Executive Summary: During this milestone period, the Energy & Environmental Research Center (EERC) completed Milestone 3, the process flow design of the system with mass and energy balances. Conversion of the microturbine from natural gas to biomass input reduces the overall efficiency to 19% higher heating value, with 150 kWth biomass input producing 28 kW output. The feed auger was repaired with ¼-inch-thick flighting and cold-solids flow testing recommended. Cold-solids flow testing was completed on corn, oak pellets, sunflower hulls, and cocoa hulls. Grass seed bridged in the feed system at the rotary valve. Additional modifications were made to minimize the potential for bridging at the rotary valve, and grass seed successfully flowed through the system. Cold-solids flow testing with 1-inch by ½-inch wood chips jammed at the hopper input to the rotary valve and damaged the hopper auger. This is currently being repaired, and the flighting was replaced with ¼-inch-thick flighting, similar to the feed auger. Two quotations for the high-temperature heat exchanger were received. A potential vendor has been selected, and the EERC is currently working with the vendor to optimize the heat exchanger design for the system. Overall, the project is on schedule. Milestone 3 was completed as per the Milestone and Payment Schedule. Work is ongoing on Milestones 4, 5, and 8. Project funding was provided by customers of Xcel Energy through a grant from the Renewable Development Fund.

Technical Progress: The process flow design for the system was completed. The system was designed to simulate current process temperature and flow conditions on the microturbine to make system modifications transparent to the current control system. The system design consists of the gasification system, including a feed system and ash extraction system, the microturbine system, a high-temperature heat exchanger, an additional blower, and an external combustor. The overall efficiency of the system is 19% higher heating value. The net output of the system is 28 kW electrical for 150 kWth biomass input. The feed auger was repaired with ¼-inch-thick flighting and cold-solids flow testing recommenced. Prior experience with moving packed-bed gasifiers indicates that the majority of problems requiring operator intervention were because of solids flow issues through the gasifier and feed system. Cold-solids flow testing was completed on corn, oak pellets, sunflower hulls, and cocoa hulls. Figure 1 shows the testing of the cocoa hulls through the simulated gasification reactor. Grass seed bridged in the feed system at the rotary valve. Figure 2 shows the bridging below the rotary valve. Additional modifications were made to minimize the potential for bridging at the rotary valve, and grass seed successfully flowed
through the system. Cold-solids flow testing with 1 inch by one-half inch wood chips jammed at the hopper input to the rotary valve and damaged the hopper auger. This is currently being repaired and the flighting replaced with \( \frac{1}{4} \)-inch-thick flighting, similar to the feed auger. The flighting is also being milled down by \( \frac{1}{8} \) inch to allow additional clearance at the hopper exit.

Two quotations for the high-temperature heat exchanger were received. A potential vendor has been selected, and the Energy & Environmental Research Center is currently working with the vendor to optimize the heat exchanger design for the system. Both the augur repair and the ordering of the high-temperature heat exchanger are expected to be completed next quarter. Cold-solids flow testing on wood chips, wood bark, and antelope coal is expected to be completed next quarter. Overall, the project is proceeding on schedule, with the third milestone completed per the Milestone and Payment Schedule. Work is ongoing for Milestones 4, 5, and 8.
Figure 2. Bridging of grass seed hulls in feed system.

Additional Milestones: Work is ongoing on Milestones 4, 5, and 8. Completion of Milestone 4, Gasifier Design, is on schedule to be completed in the next milestone reporting period as per the Milestone and Payment Schedule. Work has commenced early on Milestones 5 (Equipment Procurement) and 8 (Power System Construction). Milestone 7 (Microturbine Modification and Testing) has been put on hold until final decisions have been made on the heat exchanger and piping dimensions.

Project Status: The project is slightly ahead of schedule and on budget.
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