Adapting On-site Electrical Generation Platforms for Producer Gas

Integrating gasifiers and reciprocating engine generators to utilize biomass-based fuel

This project will integrate a biomass gasifier and a reciprocating engine generator set into a combined platform, enabling electricity generation from waste biomass while reducing diesel fuel consumption and greenhouse gas (GHG) emissions.

Introduction

Internal combustion reciprocating engine generators (gensets) are regularly deployed at distribution centers, small municipal utilities, and public institutions to provide on-site electricity generation.

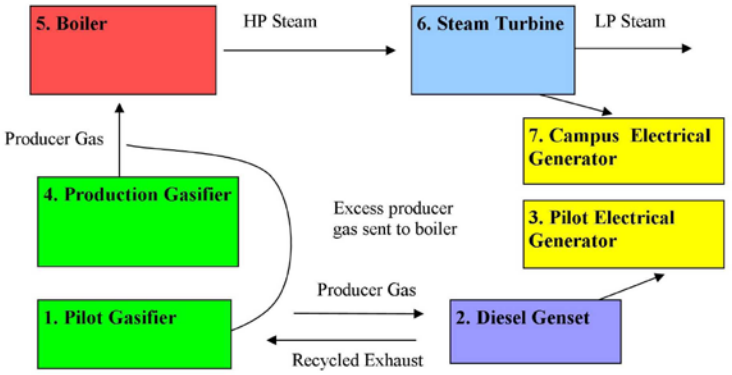
The diesel that fuels these gensets contributes a large portion of their total operating costs and also, as a fossil fuel, releases carbon dioxide (CO_2) during combustion.

Driven by a desire to reduce fuel costs and greenhouse gas (GHG) emissions, efforts are growing to utilize biomass-based fuels as alternatives to fossil fuels.

One of these alternative fuels, also known as opportunity fuels, is producer gas, created in a biomass gasifier and composed primarily of hydrogen (H), carbon monoxide (CO), CO_2, and nitrogen (N_2). The biomass is often diverted from agricultural, industrial, and municipal waste streams, and its use in gasification reduces waste disposal volumes and costs.

This project aims to integrate commercially available gasification systems and reciprocating engine gensets into a combined platform. Producer gas will displace most diesel fuel consumption using homogenous charge compression ignition (HCCI). A new compressor and cooling system dedicated to handling producer gas and its accompanying, damaging tar deposits will be designed and tested.

Exhaust from the engine will feed back into the gasifier to preheat biomass for gasification, decreasing emissions from unburned fuel and improving efficiency. The performance of the integrated system will be optimized and benchmarked for comparison against other alternatives for on-site electricity generation from biomass-based fuels, such as steam turbines.



Energy-flow schematic for use of a producer gas-powered genset.

Illustration courtesy of University of Minnesota Morris.

Benefits for Our Industry and Our Nation

Implementing combined gasifiers and reciprocating engine gensets, which together provide a renewable, high-efficiency, low-emissions source of electricity, will have major energy, economic, and environmental benefits, including the following:

- Reduction or avoidance of waste disposal fees
- Decrease in GHG emissions from the combustion of diesel fuel by substituting renewable fuel sources
- Utilization of inexpensive biomass fuels, a significant and largely untapped energy source
- Reduction in purchased electricity, and in some cases, revenue from sale of surplus electricity back to the grid

Applications in Our Nation's Industry

In its initial commercial deployment, this technology will be marketed toward retail distribution centers, small municipal utilities, and public institutions such as universities.

The ability to utilize biomass as a fuel source will also benefit industries that generate organic waste streams, such as food processing plants, pulp and paper factories, and large farms.

Project Description

The objective of this program is to optimize the integration of biomass gasification systems and internal combustion reciprocating engine gensets. The diesel engine will be fueled primarily by producer gas and data generated will be used to model operations using HCCI mode. The performance of the engine-generator will be compared to a boiler and steam turbine generator also operating on producer gas.

Barriers

- Establishing consistent chemical specifications for the variable producer gas created from biomass gasification
- Adapting existing, installed gensets for operation on producer gas

Pathways

The University of Minnesota, Morris will conduct research on fuelstock availability and cost measures for its purchase and sale. It will also design equipment for the cleaning and cooling of producer gas. The campus's biomass plant will be used as a testing site of the integrated system, and the university will create an economic analysis of the system's performance.

The University of Minnesota Center for Diesel Research will provide technical data and analysis related to fumigation and conversion to HCCI operation.

Cummins Power Generation Inc. will provide an 100 kW diesel genset modified for operation on producer gas, including a redesigned compressor for the gaseous fuel.

Milestones

- Characterization of producer gas quality
- Design of a turbocharged, low-Btu mixing system for fumigating diesel engine
- Development of HCCI control algorithms
- Development of a control scheme for integrated gasifier and genset
- Integration and analysis of the recirculation of exhaust gases into an underfed air supply or gasifier

Commercialization

Cummins Power Generation's experience in commercializing power generation equipment in worldwide markets will provide essential insight into deploying the new gasifier/genset technology.

The University of Minnesota, Morris designed, built, and now operates an $8.9 million state-of-the-art research and demonstration biomass gasification plant on its campus. The university will apply its experience in developing recommendations and guidelines for the effective adoption of on-site gasification and power generation.

Project Partners

University of Minnesota, Morris
Morris, MN
Principal Investigator: Lowell Rasmussen
E-mail: rasmuslc@morris.umn.edu

Cummins Power Generation Inc.
Minneapolis, MN

University of Minnesota Center for Diesel Research
Minneapolis, MN

For additional information, please contact

Bob Gemmer
Technology Manager
U.S. Department of Energy
Industrial Technologies Program
Phone: (202) 586-5885
E-mail: Bob.Gemmer@ee.doe.gov

U.S. DEPARTMENT OF ENERGY
Energy Efficiency & Renewable Energy

EERE Information Center
1-877-EERE-INFO (1-877-337-3463)
eere.energy.gov/informationcenter

DOE/EE-0478 • July 2011
Printed with a renewable-source ink on paper containing at least 50% wastepaper, including 10% post consumer waste.