

Project Title: Simulation-Driven Design Optimization and Automation for Cordwood-Fueled Room Heaters

Principal Investigator: Prof. Shawn Midlam-Mohler, Ohio State University

Project Partners: University at Buffalo, Oak Ridge National Lab, New Buck Corporation, and NAFEMs

Project Summary:

The goal of the proposed project is to better position the domestic wood-fueled room heater industry to meet current and future DOE and EPA goals for efficiency and emissions by modernizing their products and product-development processes. Automation and simulation have revolutionized products and design processes in many other industry sectors (*e.g.* automotive and aerospace) whereas these technologies are not in widespread use in the domestic wood-fueled heater industry. The proposed project will develop two wood-fired room heater prototypes to demonstrate the efficacy of these technologies to improve wood heater performance. The work aims to move the state-of-the art forward while simultaneously increasing the technical competency of the domestic wood stove industry. This joint approach will allow the industry to adopt technologies like simulation and automation such that their in-house R&D capability is able to deliver products that can exceed future efficiency and emissions targets.

The technical targets of the project are to: 1) Demonstrate a catalytic stove with an 8% efficiency improvement and PM emissions at 65% below the 2020 standard; and 2) Demonstrate a non-catalytic stove with a 7% efficiency improvement and PM emissions 70% below the 2020 standard. The project will develop automation systems for catalytic and non-catalytic stoves using the same approaches used in the automotive industry. This system will utilize low-cost sensors and actuators to control primary and secondary air to improve wood stove performance. The use of simulation as a “digital twin” has allowed other industry sectors to make major advances in product design. In this approach, simulations are used to support the design process as early proxies for traditional prototype-driven design processes. The team will refine existing simulation methods for use in wood stove design and apply these to develop improved designs for a catalytic and non-catalytic stove. This will result in improved combustion chamber designs, improved mixing of combustion air with gasification products, improved baffling, and improved insulation strategies.

The proposed work unifies expertise from several organizations to form the required multi-disciplinary team. The Ohio State University team brings the requisite experience in model-based design, automation for combustion/emissions control, and professional development. The University at Buffalo brings deep expertise in modeling combustion and gaseous emissions in wood combustion as well as experimental facilities for testing wood burning appliances. Oak Ridge National Lab provides expertise in particulate matter formation and modeling. New Buck Corporation is a domestic stove manufacturer with 30+ year of experience building stoves and provides prototyping capability. NAFEMS America is the primary national organization for companies conducting modeling and simulation and is well positioned to support transfer of technology from this proposed project into the domestic wood stove industry.