NAVAJO NATION EPA
AIR QUALITY CONTROL PROGRAM
INDOOR AIR QUALITY

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NNEPA AIR QUALITY CONTROL PROGRAM OVERVIEW

- Section 105 Clean Air Act Grant
  - Ambient air monitoring
  - Open Burn of Household Waste
  - **Indoor Air Quality (IAQ)**
- Operating Permit Program
  - 12 Title V Facilities
  - Developing Minor Source Program

To protect and enhance the health and livelihood of Navajo people

To protect and preserve the natural beauty and environment on the Navajo Nation

To ensure the air emissions from the industries operating on the Navajo Nation are regulated

INDOOR AIR QUALITY ON THE NAVAJO NATION : USGS STUDY

- 2010 study performed by USGS "Navajo Coal Combustion and Respiratory Health Near Shiprock, NM."
- Over 130 homes surveyed.
- Stoves in one-quarter of homes surveyed were found to be inappropriate for coal combustion.
- Study found high levels of respiratory diseases within communities. Residents appear to be at greater risk for respiratory disease than in other communities in the Four Corners region.

USGS
science for a changing world

Navajo Coal and Air Quality in Shiprock, New Mexico

Figure 1. Typical emission plume from a powerplant near Shiprock, New Mexico, is horizontal during an inversion October 26, 2002; inversions are more common in winter than summer. Photograph copyright (2003) Diane J. Schmitt; all rights reserved; used with permission.

Among the Navajo people, high levels of respiratory disease, such as asthma, exist in a population with low rates of cigarette smoking. Air quality outdoors and indoors affects respiratory health. Many Navajo Nation residents burn locally mined coal in their homes for heat, as coal is the most economical energy source. The U.S. Geological Survey (USGS) and Diné College, in cooperation with the Navajo Division of Health, are conducting a study in the Shiprock, New Mexico, area to determine if indoor use of this coal might be contributing to some of the respiratory health problems experienced by the residents. Researchers in this study will (1) examine respiratory health data, (2) identify stove type and use, (3) analyze samples of coal that are used locally, and (4) measure and characterize air quality inside selected homes. Interim results are summarized below.

Inversions.—In the Shiprock area of the San Juan basin, people are exposed to poor air quality outdoors when atmospheric thermal inversions trap combustion products from two nearby large-capacity coal-fired powerplants (fig. 1). The number of respiratory incidents in the Shiprock area increases in winter (when inversions are more common) and decreases in summer. This increase may be related to inversions and to burning coal, wood, and other materials indoors for heating during the winter.

Respiratory health data.—Our study indicates that people living in Shiprock are more than five times as likely to be seen at the Northern Navajo Medical Center (NNMC) Indian Health Service facility for respiratory complaints as are residents of other nearby communities that are less affected by inversions. Another notable finding is that Shiprock residents under the age of 5 and over 56 are more than twice as likely to be treated at NNMC for respiratory issues as would be expected of the entire Shiprock population. The very young and the elderly spend more time indoors during winter when coal may be used for home heating, and people in these age groups may have immune systems that are compromised relative to the systems of people between 5 and 56.

Stove type and use.—The use of a properly operated and maintained stove designed to burn coal should not significantly lower air quality indoors. The research team surveyed 137 households that used coal-burning stoves in 2004 and found that one-quarter of them were burning coal in stoves that were designed to operate at lower temperatures for burning wood and that many of the stoves had visible cracks or were poorly vented to the outside (fig. 2).

According to the results of this study, people can reduce their risk of respiratory disease by doing the following:

- Cleaning and properly maintaining coal-burning stoves
- Properly venting those stoves
- Using a stove designed for the appropriate fuel
- Safely handling coal and ash

Coal analyses.—Most of the coal used by our survey participants came from the Navajo mine at the Four Corners Power Plant. Samples of coal from Shiprock area homes, as well as from the mines and powerplants, have been analyzed for their chemical composition. No significant differences were found in the quality of coal from those various sources, and no dangerous levels of trace elements, such as mercury, were detected.

Particulate matter.—When coal is burned, numerous potentially harmful materials are released into the air. Of particular concern are small particles known as $PM_{2.5}$ (particulate matter 2.5 micrometers or less in diameter). These particles, less than 1/30th the diameter of a human hair, are small enough that they can travel deep into the lungs and can directly enter the bloodstream. $PM_{2.5}$ can then be transported to any organ in the body, and they have been implicated as a cause of heart disease among other ailments. From a human health standpoint, the composition of the particles may be even more important than their size. USGS scientists are currently measuring the amount of $PM_{2.5}$ indoors and outdoors and analyzing that material in the laboratory to determine what chemical elements and compounds make up or are stuck to the particles.

Results.—This collaborative study of USGS scientists with Navajo students, residents, and health officials is providing valuable training for Navajo students in geographic information science (GIS), public health research methods, and geochemistry. Final results of the study will be provided to Tribal leaders, who can use the data in developing community practices that improve the public health effects of coal used for home heating in the Navajo Nation.

Figure 2. Representative of stoves used in 25 percent of homes surveyed, this stove was not designed to burn coal safely. Photograph by Veronica Francisco-Lapahie, Diné College, 2004; used with permission.

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INDOOR AIR QUALITY ON THE NAVAJO NATION : USGS STUDY

- Hospital admissions/outpatient visits to Northern Navajo Medical Center increases during winter months

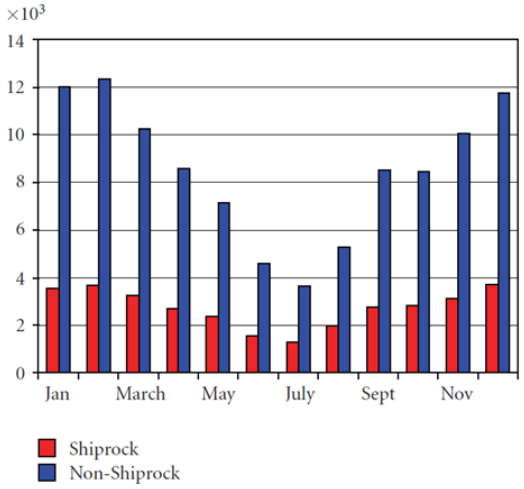


FIGURE 1: Total unadjusted raw numbers of hospital admissions/outpatient visits to NNMC for all seven diseases/conditions by month over the time period April 1997–December 2003, with residents of Shiprock in red and all other communities included in the study in blue.

- Indoor $PM_{2.5}$ 24-hour concentrations exceed $PM_{2.5}$ NAAQS with spikes in $PM_{2.5}$ concentrations coincides with activities such as adding chunks of coal to the stove.

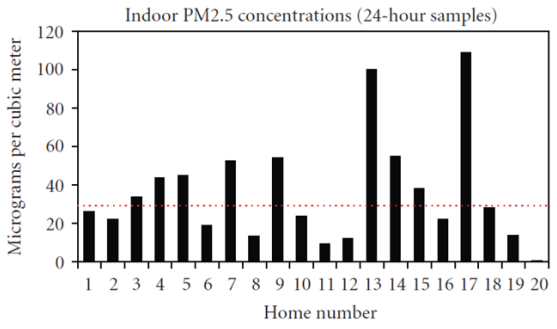


FIGURE 4: Average concentrations of winter (2005, 2006, and 2007) indoor $PM_{2.5}$ over 24 hours at 20 homes. Home numbers 1–19 were burning coal during sampling period; home number 20 had an alternate heating source. Red dotted line indicates the 24-hour ambient US Environmental Protection Agency standard of 35 $\mu g/m^3$ for comparison.

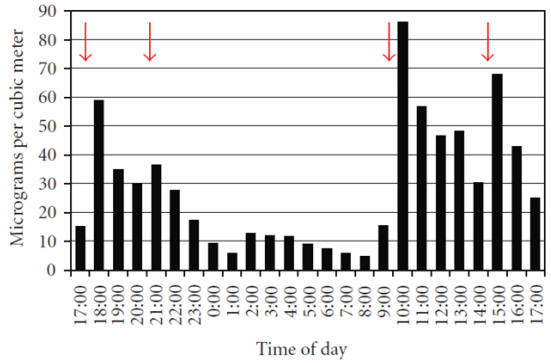


FIGURE 5: Representative display of $PM_{2.5}$ concentration hourly averages over a twenty-four hour sampling period in one home (site Nav135). On the basis of interviews with residents, spikes in $PM_{2.5}$ concentrations coincided with activities such as adding chunks of coal to the stove (red arrows).

INDOOR AIR QUALITY ON THE NAVAJO NATION: USGS STUDY

- Indoor Homes Assessment
  - Homes specific
  - Poor ventilation
  - Mold
  - High levels of PM
  - Homes not weatherized for the climate
  - High levels of Radon
  - Improper use of cleaning products
- Wood & Coal Stoves
  - Old outdated stoves
  - Burned wet wood
  - Burned coal
  - Burned trash
  - Stoves with cracks and gaps
  - Poorly ventilated stoves
  - Improperly installed stoves

INDOOR AIR QUALITY ON THE NAVAJO NATION

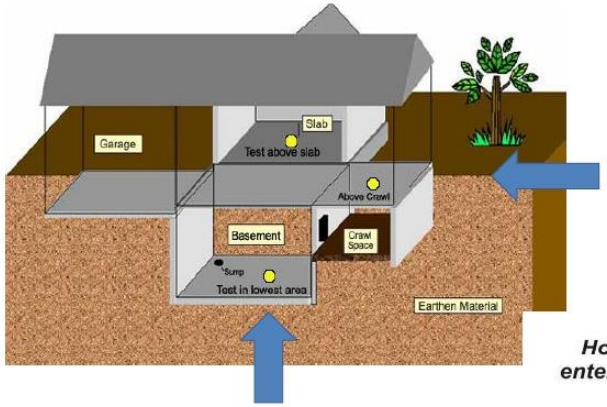
- Identified Wood/Coal Stove Problem on the Navajo Nation
- How We Started to Address the Problem
  - Indoor Air Quality Component added to CAA Section 105 Grant Work Plan
  - Outreach Material development
  - Conducted Indoor Air Quality Measurements
  - Developed Partnerships with Universities to Support IAQ Studies on Navajo Nation
    - University of Montana - Residential Wood Smoke Intervention Study (on-going)
    - University of Tulsa – Home to School Study to Reduce Asthma Triggers (on-going)
    - University of Colorado & Dine College – Impact of Heating Stove Replacement on Indoor and Outdoor Air Pollution in Shiprock, NM, Navajo Nation (proposed start date Jan. 2018)
- Mitigation project – Wood/Coal Stove Changeout

IAQ HOME ASSESSMENTS ON THE NAVAJO NATION

- Utilized Tribal Air Monitoring Support Center IAQ equipment loan program and loaner equipment from CU-Boulder and Univ. of Tulsa
- Identified what we wanted to monitor
  - $PM_{2.5}$, Particle Counts, Temperature, Relative Humidity, CO, CO_2, and Radon
- Developed an Indoor Air Quality Project Plan
  - IAQ assessment checklist
- Navajo Nation Radon Program: make sure homes were below EPA action level
  - Radon canisters
- Selected homes in each tribal agency
  - 10 homes in Fort Defiance Agency (FY16)
  - 10 homes in Shiprock Agency (FY17)
  - 10 homes in Central Agency (FY18)
  - 10 homes in Western Agency (FY19)
  - 10 homes in Eastern Agency (FY20)

INDOOR AIR QUALITY ON THE NAVAJO NATION: NAVAJO NATION RADON PROGRAM

Where to Place the Home Radon Test Canister

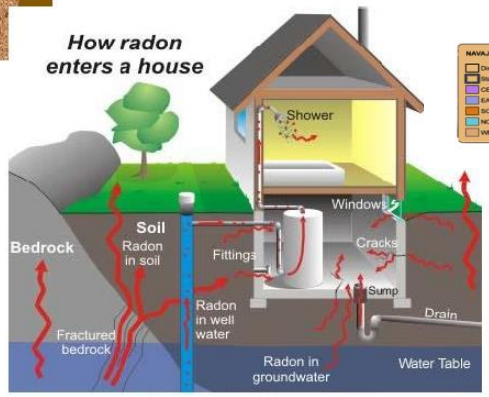


Place at least 2 feet above the floor exposed to open air

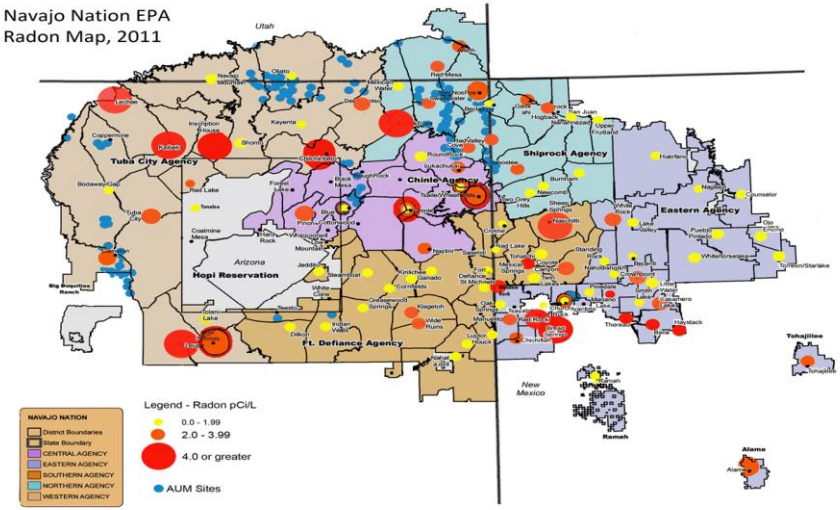
Place in lowest floor of the house, such as a basement

Do not place canisters near fans and ventilation systems.
Avoid kitchen areas, porches and bathrooms.
While testing keep windows and external doors closed.

How radon enters a house



Navajo Nation EPA
Radon Map, 2011



INDOOR AIR QUALITY ON THE NAVAJO NATION

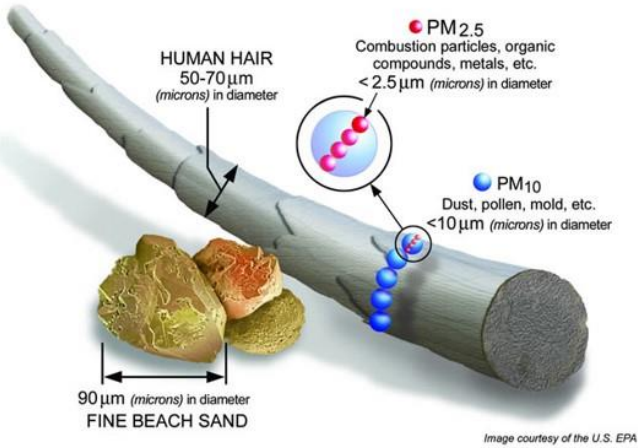
- Worked with contractors and EPA to develop flyer
- We didn't want to promote methods that people on the Navajo Nation couldn't easily follow, or carry out.
- Focused on 4 main ideas that we felt would be applicable to Navajo

1) Clean and Repair your stove and chimney
2) Burn the right fuel
3) Ensure proper ventilation
4) Use smoke detectors and carbon monoxide alarms

PARTNERING WITH RESEARCH PARTICIPANTS UNIV. OF MONTANA: RESIDENTIAL WOOD SMOKE INTERVENTION STUDY

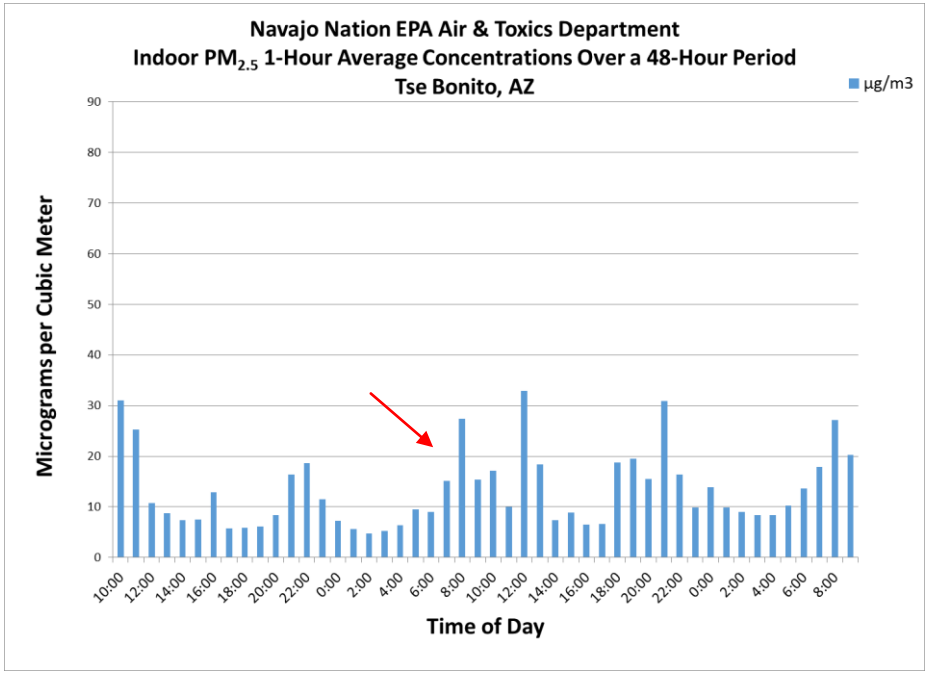
- This project is funded by the National Institute of Environmental Health Sciences (NIEHS) and aims to reduce wood smoke/particulate matter exposure among the elderly and reduce adverse respiratory outcomes.
- Test community-based exposure reduction strategies in tribal households that use wood stoves for home heating and evaluate the impact on respiratory function among the elderly.
- Community based participatory research techniques are used to adopt intervention approaches to meet cultural content of each participating community.
- Development of a community level wood yard.
- Household level education strategies will be given to participants.
- Goal is to design education based interventions that will result in sustainable strategies for reducing personal exposure to wood smoke.

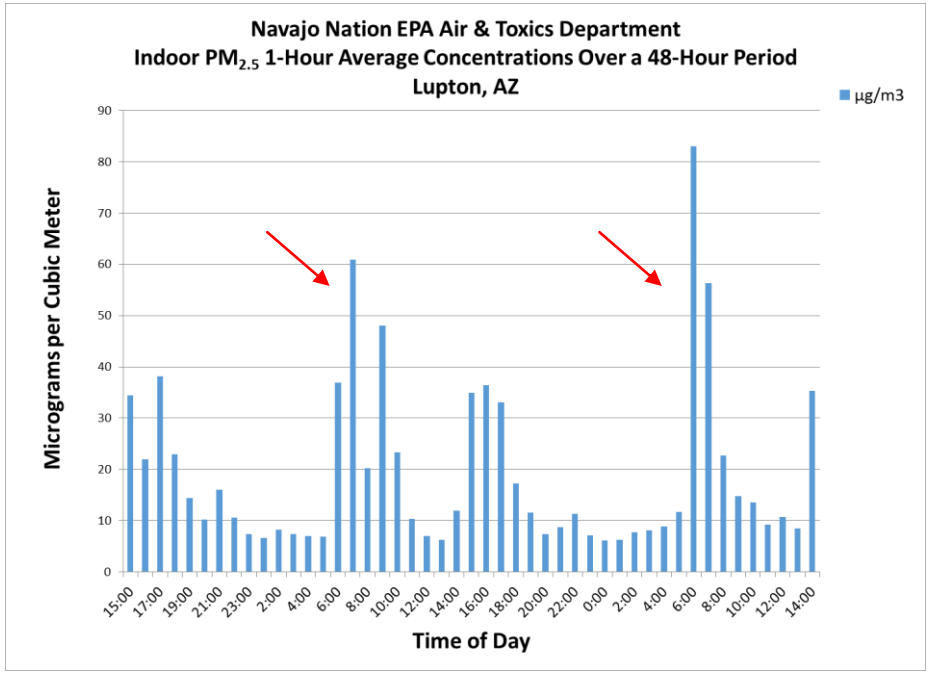
INDOOR AIR QUALITY ON THE NAVAJO NATION: UNIVERSITY OF MONTANA STUDY



PM measurements will be used to access impacts to indoor air quality.

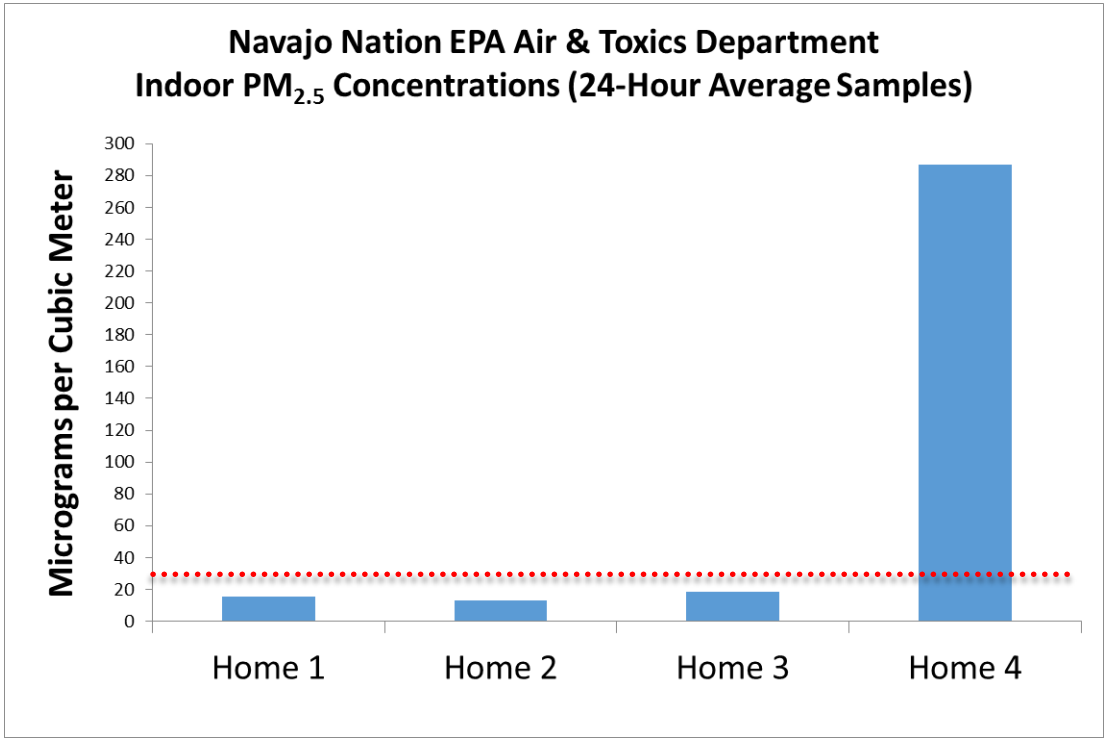
INDOOR AIR QUALITY ON THE NAVAJO NATION: UNIVERSITY OF MONTANA STUDY





INDOOR AIR QUALITY ON THE NAVAJO NATION: UNIVERSITY OF MONTANA STUDY

- Average 24-hour concentrations of winter indoor $PM_{2.5}$ for four tribal homes.
- The red dotted line indicates the 24-hour ambient U.S. EPA NAAQS 24-hour standard for of 35 $\mu g/m^3$ for comparison.



INDOOR AIR QUALITY ON THE NAVAJO NATION: UNIVERSITY OF MONTANA STUDY

MITIGATION PROJECT FOUR CORNERS POWER PLANT STOVE CHANGE OUT PROJECT

- A 2010 EPA Settlement Agreement with Four Corners Power Plant for CAA violations is providing $3.2 million in mitigation for a stove changeout project.
- 750 change-outs will occur in a five year period in the Shiprock Agency.
- The agreement requires both the use of Navajo workers where possible and the use of workers who are certified (or equivalent) for a safe installation of stoves (Wood Stove Training for Contractors).
- EPA Certified stoves are not designed to burn coal. EPA is working with manufactures to design dual fuel stoves that will be able to burn wood and coal.
  - Visited the Navajo Nation to learn more about burning habits
  - Participated on calls with occupants who burn coal
  - Want a stove that will create less pollution and burns efficiently to improve both ambient and indoor air quality

FOUR CORNERS POWER PLANT STOVE CHANGEOUT AND WEATHERIZATION PROJECT TENTATIVE TIMELINE

June 2015

Settlement Agreement

Four Corners Power Plant Settlement provides $4.7M for stove changeouts & weatherization; includes pilot-testing to develop new dual-fuel stoves for households that burn both wood and coal.

2015-2017

Stove Design

Stove manufacturers are partnering with US and Navajo EPA to develop 3 stove proto-types that meet the unique needs of Navajo households and can burn wood and coal.

Summer 2016

Job Training & Test Methods

The National Fireplace Institute, EPA, and Navajo Nation EPA trained 43 Navajo contractors to safely install stoves. We also worked with the stove testing industry and Navajo partners to develop a Navajo stove test method.

Late 2016 - Early 2017

Baseline Emission Testing

We tested 3 models of stoves commonly used on Navajo Nation to establish baseline emissions. One model was beta-tested in 5 Navajo homes.

Mid 2017

Preliminary Emissions Testing

New stoves are being tested in a lab burning Navajo fuels, and using a test method designed to reflect Navajo use. This allows us to compare performance to existing stoves.

Late 2017 (?)

Stove certification

We expect stove certification testing to begin in summer 2017 for at least 1 candidate stove. Certification can take several months. Stove manufacturing can then proceed.

2018-2022 (?)

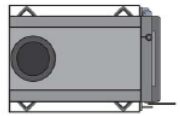
Stove Changeout

We anticipate changeouts and weatherization will begin in 2018 and will take 4-5 years to complete. We expect approximately 600-700 homes can be completed.

MITIGATION PROJECT FOUR CORNERS POWER PLANT STOVE CHANGE OUT PROJECT

The Navajo Stove Beta Model

This is a small, clean burning wood or coal stove that burns up to 8 hours on a load of fuel (wood or coal), and heats up to 1,000 sq.ft. The Navajo Stove has a hybrid wood combustion system (catalyst and secondary combustion) for maximum efficiency, output, and burn time. When coal is loaded, the catalyst is removed from the exhaust stream, and coal combustion is enhanced by providing additional oxygen for clean burning, and by secondary combustion. The basic stove includes adjustable leg height, ash box and ash pan, viewing window, fireplace tools, cooktop, and protective side and rear heat shields.



Side with Navajo heat shield | Navajo Front (v1) | Navajo Front (v2) | Side with no heat shield

The Navajo stove is designed specifically to perform well when burning wood and/or coal. The combustion design is intended to allow the user to switch from wood to coal without sacrificng clean combustion or high efficiency. A person burning wood will get approximately 30% more heat per pound of wood with hybrid combustion than with a conventional wood stove, reducing the amount of fuel consumption needed to heat a home.

When coal is burned, a separate control is used to add more oxygen for cleaner burning. The secondary combustion system works equally well with coal or wood.

The Navajo Stove is designed to heat homes up to 1,000 sq. ft. A larger stove is planned for larger homes, up to 1,400 sq. ft. This stove will burn 6-8 hours on a load of either wood or coal, and produce up to 30,000 BTUs/hr.

Dimensions and Specifications

- Dimensions: 17" W x 24"D
- Height: Adjustable 28" - 34"
- Weight: 280 lbs (Est)
- Top Vent: 5" or 6" Diameter
- Firebox Size: 1.25 cu ft. (18"D x 11"W x 11"H)
- Load Door Opening: 9" H x 8"W

Projected Clearances:
- 9" Sides/Back, 16" Front
- Minimum Hearth: 30"W x 42"D

Projected Performance:
- Area Heated: up to 1,000 s.f.
- Output: 10,000 - 30,000 BTUs/hr
- Max Wood Burn Time: 8 hrs
- Max Coal Burn Time: 8 hrs
- Hybrid Wood Combustion
- Secondary Coal Combustion
- Projected Efficiency: 72%
- Projected Wood Emissions .....1.5 g/hr

Standard Features:
- Adjustable Leg Height
- Ash Box and Ash Pan
- Viewing Window
- Heat Shields (Side and Back)
- Firetools (Shovel, Rake. Poker)
- Navajo Aesthetic
- Cooking Surface

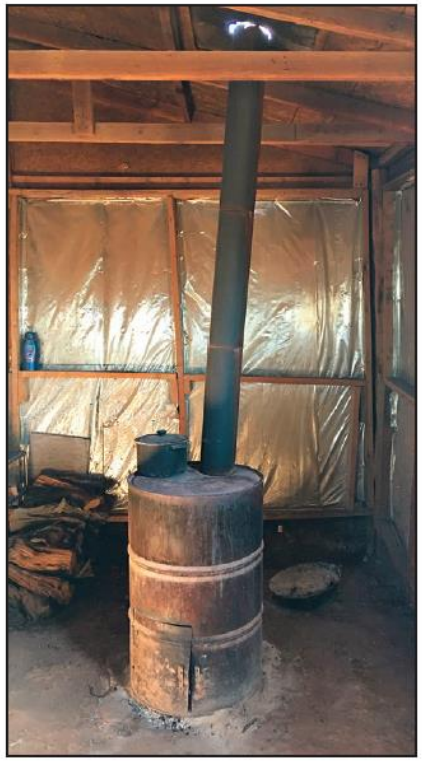
Options:
- Water Reservoir
- Thermoelectric Power System with lamp and cell phone charger
- Metal Bake Oven

Several stoves are currently deployed on the Navajo Nation and undergoing pilot testing for EPA certification

BETA TESTING OF WOOD/COAL STOVE INSTALLATION

Day 1: Lupton, AZ

Our first day began with the replacement of a home-made barrel stove, used to burn wood and coal. The area heated was about 380 sq. ft. and uninsulated.



stack height of 12'-13' was an attempt on our part to ensure there was no smoke spillage. After talking to our beta testers about how chimney temperature and stack height power the stove, along with the importance of adequate draft in keeping smoke and post-combustion odors out of the house, they understood and accepted our plans.

Most beta chimneys extended 6 feet above the roof.

There are no elbows in these installations - the stack goes straight up through the roof. If future stoves are installed in this configuration, it is possible that a slightly shorter chimney could be specified. It is also possible that the inside pipe could be single-wall as opposed to close clearance pipe. This would result in more radiant heat and lower cost for installations.

Chimneys have a huge impact on stove performance and air quality. Questions about chimney height, construction and cost are not trivial.

We had a great welcoming committee for our first installation, including Sandy, who was our guide and a fluent Navajo speaker, and 3 members of the Navajo EPA. The group is pictured below, toward the end of our first installation

Inside the house, close clearance pipe was installed to connect to the prefabricated chimney.

INTERN VIDEO PROJECT: WOOD & COAL STOVE

https://www.youtube.com/watch?v=jfq873KVxyo&feature=youtu.be

- Summer Interns developed a 5 minute video focusing on wood and coal stove intervention
- Video is completely in Navajo with subtitles
- One (1) intern was funded through ITEP, and one (1) intern was funded through the NNEPA Intern program
- The video was showcased during our end of the year intern presentation
- Final edits completed and video has been uploaded to the NNEPA AQCP website

INDOOR AIR QUALITY ON THE NAVAJO NATION

Thank You

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