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**BIOMASS-TO-ETHANOL  
TOTAL ENERGY CYCLE ANALYSIS**

**Prepared for:**

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## EXECUTIVE SUMMARY

Radian Corporation, under contract to National Renewable Energy Laboratory, has conducted a Total Energy Cycle Analysis for a waste-fired steam boiler. The boiler produces high pressure steam to drive a turbogenerator for the production of electrical energy for export and extraction steam for use in a Biomass-to-Ethanol Process. The energy cycle consists of a fluidized bed boiler, a slurry waste stream dryer, a turbogenerator, and boiler feedwater and make-up water treatment systems. Six cases were investigated having installed capital costs that range from \$43.95 million to \$58.17 million. Annual operating costs vary from \$12.60 million to \$16.73 million. Electrical power generation from the process has a minimum output of 15.90 MW for Case 6 and a maximum of 36.49 MW for Case 1. Extraction steam for the process is provided at a rate of 43,100 pounds per hour after pressure of 50 psig and between 155,400 and 172,000 pounds per hour at 150 psig pressure. The value of the energy produced ranges from \$11.063 million to \$18.991 million. Estimated emissions of SO<sub>2</sub>, CO, NO<sub>x</sub>, and VOC from the process may require additional air pollution control, based on the 1990 Clean Air Act Amendments.