

## **MCEDC Graduate Research Statement – Wyatt Champion**

### **Quick Description**

The characterization of emissions from the combustion of solid fuels is important for the viability of cookstove and heating furnace interventions in developing areas.

Furthermore, the acceptability of technologies, which would reduce the need for solid fuel consumption, such as passive solar heating, varies between cultures and locations. It is important to study both the outcomes of current technologies, as well as the plausibility of future interventions.

With a focus on the Navajo Nation, our research concerns both the emissions from solid fuel combustion, as well as the cultural acceptance and economic limitations to alternative forms of heating. As part of this work, several fuels, including pine, cedar, and various types of coal, will be evaluated by combusting them individually in a cookstove and measuring the emissions of carbon monoxide (CO), carbon dioxide (CO<sub>2</sub>), and particulate matter (PM) using a Portable Emissions Monitoring System (PEMS). A published Water Boiling Test (WBT) will be used to compare various stoves and fuels.

### **Purpose and Hypothesis**

One purpose of our current research is to provide a portrait of the solid fuels most commonly used in the Navajo Nation for heating. By better understanding the “polluting potential” of these fuels, residents may be more informed in their fuel and stove use. Our hypotheses include that the combustion of the BHP Billinton coal, made available to local residents for free, produces higher amounts of pollutants when compared to the Black Mesa coal due to the increased ash content of the BHP coal (Bunnell et al., 2010). We also expect that the combustion of coal in wood-stoves, which are not properly designed for the increased temperatures needed for coal combustion (Bartok, 2003), further promotes elevated levels of air pollutants indoors.

Another goal of our research is to explore alternatives to the use of stoves indoors. These technologies and approaches must be appropriate for use in the Navajo Nation.

Alternative sustainable options for the Navajo presently being considered include housing design to better incorporate passive solar heating, the use of cleaner burning gaseous fuels, and improving the condition of current stoves.

### **Review of Literature**

A study of 20 homes conducted in the Navajo community near Shiprock, NM found that the winter 24-hour average concentration of fine particulate matter (PM<sub>2.5</sub>) indoors exceeded the guidelines established by the World Health Organization by nearly 45% (36 µg/m<sup>3</sup> compared to the WHO guideline of 25 µg/m<sup>3</sup> for a 24-hour period) (Bunnell et al., 2010). Associations between elevated levels of fine particulate matter (PM<sub>2.5</sub>) and negative health effects including asthma exacerbation (Penttinen et al., 2006), chronic obstructive pulmonary disease (COPD) (Schwartz et al., 1996), and increased mortality (Fann et al., 2012; Pope III et al., 2009) are well-established in the literature.

Furthermore, Bunnell et al. (2010) found that Shiprock residents were five times more likely to develop respiratory disease than residents in surrounding areas.

A 2010 study (MacCarty et al.) utilized a Portable Emissions Monitoring System (PEMS) developed by the Aprovecho group to evaluate 50 different cookstoves and measure their emissions. Improved charcoal cookstoves emitted over twice as much CO, but 90% less PM when compared to improved, non-rocket style wood cookstoves. Recommendations from that study were to use well-designed stoves and effectively route cookstove emissions out of the kitchen, reinforcing the importance of improving current stoves in the Navajo Nation.

Our study will utilize protocols established by Aprovecho and our measurements will be compared to appropriate emissions data from that study. Emissions data for specific fuels used in the Navajo Nation will also be collected.

## **Results**

Our research thus far has been primarily literature review, to identify viable alternative heating technologies for the Navajo Nation. Cultural acceptance is an important benchmark of viability and our colleagues at Diné College identified some advantages and disadvantages of various technologies. Concerning combustion emissions, our efforts have been to prepare and test the experimental setup, acquire solid fuels used by the Navajo, and to establish replicable results using the PEMS and the WBT protocols.

## **Conclusions**

Solid fuels to include in this study have been identified and some have been acquired. Some experimental protocols have been identified and tested. In addition, since cost is very important when considering heating alternatives for the Navajo Nation, the simplest and most cost-effective technologies will be evaluated first.

## **References**

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