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U.S. Department of  
Transportation



**SunGrant**  
*INITIATIVE*  
South Central Region



## Project Title: Optimizing a New Downdraft Gasification System for Synthesis Gas Production from Low Bulk Density Biomass Material

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#### Rationale

A unique biomass downdraft gasification design was developed at OSU. The new gasifier has the potential for heat and power applications and for generating high quality syngas which is the basic building block for generating chemicals and liquid fuels. One of the main requirements for the unique design was an ability to convert low bulk density feedstocks. In initial tests using wood pellets, a high density biomass, the laboratory-scale gasifier produced very good quality syngas with relatively high concentrations of CO and H<sub>2</sub>. The primary aim of this project was to test and evaluate the gasifier using low bulk density biomass materials like switchgrass, wheat straw and wood-based feedstocks which constitute the major biomass resource base in Oklahoma and South Central region. Once the gasifier is tested using low bulk density feedstocks, it will be demonstrated to potential industries in Oklahoma and South Central region to creating awareness about the fossil fuel saving potential.

#### Project Outcomes

- The main results for wood pellets gasification include tar cracking temperatures close to 1000<sup>0</sup>C; the average volumetric concentration levels of 20% CO and 13% H<sub>2</sub> in the gas, and hot and cold gas efficiencies of 78 and 64%, respectively.
- A series of research trials were conducted on low bulk density biomass materials including wood shavings, switchgrass and sweet sorghum bagasse. The maximum tar cracking temperatures exceeded 1100<sup>0</sup>C. Among all the low bulk density materials, switchgrass generated syngas with highest lower heating value of 1448 kcal/Nm<sup>3</sup> and 24% CO concentration level by volume. The tar content was 18 g/Nm<sup>3</sup>. Sweet sorghum showed syngas generation with lowest lower heating value of 1086 kcal/Nm<sup>3</sup> while the tar content in the gas was 58 g/Nm<sup>3</sup>.
- The hot and cold gas efficiencies for low bulk density biomass materials varied from 60 to 79%, and 52 to 72%, respectively.
- A gasifier design patent was generated: U.S. Patent 8,657,892 "Downdraft Gasifier with Internal Cyclonic Combustion Chamber" issued 02/25/2014.
- The gasifier system was successfully demonstrated to numerous companies. Unfortunately, the downturn of the economy prevented any of these companies to invest in this technology during the project duration. Technology update (January 2015): A license agreement has been established with a company intending to use this technology in a decentralized electricity generation system. A scaled-up version (60 kWe) is currently being fabricated at OSU with testing to



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