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BIOMASS POWER FOR RURAL DEVELOPMENT

TECHNICAL PROGRESS REPORT

Contractual Reporting Period
January 1 - March 31, 1997

PREPARED FOR THE UNITED STATES DEPARTMENT OF ENERGY

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with Salix Consortium Members:
New York State Electric and Gas (NYSEG)
Burlington Electric Department (BED)
General Public Utilities (GPU)
Ontario Hydro Technologies (OHT)
State University of New York College of Environmental Science and Forestry (SUNY ESF)
Cornell University College of Agriculture & Life Sciences
University of Toronto
Empire State Electric Energy Research Corporation (ESEERCO)
New York Gas Group (NYGAS)
South Central New York RC&D
New York State Energy Research and Development Authority (NYSERDA)
Gas Research Institute (GRI)

August 1997

DISCLAIMER

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1.0 INTRODUCTION

Developing commercial energy crops for power generation by the year 2000 is the focus of the DOE/USDA sponsored Biomass Power for Rural Development project. 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 under way. 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. Willow is well suited to the climate of the Northeastern United States, and initial field trials have demonstrated that the yields required for the success of the project 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 the goals of this project 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 generator of CO_2. Therefore, substituting biomass for coal can also reduce CO_2 emissions. Although reducing greenhouse gases is being pursued by utilities on a voluntary basis, 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, the participation of Burlington Electric 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. Initial plans in Burlington 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.

- 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 97	August 1997
Dunkirk -	July 97	November 1997
Fuel Supply & Site Development Plans		
Greenidge -	January 97	August 1997
Dunkirk -	July 97	October 1997
Risk Management Report -	July 97	August 1997
Optimization and Experimental Plan -	July 1997	August 97

2.0 PROGRESS SUMMARY

Effort during the first quarter of 1997 has focused on continued feedstock development, fuel supply planning and contract development, and power plant testing. A few of the more important milestones are outlined below. Activity in the second and third quarter is expected to increase in preparation for the Spring plantings and the Phase-II effort.

Fuel Supply Development

- Several iterations of a proposal to involve entrepreneurial farmers in the scale-up program have been developed cooperatively with the staff at the South Central New York RC&D. An initial proposal was circulated to other Salix Consortium partners and discussed with selected farmers. Feedback on the proposal will be used to finalize contracts for Phase-II scale-up acreage. Non-binding letters of intent have been signed by a number of area farmers to commit to willow production in the Greenidge and Dunkirk areas. More formal negotiations of land contracts will be carried out this Summer to ensure adequate time for willow production site preparation.

- In December of 1996, cuttings of various willow clones were removed from freezers at Tully station, placed in alternate cooling facilities early in 1997, and tested for viability.

Twenty of the twenty-four clones had survival rates in excess of 90%, despite less than ideal storage conditions. Plans were made to construct a more suitable storage facility for the Phase-II effort.

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

- Laboratory and nutrient analyses of foliage and stem samples continued during the first quarter.

- Plans were made to expand and improve the irrigation system at Tully so that the cutting orchards established in 1997 can be irrigated.

- Weed control and pest monitoring continued at the BED test plot during the first quarter. Planting of this plot is expected in the Spring of '97.

- GPU and the Pennsylvania DNR are discussing potential acreage development with Lafayette College in the northeastern part of the state.

Power Conversion Technology Development

- 25.5 tons of willow harvested in the fall of 1996 was chipped and distributed to key Consortium members (BED, NYSEG, NMPC) and the Federal Energy Technology Center for Phase-I testing. Early in the second quarter, NYSEG expects to run a test of installed biomass handling equipment at Greenidge using several tons of the material and conduct a limited test burn. FETC expects to test the material in the second or third quarter of 1997.

- NYSEG continues to monitor and evaluate its single shift cofiring operations to identify and resolve any handling and combustion problems prior to Phase II scale-up.

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*

3.0 DETAILED TASK PROGRESS REPORTS

3.1 Task 1. Design Packages

NYSEG continues to evaluate potential improvements in the design for the retrofit at Greenidge Station. Testing and tuning of the system is providing the experience needed by NYSEG production staff to refine the design. Cost estimates for additional storage and handling capacity have been prepared and are being evaluated.

The test system was completed by September 11, 1996, and test co-firing at a rate equivalent to a heat input of 10% has been underway for seven months. The test system has been successfully operated at 5 to 7 MWe biomass power output. In the second quarter of 1997, NYSEG expects to test the handling equipment using approximately 15 tons of available willow. The results of this test will be important in determining and sizing the equipment necessary for efficient handling of the material.

NMPC completed a conceptual assessment of cofiring for the Dunkirk Steam Station in 1996. NMPC's engineering staff has selected burners and determined burner locations for initial operational tests using sawdust. These tests are expected to occur in the second or third quarter.

Under a separate contract BED is nearing completion of its gasification facilities. GPU is continuing to evaluate its test system at Seward prior to designing a permanent cofiring facility.

3.2 Task 2. Fuel Supply and Site Development Plans

The fuel requirements for the targeted biomass co-firing levels (5-15% on a heat input basis) at Greenidge and Dunkirk will require that a mixture of biomass residues and willow feedstock be obtained. To that end, non-binding letters of intent have been signed by a number of area farmers offering over 2,600 acres to willow production in the Greenidge and Dunkirk areas. In addition the utilities have identified company land suitable for willow development. As the local communities learn about the project, inquiries about participation in the project are being fielded by the Consortium With the intent of letting the first contracts in the second or third quarter.

A draft fuel supply plan is being prepared by

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.

SUNY ESF for NYSEG. NYSEG is targeting using willow for approximately 30% of the biomass co-firing requirements in the Greenidge Station boiler by the end of Phase-II.

A partial harvest has been taken at the willow trial site in Tully, NY. On March 13, 1997, NYSEG contracted for chipping harvested willow stems for fuel testing and characterization at the Greenidge Power Station. Some material will be sent to FETC for additional co-firing tests and ash tests in cooperation with Sandia National Laboratories.

Field trials of willow have also been proceeding. Thirty acres of willow have already been planted, and new sites are to be added in the second quarter of 1997 near La Fayette, NY, Wolcott, NY, and Burlington, VT. As these field trials progress, questions about potential yields and clone selection should be answered for the demonstration phase.

Development of native willow test plots is on schedule. Native willows and SV1 seedlings were planted in a green house under intermittent mist. Initial rooting percentages were better than 95% for most clones. These plants will be cultivated in Tully during the Spring of '97. Plans were also made to improve the irrigation system at Tully so that the new orchards can be irrigated.

The Consortium is setting aside willow for gasification trials at BED in fall of 1997. Initial plans include a 5-10 hour test using a biomass residue and willow blend as the feedstock.

Major Equipment Guarantees and Project Risk Sharing Statement of Work

A plan and substantiating documentation should be provided which indicates process and equipment guarantees for planters, harvesters, fuel processors, and fuel preparation and feed systems. Furthermore, the plan should address how each party associated with the project will assume or share the risks of the project.

3.3 Task 3. Major Equipment Guarantees and Project Risk Sharing

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

3.4 Task 4. Power Production Commitment

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.

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.

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. 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.

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.

A decision about permanent facilities for GPU is not likely to be in Phase I. GPU will need more time to evaluate the long term fuel supply situation and the performance of the test system at Seward.

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

The crop development studies initiated during the past reporting period are still underway. Preliminary results are expected in the second or third quarter of 1997. The studies include: a comparative site preparation study, a comparative soil amendment and fertilizer study, a characterization of willow resistance to insects, monitoring soil carbon in willow, a biological characterization of first-year willow growth, and a riparian areas initiative.

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.

On March 3rd in Utica, NY a meeting was held to discuss the possibilities of focusing a new project on the application of biosolids to willow biomass crops. The goals would be to test the environmental safety of the application, make use of an existing waste stream, and lower the production costs for willow by substituting chemical fertilizers with an organic nutrient source.

On March 25 a meeting was held at SUNY ESF with personnel from the Consortium and Dale Baker of Case International. The discussion focused on developing a cooperative agreement with Case to test their woody biomass crop harvester in Salix Consortium plantings. Case International now produces the modified sugar cane harvester for willow production in Europe. The meeting was very positive and follow-up discussions will be conducted to make the final arrangements for the Phase II demonstration.

Power system optimization studies at Greenidge power station are well underway. The fuel delivery/processing system is operational, options regarding biomass drying have been addressed, the first system tests have been performed, and storage plans are being developed. In addition, combustion tests at the Federal Energy Technology Center (FETC), Pittsburgh, on waste wood are complete and combustion tests for willow are anticipated late in the next quarter.

3.7 Outreach, Extension, & Technology Transfer

Numerous outreach, extension, and technology transfer events have also occurred during the first quarter. A highlight of these events has been provided below. Presentation materials, and newspaper articles have been included as part of the Appendix.

- An educational display for the willow biomass program was completed in mid-January and displayed at the New York Corn Congress meetings in three locations across the state.

- SoCNY RC&D has been instrumental in working closely with its farm and landowner community to evaluate prospects for the energy crop and determine equitable terms and conditions for contracting with landowners or farmers for willow production. They are actively serving as liaison with the Sullivan trail RC&D and other agricultural organizations in the region.

- SUNY ESF presented information on the willow cropping system to a meeting of the NY State Ag-Business Council.

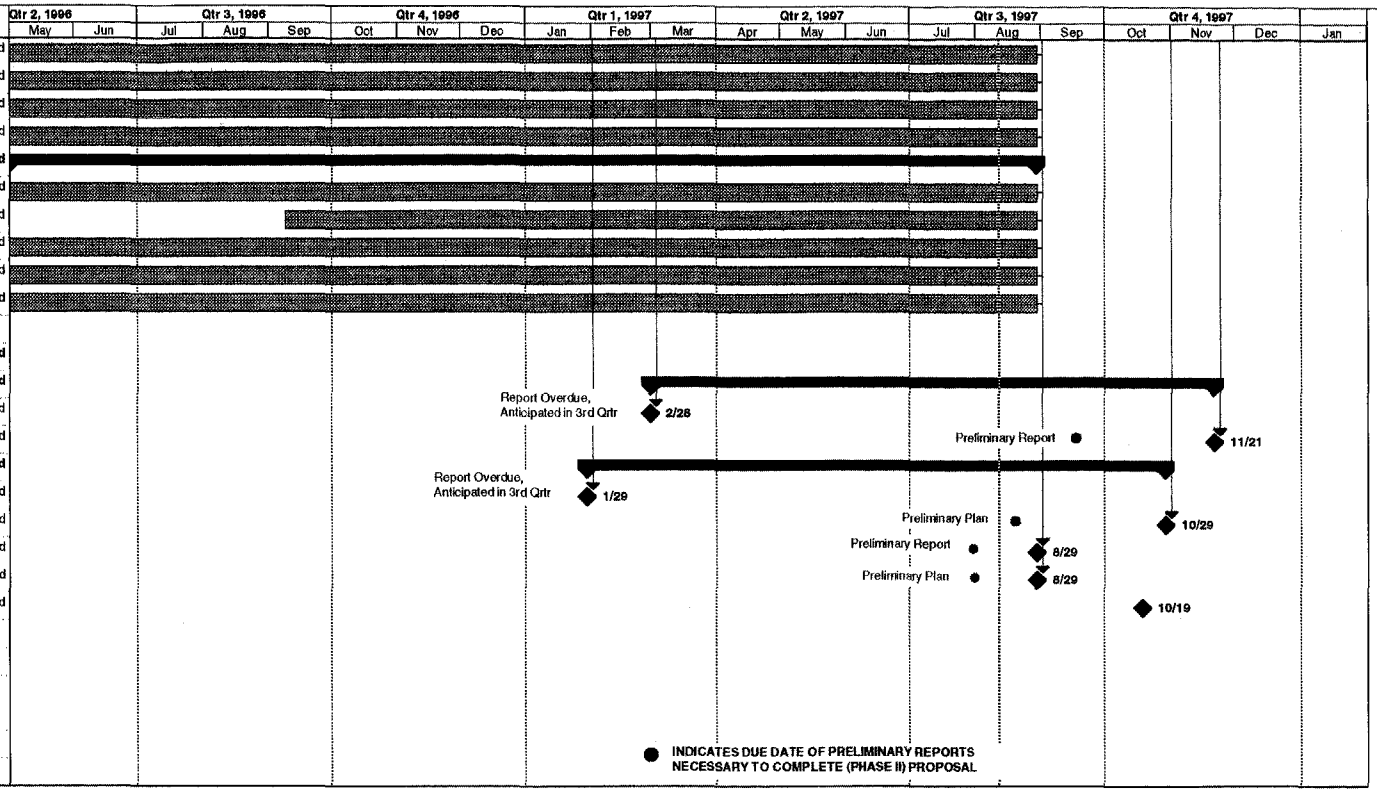
- Over 200 people gathered to learn about the willow biomass program a the Lake Ontario Regional Grape Growers Conference on February 14th. The presentations went very well and generated a lot of interest in willow production project time lines, risks, and long term potential.

APPENDIX A

PROJECT SCHEDULE

BIOPOWER FOR RURAL DEVELOPMENT
SALIX CONSORTIUM
SCHEDULE OF WORK & DELIVERABLES

ID	Task Name	Duration
45	Evaluate Planting, Cutback, Weed Control	348d
46	Study Harvesting Equipment/Processes	348d
47	Monitor Soil Nutrient, Carbon Sequestration	348d
48	Study Clone-Sites for Improved Productivity	348d
49	**Power**	**348d**
50	Evaluate Ash Composition	348d
51	Evaluate Economics	255d
52	Study Fuel Preparation	348d
53	Conduct Combustion Tests	348d
54	Study Advance Conversion Technologies	348d
55		
56	**DELIVERABLE Schedule**	**212d**
57	**Task 1 & 5 (Design Reports)**	**190d**
58	Greenidge	0d
59	Dunkirk	0d
60	**Task 2 (Fuel Supply Plan)**	**195d**
61	Greenidge	0d
62	Dunkirk	0d
63	**Task 3 & 4 (Risk Management Report)**	0d
64	**Task 6 (System Optimization/Experimental Studies Plan)**	0d
65	**PHASE II Proposal**	0d



Project:
Date: 8/12/97

Task | Milestone | Rolled Up Task | Rolled Up Progress
Progress | Summary | Rolled Up Milestone

BIOPOWER FOR RURAL DEVELOPMENT
SALIX CONSORTIUM
SCHEDULE OF WORK & DELIVERABLES

ID	Task Name	Duration
1	**Design Packages (Work Schedules)**	438d
2	**Task 1 Schedule**	408d
3	**Greenidge**	218d
4	**Engineering Design Package**	158d
5	Preliminary Design	0d
6	Design Review	40d
7	Final Design / Optimization	118d
8	**Permit Modifications**	45d
9	**Cost Estimates**	30d
10	**Construction Bids and Orders**	30d
11	**Dunkirk**	190d
12	**Engineering Design Package**	160d
13	Preliminary Design	75d
14	Design Review	45d
15	Final Design / Optimization	40d
16	**Permits**	55d
17	**Cost Estimates**	20d
18	**Construction Bids and Orders**	10d
19	**Task 5 Schedule**	398d
20	**Greenidge**	206d
21	Site Plan	58d
22	Environmental/Project Monitoring Plan	88d
23	**Dunkirk**	100d
24	Site Plan	60d
25	Environmental/Project Monitoring Plan	60d
26		
27	**Fuel Supply Plan (Work Schedule)**	438d
28	**Task 2 Schedule**	438d
29	**Greenidge**	438d
30	Fuel Supply Plan	88d
31	Field Trials / Crop Development	438d
32	**Dunkirk**	200d
33	Fuel Supply Plan	88d
34	Field Trials / Crop Development	200d
35		
36	**Risk Management (Work Schedule)**	130d
37	**Task 3 & 4 Schedule**	130d
38	Develop Equipment/Process Guarantee Plan	90d
39	Develop Risk Distribution Plan	80d
40	Provide Letters of Intent for Power Production	30d
41		
42	**System Optimization (Work Schedule)**	348d
43	**Task 6**	348d
44	**Feedstock**	348d

Project:
Date: 8/12/97

Task
Progress
Milestone
Summary
Rolled Up Task
Rolled Up Milestone
Rolled Up Progress