



# **Solar Thermal Conversion of Biomass to Synthesis Gas**

## **Cooperative Research and Development Final Report**

**CRADA Number: CRD-09-00335**

NREL Technical Contact: Judy Netter

**NREL is a national laboratory of the U.S. Department of Energy  
Office of Energy Efficiency & Renewable Energy  
Operated by the Alliance for Sustainable Energy, LLC.**

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at [www.nrel.gov/publications](http://www.nrel.gov/publications).

**CRADA Report**  
NREL/TP-7A10-57184  
August 2013

Contract No. DE-AC36-08GO28308

## NOTICE

This report was prepared as an account of work sponsored by an agency of the United States government. Neither the United States government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States government or any agency thereof.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at [www.nrel.gov/publications](http://www.nrel.gov/publications).

Available electronically at <http://www.osti.gov/bridge>

Available for a processing fee to U.S. Department of Energy and its contractors, in paper, from:

U.S. Department of Energy  
Office of Scientific and Technical Information  
P.O. Box 62  
Oak Ridge, TN 37831-0062  
phone: 865.576.8401  
fax: 865.576.5728  
email: <mailto:reports@adonis.osti.gov>

Available for sale to the public, in paper, from:

U.S. Department of Commerce  
National Technical Information Service  
5285 Port Royal Road  
Springfield, VA 22161  
phone: 800.553.6847  
fax: 703.605.6900  
email: [orders@ntis.fedworld.gov](mailto:orders@ntis.fedworld.gov)  
online ordering: <http://www.ntis.gov/help/ordermethods.aspx>

*Cover Photos: (left to right) photo by Pat Corkery, NREL 16416, photo from SunEdison, NREL 17423, photo by Pat Corkery, NREL 16560, photo by Dennis Schroeder, NREL 17613, photo by Dean Armstrong, NREL 17436, photo by Pat Corkery, NREL 17721.*



Printed on paper containing at least 50% wastepaper, including 10% post consumer waste.

## Cooperative Research and Development Final Report

In accordance with Requirements set forth in Article XI.A(3) of the CRADA document, this document is the final CRADA report, including a list of Subject Inventions, to be forwarded to the Office of Science and Technical Information as part of the commitment to the public to demonstrate results of federally funded research.

**CRADA Number:** CRD-09-00335

**CRADA Title:** Solar Thermal Conversion of Biomass to Synthesis Gas

**Parties to the Agreement:** University of Colorado at Boulder

### **Joint Work Statement Funding Table showing DOE commitment:**

<b>Estimated Costs</b>	<b>NREL Shared Resources</b>
Year 1	\$ 00.00
Year 2	\$ 00.00
Year 3	\$ 00.00
TOTALS	\$ 00.00

### **Abstract of CRADA work:**

The CRADA is established to facilitate the development of solar thermal technology to efficiently and economically convert biomass into useful products (synthesis gas and derivatives) that can replace fossil fuels. NREL's High Flux Solar Furnace will be utilized to validate system modeling, evaluate candidate reactor materials, conduct on-sun testing of the process, and assist in the development of solar process control system. This work is part of a DOE – USDA 3-year, \$1M grant.

### **Summary of Research Results:**

The research results are contained in the following paper co-authored by Carl Bingham of NREL:

Lichty, P.R.; Perkins, C.; Woodruff, B.; Bingham, C.; and Weimer, A.W. (2010). "Rapid High-temperature Solar-thermal Biomass Gasification in a Prototype Cavity Reactor," Journal of Solar Energy Engineering, 132, 011012.

Martinek, J.; Bingham, C.; Weimer, A.W.; (2012). "Computational Modeling and On-sun Model

Validation for a Multiple Tube Solar Reactor with Specularly Reflective Cavity Walls, Part 1: Heat

Transfer Model” Chemical Engineering Science, 81, 298-310.

Martinek, J.; Bingham, C.; and Weimer, A.W. (2012). “Computational Modeling of a Multiple Tube Solar Reactor with Specularly Reflective Cavity Walls, Part 2: Steam Gasification of Carbon,” Chemical

Engineering Science, 81, 285-297.

Saade, E.; Bingham, C.; Clough, D.E.; and Weimer, A.W. (2012). “Dynamics of a Solar-thermal Transport-tube Reactor,” Chemical Engineering Journal, 213, 272-285.

**Subject Inventions Listing**: None

**Report Date**: May 29, 2013

**Responsible Technical Contact at Alliance/NREL**: Judy Netter

**This document contains NO confidential, protectable, or proprietary information.**