nursery where an additional 18,000+ willow cuttings were planted this spring. Survival is acceptable but growth was generally poor due to the drought in late July and early August. By this time some of the surrounding willow had grown tall enough so that it was interfering with the irrigation system. Steps are being taken to resolve this problem by increasing the height of the risers from 30cm to 175cm. An agreement was reached with the Saratoga Tree Nursery to renovate their freezer to accommodate year round storage of cuttings. Work has been initiated to modify the cooling system so that the building can be divided to accommodate both tree seedlings in the spring (which are held at about 5°C) and cuttings which are held at about -2°C ± 1°C.

Statistical analyses continued on 1996 foliar tissue samples for the fertilizer rate studies imposed over the willow clone-site trials at Tully, King Ferry, and Somerset, NY. Foliage samples collected in 1997 were weighed for whole-tree foliar biomass estimation and are being prepared for tissue nutrient analyses. Laboratory analyses of 1995 soil samples was nearly completed. Soil samples will be taken during the early part of November from the Tully, King Ferry, and Somerset sites.

Results from the biosolids research on nitrate and ammonium leaching assessed by ion exchange resins in the greenhouse and in the field were presented at the annual conference of the Soil Science Society of America in Anaheim, CA. Data analyses and interpretation continued on the field aspect of the study. The amount of nitrate leaching from poultry manure compost plots was less than from lime-stabilized biosolid plots, and the release from poultry manure was steady through the growing season. Nitrate leaching from lime-stabilized manure was rapid and most leaching occurred early in the growing season. In general, the leaching data had high variability suggesting that the number of samples should be increased.

Data analyses continued on the insect feeding preference studies completed on willows growing at Tully during summer 1997. Feeding preferences of seven common defoliating insects were tested on twenty five willow and poplar clones. Willow clones S185, SV1 and S25 were the clones most preferred by insects. Poplar clones NM6, NE299, NM5, Wis5 and willow clones SH3 were the least preferred clones.

Regression equations were developed to predict leaf area based on leaf mass measurements in the genetic selection trial. These regression equations had R^2 values from 0.75 to 0.98 suggesting that leaf area can be reliably predicted based on leaf mass measurements. These equations will be tested during the 1998 growing season.

Biomass harvest was completed in the clone-site trial at Massena. Stems were four years old on five year old root systems. A four-year harvest cycle was used because first- and second-year growth was severely damaged by deer, but trees grew above the browse line during their third growing season (1996). Samples were collected for wood moisture content determination and placed in a drying oven. Biomass production will be calculated after sample dry weights are obtained. All trees were stacked in an accessible location to facilitate chipping at a later date. Harvest at the Tully field station and cutting production was initiated. Large rocks were removed from the demonstration farm at Lafayette, NY. Willow cutting production began in the Tully cutting orchards.

Modifications of SUNY ESF's planters continued during this quarter. The packing wheels were modified to operate closer to the discharge tube. Preliminary results indicate that moving the packing wheel location improved cutting positioning. Video tape comparisons of original and new packing wheel location showed an improved cutting stand in heavy soil conditions. In loose soil the new packing wheel frame interfered with cuttings. Additional packing wheel arrangements are under review.

The existing planter's spacing indicator is a modified packing wheel with an adjustable striker bell system. The packing wheel has a 36-inch circumference and timing settings are limited to 12-, 18- and 36-inch increments. Tests indicate that soil tends to clog the wheel and make the bell inaudible above the tractor noise. A new independent sensor wheel will be mounted between the operators and will have a spacing timing of 12 or 24 inches. The bell will be made louder and re-located closer to the operators.

Interest was expressed for utilizing willow as a visual screen at a gravel quarry in eastern New York. However, this site was deemed as unsuitable for willow growth because of excessively wet site conditions. Building the area up with a berm was not a viable option. SUNY ESF will continue to investigate the possible use of willow for this sort of application if a suitable site can be located.

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.

A presentation "Willow Energy Crop Development" was made to the EPRI Biomass Committee on October 16. This meeting provided a forum to meet with individuals from GPU-Pennsylvania who are interested in establishing willow clone-site trials. Another meeting was held with staff from FETC to discuss the transfer of three-year-old harvested willow this fall for extended firing tests. Results from the initial short duration tests done at FETC indicate that willow is a favorable fuel for co-firing.

Salix Consortium members met on October 28th to discuss plans for the next five years. The current deregulation of utilities in the state has created additional challenges for the Consortium but creative solutions were explored to resolve them. Progress reports were presented to USDOE staff on October 29th.

A meeting of the Salix Consortium was hosted in Syracuse on December 5th to finalize details of the phase II proposal for the USDOE Biomass Power for Rural Development Program. Staff from SUNY ESF, NMPC, NYSERDA, ANTARES, Cornell University Dept. of Agricultural and Biological Engineering, South Central NY RC&D, and FORECON participated.

Staff from SUNY ESF and South Central NY RC&D met with staff from Natural Resources Conservation Service (NRCS) and the Farm Services Agency (FSA) to discuss the possibility of including willow biomass crops as an acceptable practice on Conservation Reserve Program lands. The tone was very positive and the decision was made to submit a proposal to submit to the statewide review committee in late January. It is possible that the proposal could be accepted in time to include some of the land being secured for 1999 planting.

Two formal presentations were made during the month. Russ Briggs and Hector Adigbidi gave a presentation called "Biosolids, Bioenergy, & Willow: Closing the Loop" at the NorthEast Committee for Biosolids (NEC 100) meeting in Syracuse, NY. The second presentation was "Screening Willow and Poplar Biomass Production Clones for Resistance to Insect Pests" by E. Nordmam, D.J. Robison, and L.P. Abrahamson at the Entomological Society of America meeting, Nashville, TN.

Owners of Mesa Reduction Engineering and Processing Inc. visited SUNY ESF's research and demonstration plots at Tully, NY. The company developed a grinding machine that has effectively reduced willow chips to less than a 1/4" diameter. There is interest in using whole stem willow harvested in November 1996 in some trials with the grinding machine.

Two presentations about the willow biomass program were made to classes at SUNY ESF. The presentations included a classroom lecture and a tour of the research plots at Tully, NY. A group of high school students from Baldwinsville, NY toured the research station at Tully to learn about willow biomass crops. They were enthusiastic and asked many good questions about the production system and the environmental benefits. Two posters on the willow biomass program were presented at the "Adirondacks and Beyond: Understanding Air Quality and Ecosystem Relationships" conference on November 12-13. An article entitled "Commercialization and Scale Up of Willow Biomass for Renewable Energy" was published in the November issue of the New York Forest Owner magazine.

Slides and materials on the willow biomass program were supplied to a cooperator in Pennsylvania. The material was used for presentations to Council of Industrial Boiler Owners (CIBO) in Washington, DC, and the Pennsylvania Farm Bureau.

Response was favorable and plans are being drawn up to make a more formal presentation to the Pennsylvania Farm Bureau early in 1998 and discuss approaches to moving the program ahead in Pennsylvania.

Trips were made to the UK, Denmark, and Sweden to review willow biomass projects. A wide range of sites were visited including farmer cooperatives, individual producers, research institutions, and commercial willow and power production operations. A wealth of knowledge was gained, ranging from practical tips for improving the production system to ideas on how to advance commercialization of the crop. Discussions were held to establish working relationships with a number of the operations in the areas of genetics, equipment, technical expertise, and research programs. A trip report documenting these events is included in the Appendix.

The POLYSYS Data Review Workshop was held on November 19. A information packet was produced that contained information on:

- energy crop current and projected yields by state
- land base suitable for energy crop production by state
- management practices assumed for energy crop production
- selected examples of estimated energy crop production costs and harvest costs

Several articles and news letters contributed to by Consortium members have been included in the Appendix. This form of outreach continues to generate a larger amount of community interest in the project.

APPENDIX A

ARTICLES

Reprints removed

APPENDIX B

EUROPEAN TRIP REPORT

International Assignment Executive Summary
Phil Metzger, Project Coordinator, USDA – NRCS/South Central NY RC&D Project
Biomass Research Europe Trip

Section A

I traveled throughout Europe on November 8-21, 1997, with SUNY College of Environmental Science & Forestry Researcher Tim Volk, to the countries of Northern Ireland, England, Denmark and Sweden. We conducted research, information gathering and established contacts with numerous individuals and institutions utilizing willow shrubs (*Salix*) as a conservation crop and who are pursuing rural development opportunities through the production and use of *Salix*. Potential enterprises and uses include: *Salix* as a cash crop (bio-fuels - burning for energy production, chipboard manufacturing, pulp – paper production, cuttings production, clone production, custom planting and harvesting); as a filter for municipal bio-solids and wastewater and as a filter for non-point source agricultural runoff; in critical area treatment plantings and steep bank stabilization; as an environmentally beneficial fuel in energy production (willow is CO₂ neutral and reduces sulfur output and possibly NO₂ which is produced when burning coal).

Section B

While in Europe we met with numerous researchers, private entrepreneurs, farmers and related business people. The content of these visits included:

Rural Development Opportunities / Waste Water – Bio-solid Use / Entrepreneurial Pursuits:

Northern Ireland - Met up with host Murray Carter, Ingerthorpe Hall Farm, North Yorkshire, England who accompanied us to John Gilliland's farm, Brook Hall Estate, Londonderry, No. Ireland. John produces enough willow and forestry residues to operate a 200 kw gasifier, which supplies enough electricity to operate his farm. *England* - Visited Murray Carter's Farm to look at willow plantations and a modern Step planter. Met with Barbara Hilton, Arbre Energy Ltd., Leeds and visited 2 site plantings. *Denmark* - Visited Johannes Falk Farm, Hvidsted Energy Forest in Taars, to look at willow plantations, a modified Step planter and a wet condition harvester. Discussed alternate planting and harvesting methods and alternate uses of willow including willow mats for wet roads, visual/aesthetic screens, bio-filters, etc. *Sweden* - Met Nils-Erik Nordh, Dept. of Short Rotation Forestry, Swedish University of Agricultural Sciences in Uppsala, who took us to Kolbach to visit a farmer owned heating plant that sells heat to their local village. Also visited a large willow clone site planting, the Lundy Farm which grows willow cuttings and willow as a cash crop. Toured a large power plant in Enköping, which is fueled 100% by willow, forestry residues and waste wood. Visited *Salix Makiner*, an entrepreneurial company in Hedemora that makes the new Bender harvester; met with Mats Wilstrand, President and Rodolfo Lindqvist, Marketing Director. Also met with the Mayor of Hedemora who is attempting to model his city as environmentally progressive, while assisting the local economy by adding value to locally grown willow by utilizing it in their hometown power plant which is 100% wood fueled. Participated in an interview with local paper about our visit to Sweden and Hedemora.

Willow Production Systems: *Northern Ireland* - Met with Malcolm Dawson, N. I. Horticulture and Plant Breeding Station in Loughall, who conducts research on breeding improved clones of willow and hybrid poplar. *England* - Visited Long Ashton Research Station (LARS) in Bristol to meet with Dr. David Royale and his staff of researchers including Kevin Lindegaard and David Clay. Viewed largest native willow plantation in existence that included many American

species, improved clone and variety plantings, related insect pests and diseases and a functional small-scale gasifier. *Sweden* - Visited Svalof Weibull, in Svalof, a private grain and willow breeding company and met with Dr. Stig Larsson and Inga Ahman to discuss clone development and breeding work. Met with Lisa ? and Stig Ledin of Swedish University Ag Sciences to discuss ongoing works at the University. Visited University Department Chairman Lars Christersson and his PhD research students including Nils-Erik Nordh and Lars Bollmark.

Conservation Uses / Farmer Cooperatives: *England* – Met with Director of LARS low input sustainable research farm which is doing studies on using willow as a (harvestable) buffer crop in large crop fields. They are looking at benefits of sheltering beneficial insects, plant transpiration reduction, wind erosion reduction, etc. *Denmark* - Discussed Denmark's policies and J. Falk's use of locally produced wastewater and bio-solids on willow plantations. *Sweden* - Visited Gustav Melin and Goran Berggren of Agrobransle, a large farmer's cooperative in Orebro which recruits farmers to grow willow, plants willow, purchases willow and hires custom harvesters to supply willow fuel to regional power plants. Looked at the common practice of utilizing bio-solids and wastewater to fertilize willow plantations in Sweden.

Section C

The immediate benefits to U.S. agriculture, NRCS and cooperating countries was the opportunity to share information and data in a new and potentially beneficial (environmentally and economically) field of agriculture, willow production. The U.S. involvement in willow production is in its infancy with less than 50 acres in production. Plans to increase this over the next few years to 500 acres in Upstate NY are in place. Sweden on the other hand has willow planted throughout the landscape since it being touted is a major energy crop to be used in their plan to shut down all nuclear power plants. They will shut down their first of twelve nuclear plants in 1998.

There is much to learn from the Swedish experience as well as from the UK and Denmark in the production and usage of Salix. It was also quite evident from our discussions with the Europeans that there is a great deal of interest on their part in what the U.S. plans are. There is a great deal of respect for U.S. agriculture and they would like to encourage cooperation for the mutual benefit of all concerned.

Opportunities for benefiting U.S. agriculture include:

<u>Conservation</u> -	Controlling wind erosion with harvestable willow plantings.
Controlling water induced erosion with harvestable Salix plantings.
Improving water quality through the use of harvestable willow buffers.
Improving and increasing wildlife habitat through Salix plantings.
Wet roads "live" travel mats made of willow cuttings.
<u>Environmental</u> -	Treating municipal bio-solids on agricultural land with willow plantings.
Treating municipal wastewater on agricultural land with Salix plantings.
Treating non-point source agricultural runoff with willow filters.
Treating private point source wastewater with Salix filters.
Air quality improvements - reduction in CO ₂ , sulfur and possibly NO ₂ .
<u>Alternate Crop</u> -	Willow production as a cash crop for energy.
Use as "harvestable" conservation use crop unlike many current choices.

Potential as value added energy crop (farmer owned heating plants).
Cash crop with multiple uses (energy, heat, pulp, chipboard, etc.)

Personally and professionally I have gained an entirely new perspective on issues including:

- how government can more successfully work with private industry, farmer cooperatives and entrepreneurial individuals;
- the wide variety of potential commercial uses of willow;
- the many uses of Salix as a conservation crop;
- the many uses of willow as an environmental filter for municipal and private waste;
- the rural development opportunities available in value adding to Salix through local or regional heating plant operation;
- the potential buy in by industry and government institutions to using Salix.

Section D

Many of the individuals we met with expressed the desire to maintain and strengthen their relationship with our project. They were unending in their desire for information on what we were going to do next and how could they fit into our plans. Some of this desire was commercial in nature (wanting to sell planters/harvesters, improved willow clones, consulting services, etc) but most of it was professional in nature. There was acknowledgment that U.S. agriculture has a lot to offer in that it is progressive and highly competitive.

Tim Volk and I will first make a full presentation to our key partners in the Biomass for Energy Project. We will then make presentations to SUNY College of ESF and the South Central New York Resource Conservation & Development Council at their Annual Meeting in March. Prior to that we will make a presentation to the SoCNY RC&D Forestry Committee at their next bi-monthly meeting. I will be making consolidated presentations to member county Soil & Water Conservation Districts at their monthly Director meetings over the next year. In addition, we will advertise the fact that we are available to speak at any and all public functions to relate our experiences on what Europe is doing with Salix as it relates to conservation and rural development. I will focus particular attention on efforts to use Salix as a conservation crop, the activities of entrepreneurial farmers and value adding, as well as local rural development opportunities available to rural communities.

Perhaps the most important follow-up activity will be to maintain contact and a working relationship with the many people we met throughout Europe. There was much insistence on their part that we need to begin working together on Salix production and utilization for the mutual benefit of all our rural communities and the global environment.

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