Woodstove Operation & Maintenance Webinar 1

December 1, 2020

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- Certificates will be emailed to participants

Thank you for joining the webinar!

Thursday, November 12, 2020; 10:00am-11:30am Pacific Time

Submit questions in the "Questions" pane

Raise your hand if you would like to be unmuted

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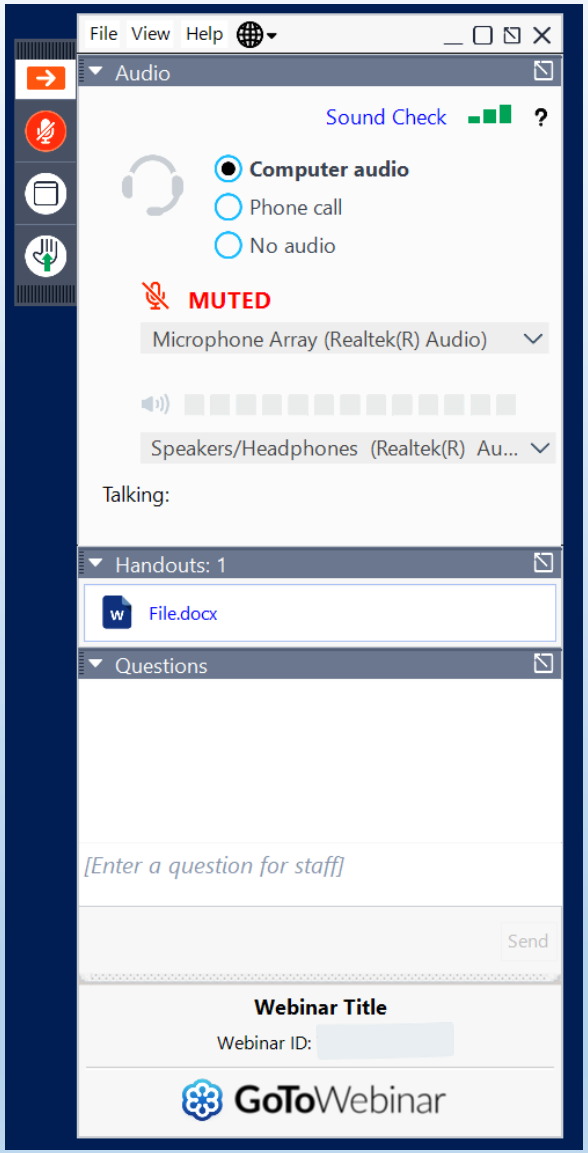

Presented by the Institute for Tribal Environmental Professionals
American Indian Air Quality Training Program
Questions? Contact Darlene.Santos@nau.edu

Polling Questions

Poll Question 1

- Which of the following best describes your role?
  - Environmental Staff
  - Housing Staff
  - Community or Tribal Leader
  - Federal or State Partner
  - Other

Poll Question 2

- How many years have you worked in Air Quality or Housing?
  - Less than a year
  - 1-3 years
  - 3-5 years
  - 5-10 years
  - Over 10 years

Presenters

Tony Ward
University of Montana

Tony.Ward@mso.umt.edu

Perry Charley
Dine College

phcharley@dinecollege.edu

Overview of residential wood smoke and interventions

Tony Ward

Dec 1, 2020

UNIVERSITY OF MONTANA
SCHOOL OF PUBLIC AND COMMUNITY HEALTH SCIENCES


US MAP
State and Capital
C A N A D A
Olympia
WASHINGTON
Salem
OREGON
Boise
IDAHO
MONTANA
Helena
NORTH DAKOTA
Bismarck
MINNESOTA
St. Paul
WISCONSIN
Madison
L. Superior
L. Huron
L. Michigan
MICHIGAN
Lansing
L. Ontario
L. Erie
VERMONT
Montpelier
MAINE
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MEXICO
Gulf Of Mexico
THE BAHAMAS
CUBA
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LEGEND
International Boundary
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Country Capital
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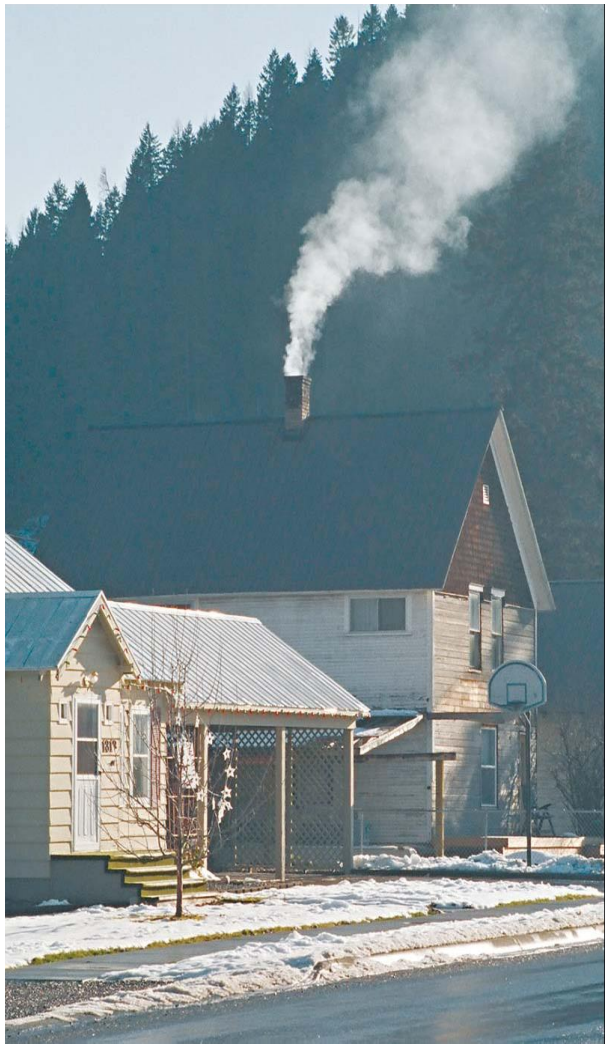
(Updated on 13th May, 2013)

Overview

- Composition of wood smoke
- Health effects related to wood smoke exposures
- Wood stove impacts to both outdoor and indoor air
- Interventions to improve indoor air quality

Wood stoves



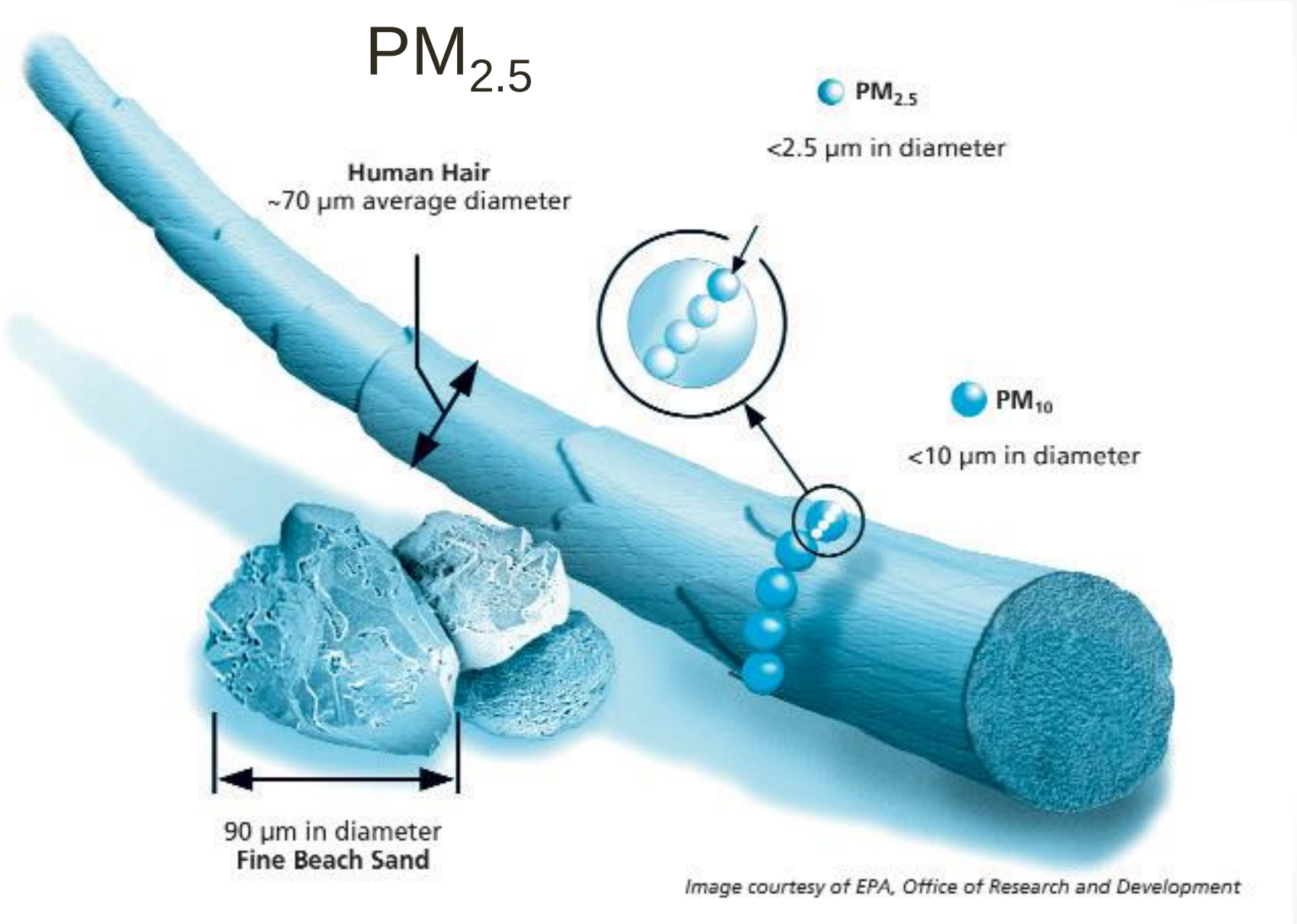
Across the US, ~11 million homes report the use of wood as either a primary or secondary heating fuel.

Over 80% of these woodstoves are old and inefficient.

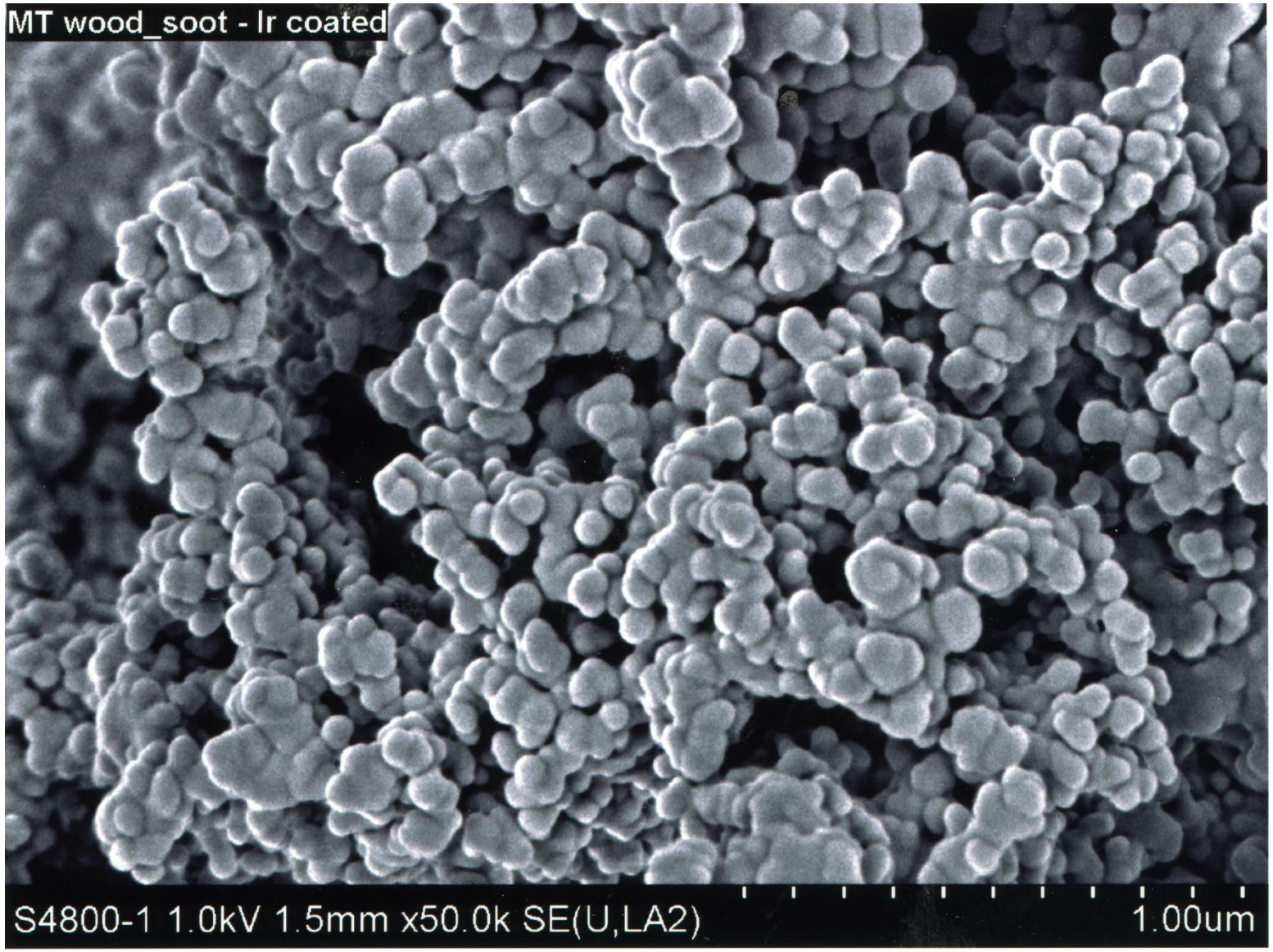
Composition of wood smoke

- Composed of a complex mixture of gases and fine particles
- Volatile Organic Compounds (VOCs)
- Toxic air pollutants including:
  - Benzene
  - Formaldehyde
  - Polycyclic Aromatic Hydrocarbons (PAHs)
- Particulate matter (PM)

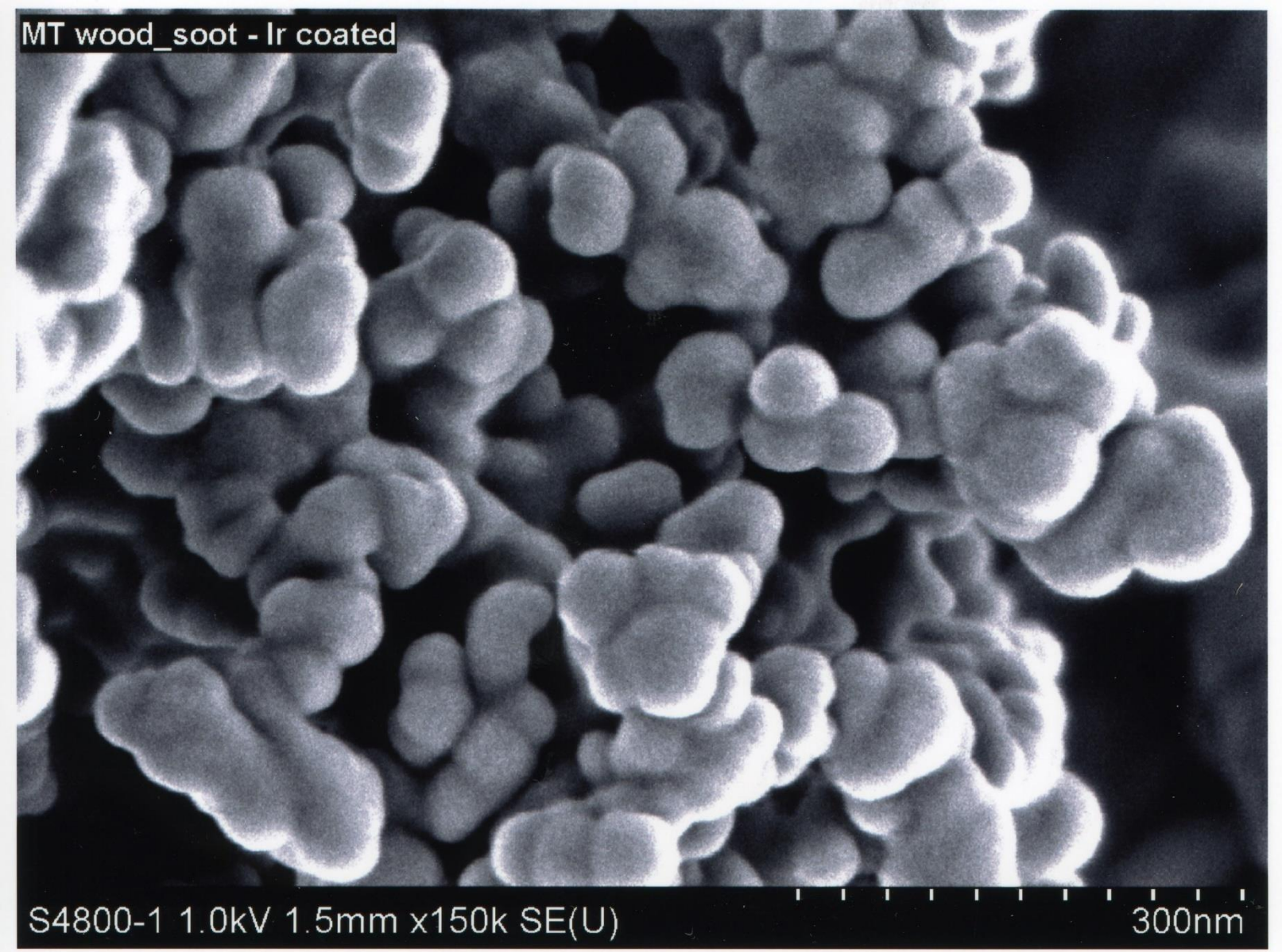
$PM_{2.5}$


PM2.5
<2.5 µm in diameter
Human Hair
~70 µm average diameter
PM10
<10 µm in diameter
90 µm in diameter
Fine Beach Sand
Image courtesy of EPA, Office of Research and Development

Wood smoke $PM_{2.5}$

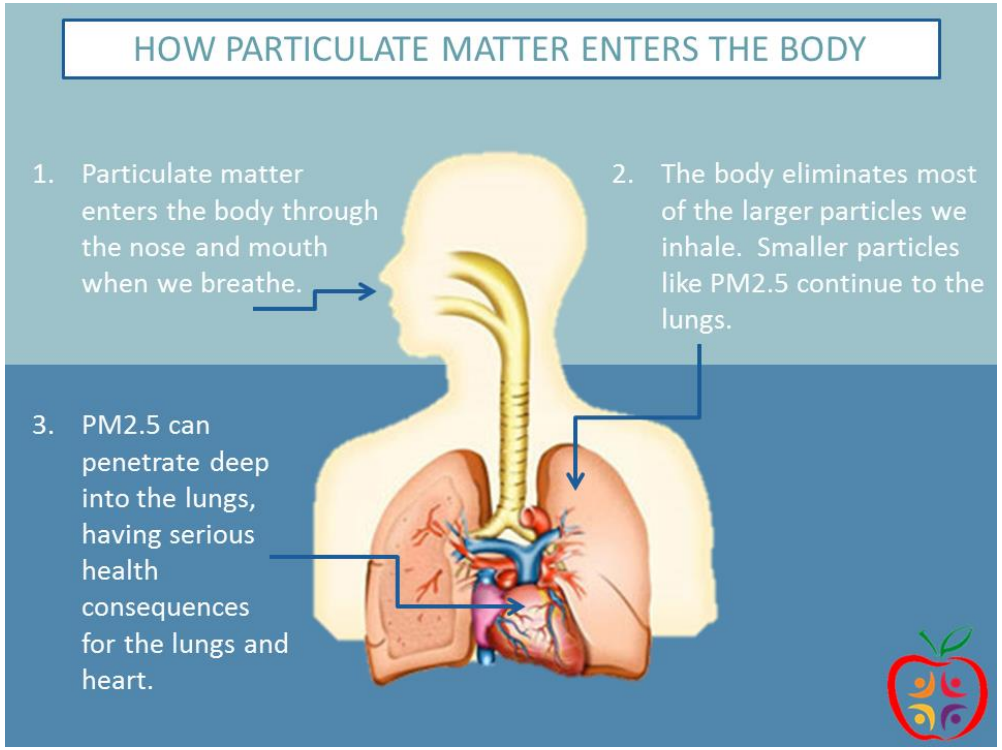


Wood smoke $PM_{2.5}$



$PM_{2.5}$ health effects

- Over more than 50 years, epidemiologic and clinical research has established the adverse effects of $PM_{2.5}$ on human health.



$PM_{2.5}$ health effects, cont.

- Long term $PM_{2.5}$ exposure is associated with:

- Cardiovascular events and reduced lung function
- Increased respiratory and cardiovascular hospital admissions
- Increased emergency department visits
- Increased *mortality* from lung cancer and heart disease

EPA regulated air pollutants

1) Carbon monoxide
2) Lead
3) Nitrogen dioxide
4) Ozone
5) Sulfur dioxide

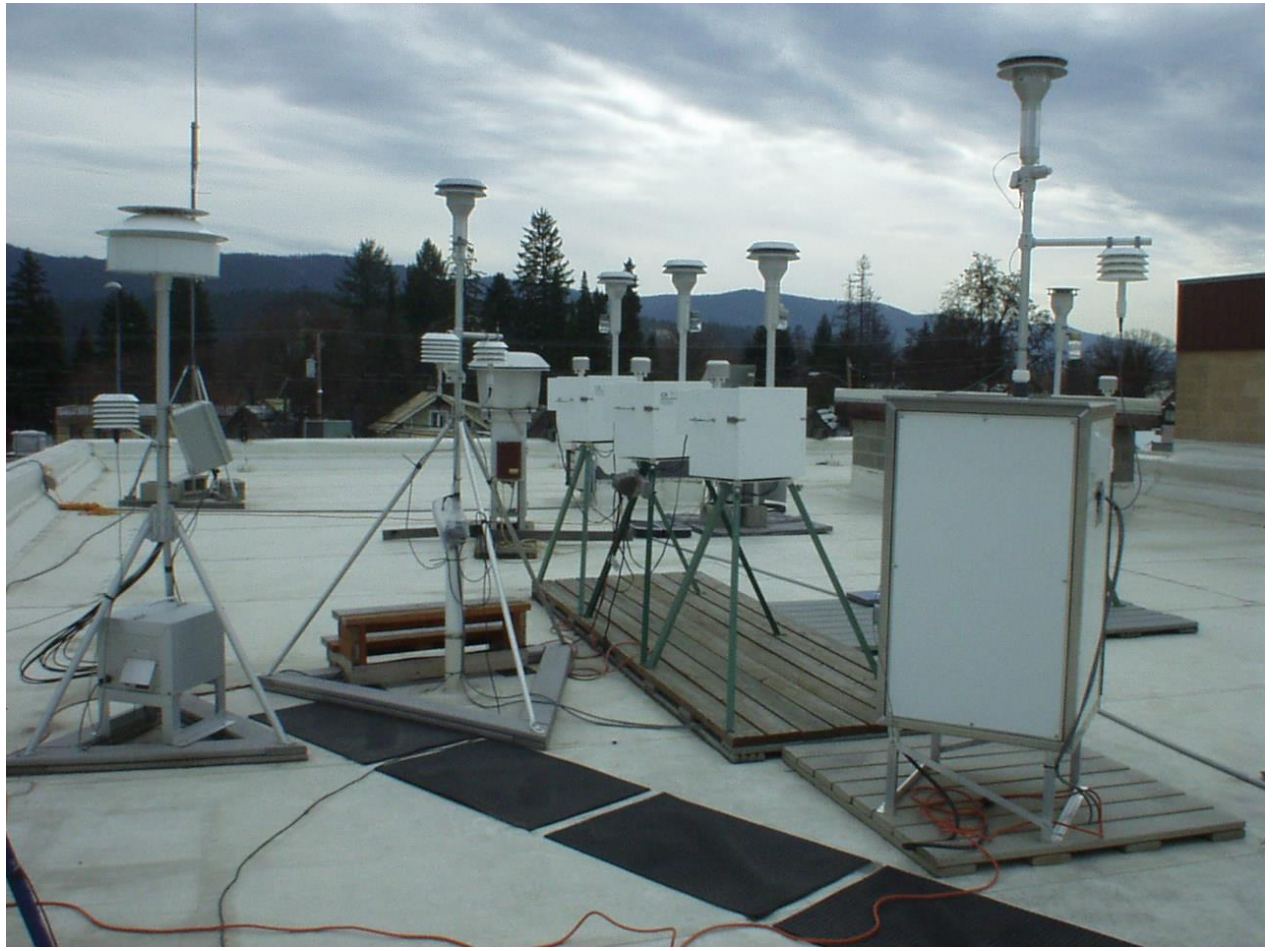
6) Particulate matter ($PM_{2.5}$)*

*Daily and annual standard for $PM_{2.5}$

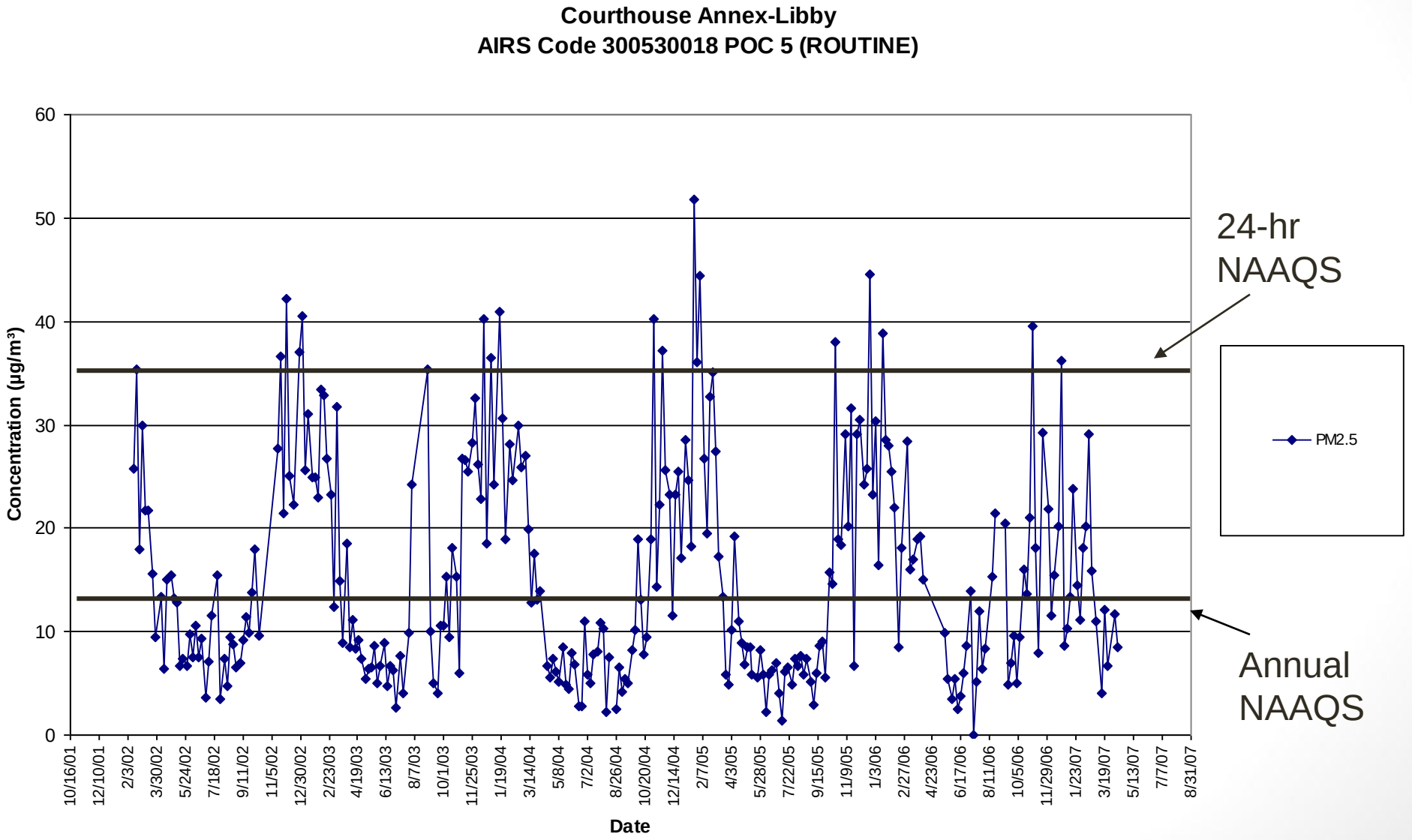
Impacts of residential wood combustion on ambient air

The Conversation

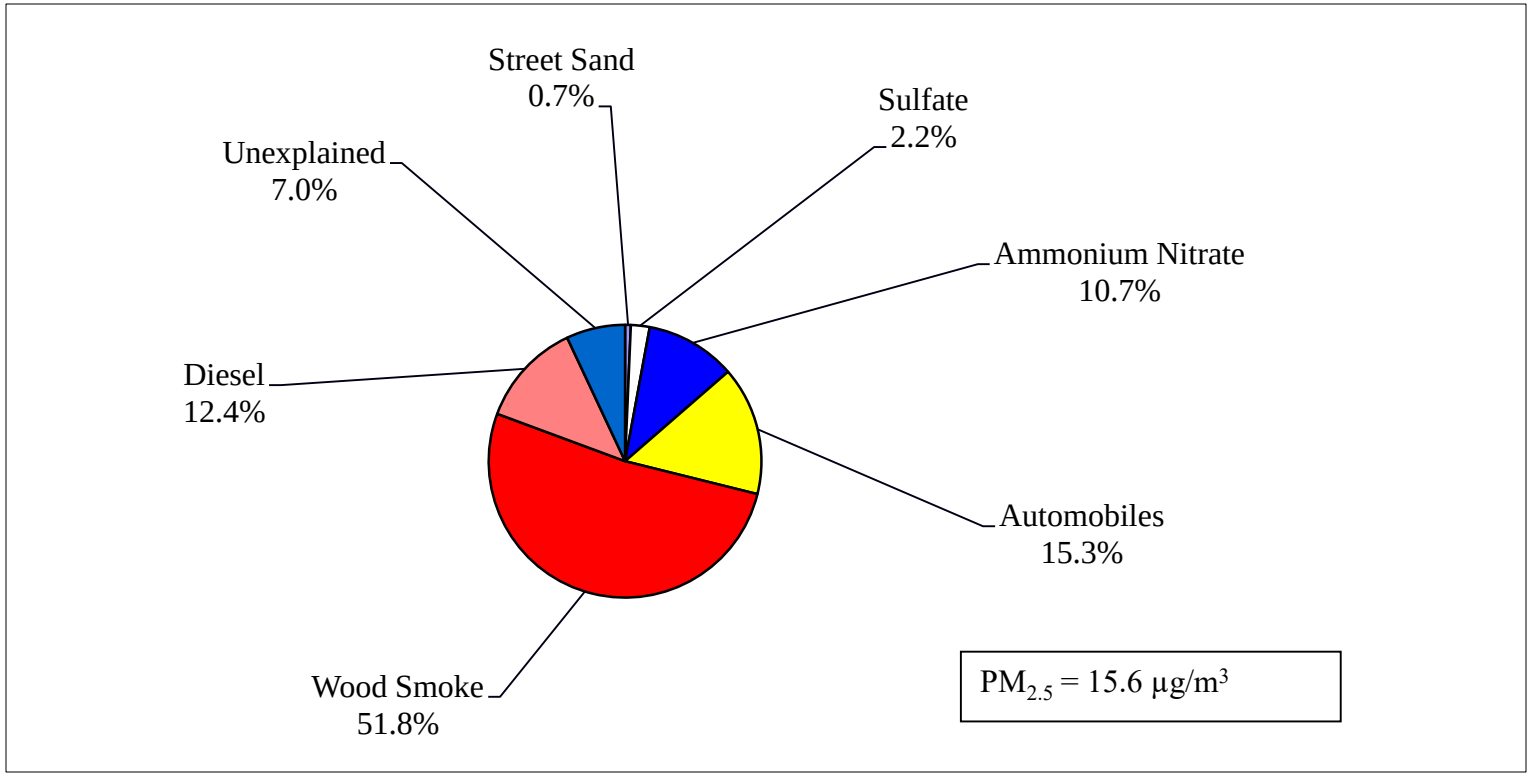
$PM_{2.5}$ sampling site



$PM_{2.5}$ seasonal trends



Montana/Idaho $PM_{2.5}$ sources



- Residential wood smoke is a major source of $PM_{2.5}$ in all the western Montana valleys we have investigated.

- Contributes 52% - 77% winter time $PM_{2.5}$.

Impacts of residential wood combustion on indoor air

Chico Enterprise-Record

Indoor wood smoke exposures

High's Chimney Service

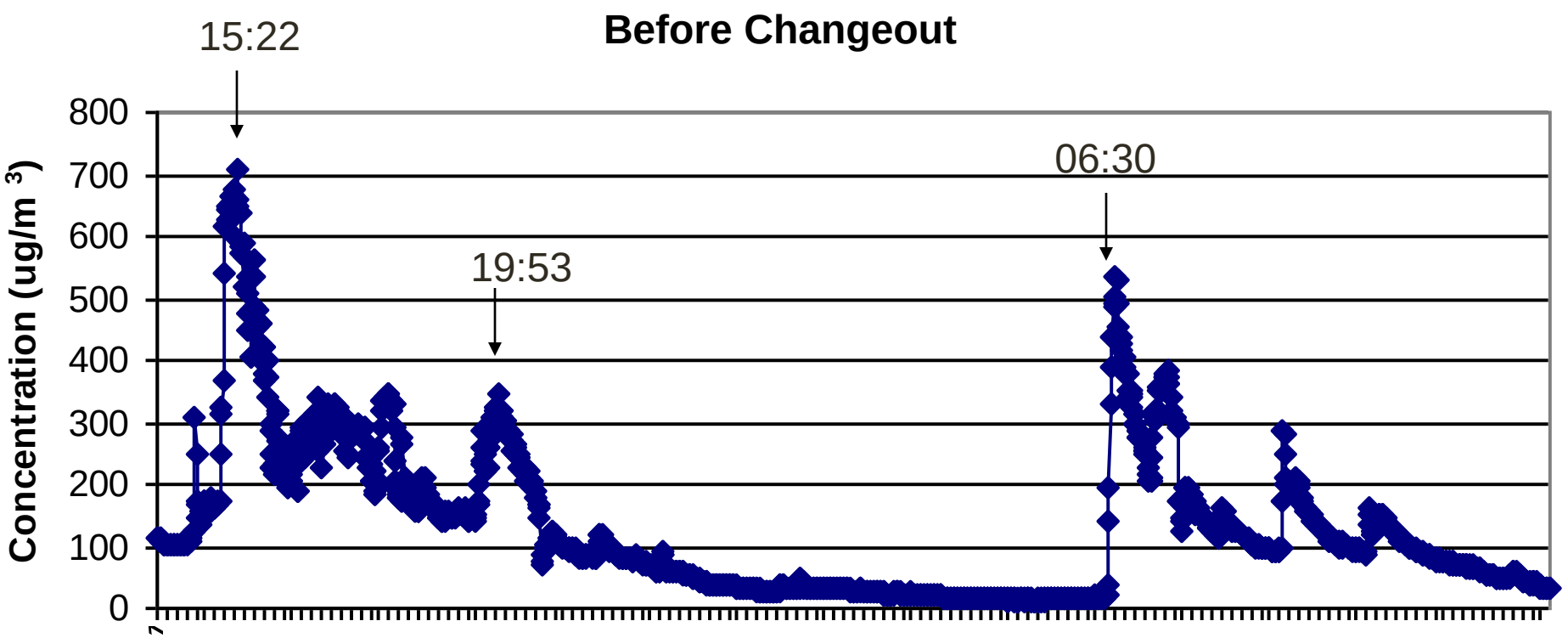
Collector's Weekly

Reddit

Residential $PM_{2.5}$ Program

$PM_{2.5}$ Mass - Home 4A

Before Changeout



Avg = 131.8 µg/m^3

Indoor Residential $PM_{2.5}$ Sampling Programs

- Northern Rockies / Fairbanks, AK intervention study (97 homes).
- Avg (sd) indoor $PM_{2.5}$ across all homes was 34.8 ± 56.5 µg/m^3.

- Indoor $PM_{2.5}$ concentrations often exceed health based standards such as WHO and EPA NAAQS.

Interventions – indoor air

Our team has evaluated:

- use of filtration units
- wood stove changeouts

Household level intervention
- air filtration units

Monitor compliance
(KiloWatt meter).

Filtration units

- ~60% improvement in air quality.
- Expenses: costs of the unit (~$200), yearly filter replacement (~$100), and energy usage (~$100-$200/year).
- Noise, filter replacement, etc.
- Compliance issues.

Wood stove changeout

Old stove
40-60 g smoke/hr

EPA-certified stove
2-5 g smoke/hr

Wood stove changeouts

- Promoted by USEPA to reduce wood smoke.
- Expensive (~$1500 - $4500).
- Effective in reducing ambient $PM_{2.5}$.
- Results can be variable for indoor air.
- Learning curve.

Education?

- Can education be used as an effective, economical, and sustainable intervention to improve indoor air quality and health effects?

- Education coupled with the use of inexpensive tools.

“EldersAIR”

- *Residential Wood Smoke Interventions Improving Health in Native American Populations.*
- Annie Belcourt, Curtis Noonan, and Tony Ward (co-PIs).
- 5-year R01 funded by the National Institute of Environmental Health Sciences (NIEHS).
- Partners are the **Navajo Nation** EPA (Air and Toxics Department) and the **Nez Perce** Tribe Environmental Restoration and Waste Management (Air Quality Program)

Aims and Hypothesis

- **Primary aims:** Assess impact of **community level** (wood yard) and **household level** (filtration units and education) interventions on:
  - changes in indoor and personal $PM_{2.5}$ exposures.
  - cardiopulmonary health and infections of 126 elderly participants.

- **Hypothesis:** Locally-designed **education-based interventions** will result in sustainable strategies that reduce personal $PM_{2.5}$ biomass smoke exposures and lead to respiratory health improvements in elderly NA populations.

Community level intervention: wood yard

Household level intervention:
- air filtration units

Monitor compliance
(KiloWatt meter).

Household level intervention:
- education on best-burn practices

- Videos on Best Burn Practices.

- Training on simple tools:

moisture meter

stove thermometer

firestarter

EldersAir sampling

- **Participants** (126 across Navajo and Nez Perce Reservations):
  - Elderly populations (55 and over) living in homes that utilize a wood stove as their primary source of heating.

- Homes were followed over two winter periods (November through February).

- We did not exclude homes that have tobacco smoking residents.

Exposure measures

- Personal $PM_{2.5}$: MicroPEM.
- Indoor $PM_{2.5}$: DustTrak.
- Activity log.
- In-home log.
- Wood burning log.
- Surface dust wipes for nicotine.

48-hour sampling periods (two events/winter).

Health measures

- Peripheral systolic and diastolic blood pressure.
- Pulmonary function tests (forced vital capacity [FVC], forced expiratory volume in one second [FEV1], and FEV1/FVC ratio).
- Questionnaire on respiratory symptoms and conditions.

Lung function measured twice per winter (four times total).

Final thoughts…

- Residential wood combustion is a large source of $PM_{2.5}$ to both the outdoor and indoor environments.
- Wood stove changeouts and programs targeting older model stoves can be effective at reducing **ambient** $PM_{2.5}$.
- Wood stove changeouts have a variable impact on **indoor** air quality.

Final thoughts, etc.

- Air filtration units work well to improve indoor air quality, but there are compliance issues and expenses (filters and electricity).
- Education on best-burn practices shows promise in reducing ambient and indoor air pollution, but needs to be comprehensively evaluated.
- Education strategies also need to be culturally relevant based on community.

Acknowledgements

Funding

- NIEHS (1R01ES022583).
- Additional support: 1R01ES022649; 1P20GM130418.

- Navajo Nation EPA, Air and Toxics Department (Eugenia Quintana, Nolan Hoskie)
- Nez Perce Tribe, Environmental Restoration and Waste Management (Johna Boulafentis, Crissy Garcia, Julie Simpson)

- UM (Annie Belcourt, Curtis Noonan, Erin Semmens, Emily Weiler, Carolyn Hester, Desirae Ware, Paul Smith, Ethan Walker)

Tony Ward
(406) 243-4092
Tony.Ward@umontana.edu

Thank you.

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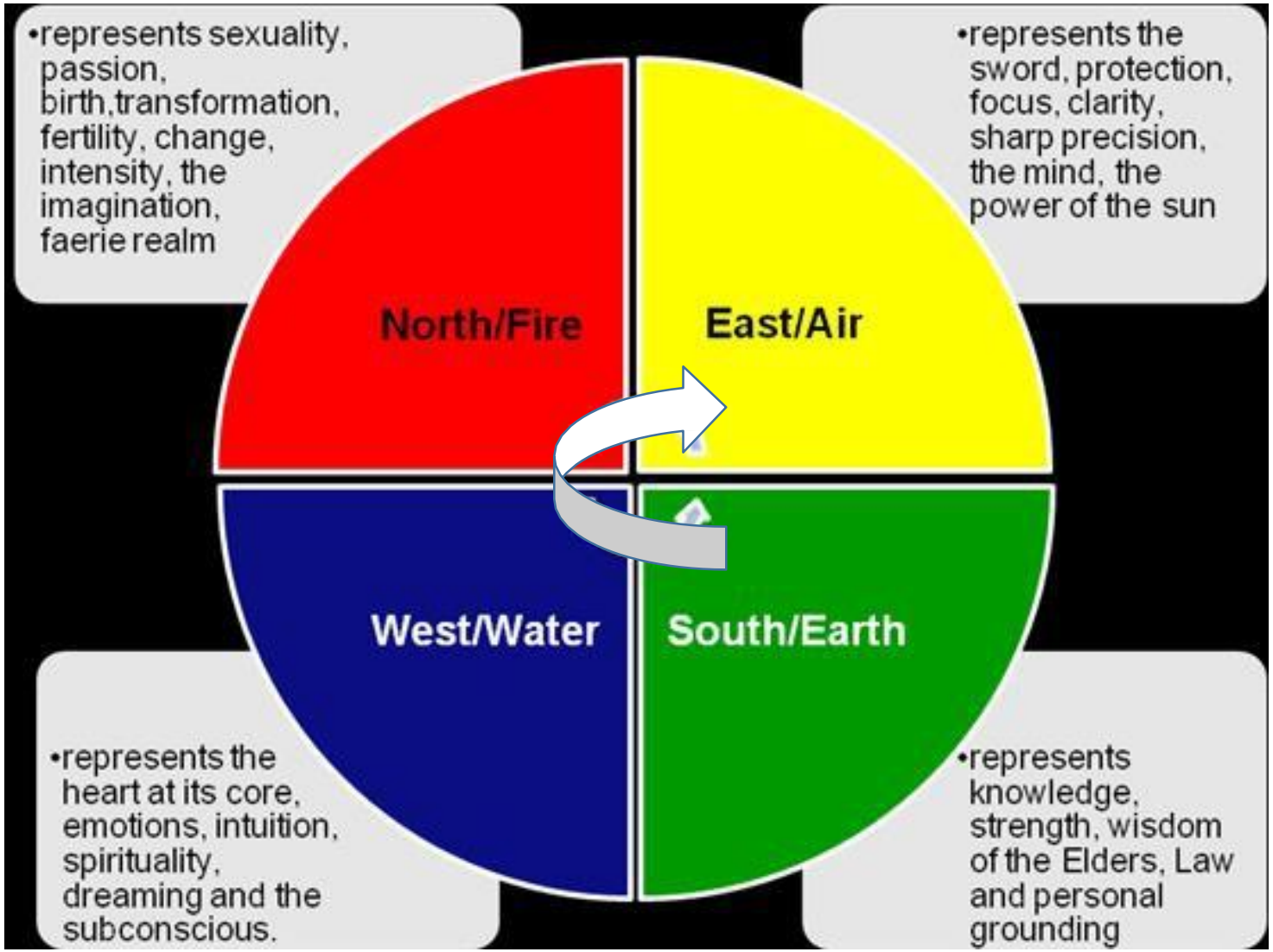
http://health.umt.edu/publichealth/

CUTURAL PERSPECTIVE OF FIRE

Perry H. Charley, Director/Sr. Scientist

Diné College –Diné Environmental Institute

The Sacred Elements of Life



Perception, Culture, and Science: A framework to identify in-home heating options to improve indoor air quality in the Navajo Nation

Champion, W.M.1, Charley, P.H.2, Klein, B.2, Stewart K.3, Solomon P.A.3, and Montoya, L.D.1*

- A 2010 study identified higher than average incidence of respiratory disease in Shiprock, NM, the largest city in the Navajo Nation.
- That study suggested that the potential cause was the combustion of solid fuels in in-home heating stoves and that respiratory disease could be greatly reduced by changing indoor heating behaviors and improving heating stove quality.
- Since the Navajo people are deeply embedded in culture and traditions that strongly influence their daily lives, a new framework was needed to identify feasible heating alternatives that could reduce the negative environmental and health impacts related to solid fuel use while respecting the culture of the Navajo people.

Perception, culture, and science: A framework to identify in-home heating options to improve indoor air quality in the Navajo Nation

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- A new framework for identifying appropriate heating alternatives for the Navajo Nation was undertaken in the study.

- **This framework balances reducing health and environmental impacts with Diné culture, perception, and technical assessment**.

- This assessment uncovered difference between Diné perception and Western technical results, which are vital in risk assessment strategies.

- Involvement of the Diné people at the onset and throughout a study such as this is critical to a successful result.

Perception, culture, and science: A framework to identify in-home heating options to improve indoor air quality in the Navajo Nation

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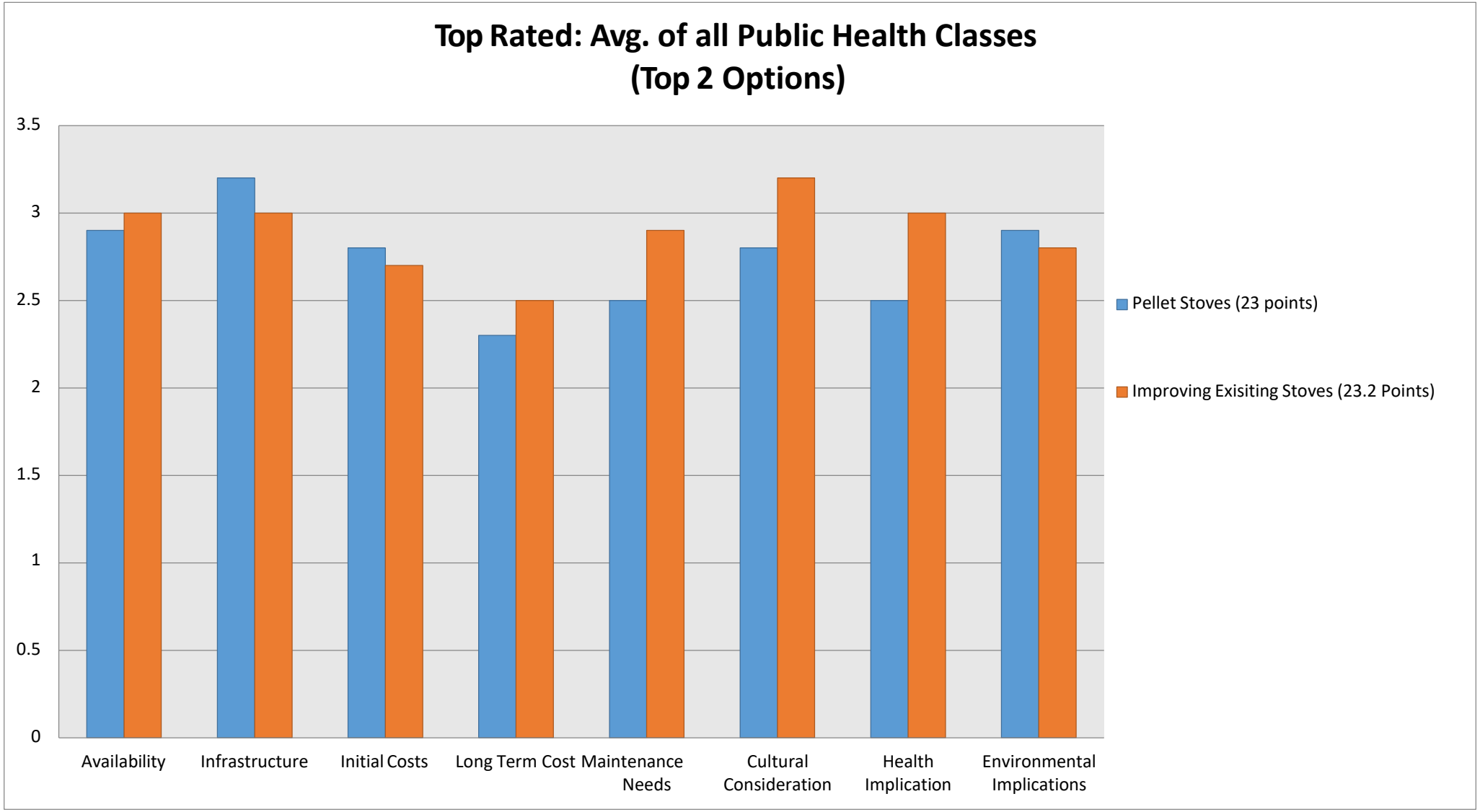
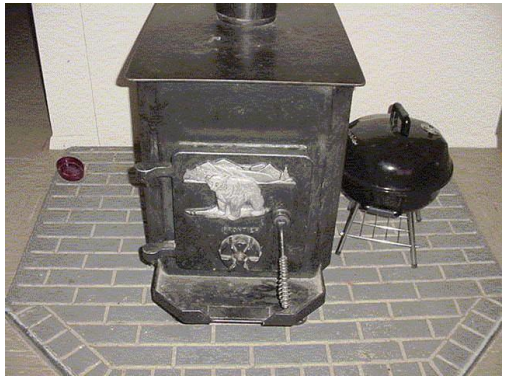
Weight	Meaning
5	Very feasible: Option clearly exceeds listed Criterion expectations
4	Highly feasible: Option consistently exceeded Criterion expectations beyond the point where it deserves special attention
3	May be feasible: Meets most of the Criterion by a reasonable margin
2	Not recommended: Does not meet Criterion
1	Not Feasible: Failed to meet any of the Criterion



Solid fuel (wood): the preferred method of domestic use



Target population & life style behavior

Diné Research and Analytical Framework

A Diné research method was developed to integrate the core ancient principles and values of the Fundamental Law of the Diné with Western approaches to research and analysis. The approach was reviewed and accepted by Diné Traditional Practitioners. Some characteristics of this unique methodology include:

- Review of critical thinking processes (associated with the East: *Nahata*),
- An examination of the planning process (associated with the South: *Iina*),
- An investigation of the processes involved with sustaining life (associated with the West: *Siihasin*),
- Review of spiritual aspects and reverence for creation (associated with the North: *Nitsahakees*).

Diné Research and Analytical Framework

- By weaving the classical Diné thought process into the assessment of alternatives, any future heating interventions may be more easily understood and supported by the Diné community.
- Furthermore, findings based on the importance of community-based initiatives, self-governance, and connections to the natural world may also provide a useful framework for the development of solutions appropriate to other Native Nations.

The analysis phase of the study consisted of three parts:

1. Student Research: Gauging of community perception conducted by Diné College Public Health students with their families.

2. Traditional and Cultural Analysis: Conducted by the Diné Policy Institute (DPI) at Diné College, using Traditional Practitioners.

3. Scientific Analysis: A technical analysis focused on the top seven options identified through the community perception analysis.

These parallel convergent mixed-methods approach was employed to integrate qualitative and quantitative results in addressing the problem of heavy reliance of solid fuel by the Diné and addressing behavioral modifications.

Use of Propane and Natural Gas Stoves

Gaseous fuels are considered a product of decomposition of natural organisms, and for the Diné, the use of such fuels is not perceived to be harmful to humans; however, the appropriate protocol for accessing and utilizing these natural elements should be respected.

- In terms of stove use, flame color is important. The fire produced from wood combustion (red, yellow, and white) is the natural flame in Diné thought, while the blue flame produced when burning some gases could be associated with danger and lightning.
- Those who have been near a lightning strike or use struck wood may suffer from an imbalance within their body. This blue flame is also perceived to burn hotter and have effects on the body, particularly the gall bladder and lungs.

Electrical Heating

- Heating with electric stoves can have negative health effects due to dehumidification of air within the home, and subsequent dry skin and irritation of the nostrils.
- It is believed that modification of the air molecules by an electric heater can cause the wellbeing of a resident to be endangered.
- Particular caution should be given to electricity-based heating sources that provide heat through direct contact with the body. For example, individuals using electric blankets have undergone ceremonies to counteract the negative effects of this direct exposure to electricity.
- Though short-term exposure may not affect a person, it is believed that long-term exposure can lead to ailments such as nose infection, bleeding rashes, cramping, dry throat, itching skin, leg pains, and bronchitis.

Passive and Active Solar Heating

The Diné maintain a strong relationship with the Sun as a holy being and feel that the power of sunlight is theirs to use with care.

- Sunlight is to be respected and is present for everyone to experience. In this sense, solar radiation is not owned by anyone in particular, and small-scale solar installations are acceptable and could promote the Diné ideal of self-sufficiency (Yazzie, 2007).
- In general, sunrays (*Shandiin*) are considered good and positive energy, though some protocols are to be observed during their use.
- For example, one should not overexpose oneself to the sun as this can cause imbalance, and the use of solar energy for personal profit is questionable.

Pellet Stoves

The pellets used in these stoves are produced by compressed sawdust from lumbering waste materials; however, the wood types used must be carefully considered.

- Certain species are prohibited, including Aspen and Cottonwood, which belong to the snake family and produce considerable amounts of smoke. If wood pellets made of these species, or other prohibited types, are utilized within the home the resident could experience negative health effects.
- Also, some healing and protection ceremonies require wood embers and the high efficiency combustion of the pellet stove produces only ash in the solids stream, pellet stoves are not appropriate for traditional Hogan settings.

Coal (*Łeejin*) Usage

The implications of coal mining and wood harvesting must be considered when assessing the use of a solid fuel stove as a heating option.

- In Diné teachings, coal is a sacred element of the body of Mother Earth, and the removal of this resource must be a matter of caution.
- Proper protocols of respect and offering should be undertaken, but the use of coal that has been acquired through mass extraction may preclude such protocols.
- In general, large-scale extraction of elements for consumption should be approached with great care as the disregard of respect for these elements can lead to imbalance and negative effects in those who utilize those elements.

Stove Replacement and Improvement of Existing Stoves

Interestingly, traditional biomass combustion may be a preferred means of home heating in terms of Diné culture. The connection between the fire and Mother Earth is strongest when the fuel is burnt on the ground.

- Also, healing properties of various biomasses are important in Navajo culture (e.g. burning of cedar indoors is considered beneficial for health).
- According to Diné teachings, **the use of wood is the preferred method of heating dwellings and cooking food**, and naturally harvested cedar and oak are optimal for these purposes.
- The fuels produce red, yellow or white fire flames, which are viewed as the natural flames representing Diné sacred relative fires. Other tree species native to Diné homelands are also acceptable, such as Pine and Pinyon.

Diné lifestyle is rooted in the ways of nature and the concept of the Universe brings daylight, the seasons, and the phases of life. For this reason, there is a great reliance on the Sun, the father, as a sacred entity (*Diyin*). The idea of building according to the Sun is an ancient concept for the Diné people. In the past, material selection and the orientation of a Diné family's home would be dictated by the angle of the sun during a particular season, and the Diné phrase *T'aa shá bik'ehgo hooghan há dítéél* means that a home was built according to the motion of the Sun and consequently with nature. It is notable that the main door of a Diné home should face east to greet the rising sun.

Cultural Implications and Concepts

The Fundamental Law of the Diné was integrated into this study and states that tradition is a vital resource towards a solution. More specifically the Natural Law.

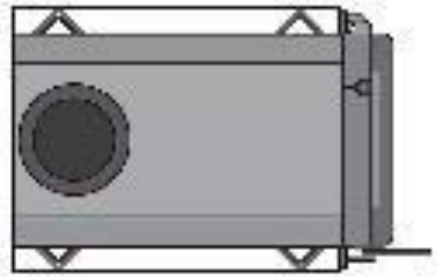
The Diné holistic experience is inherent with the natural environment, and lives are guided by the overarching philosophy of *Są'ah Naagháí Bik'eh Hózhó*.

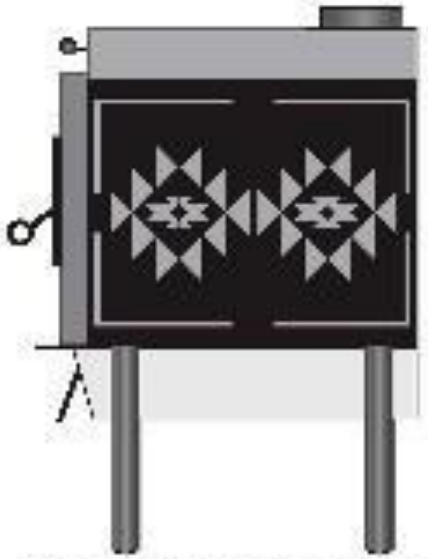
This concept with the Fundamental Law of the Diné represents the "duality of knowledge" in both male and female forms (Mother Earth and Father Sky) and provides for the foundation of Diné concepts of Balance and Harmony (Hozho).

Navajo Stove 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.

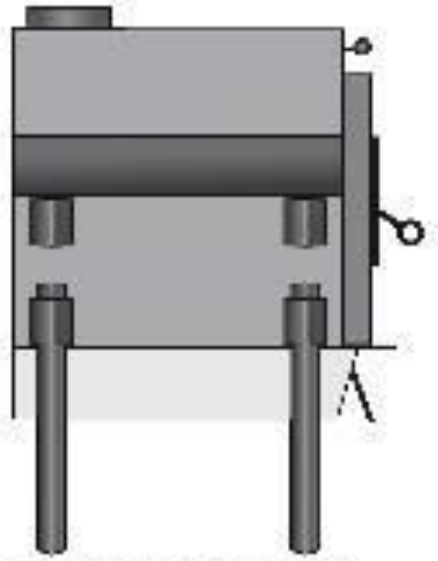




Side with Navajo heat shield

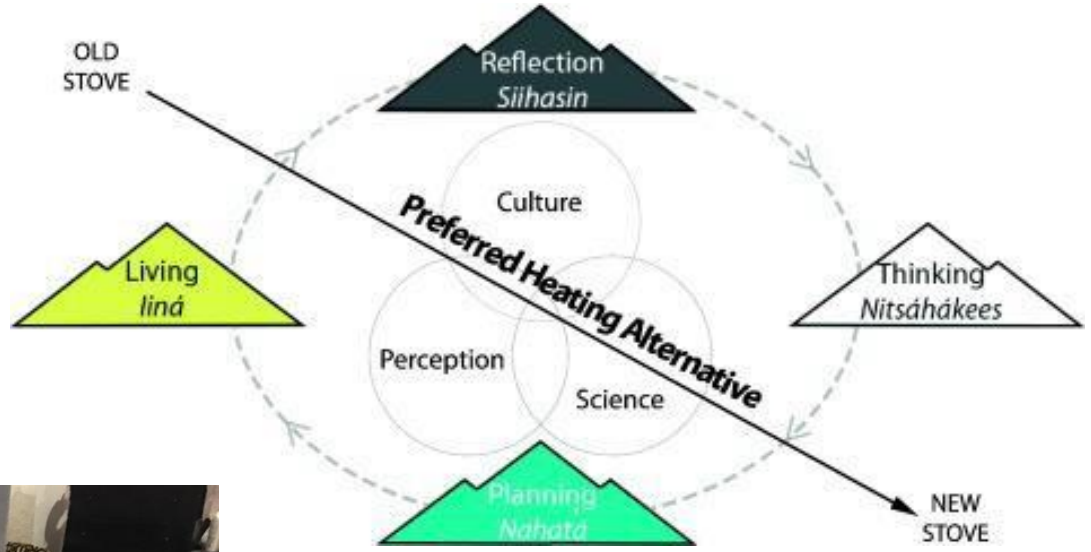
Navajo Front (v1)

Navajo Front (v2)



Side with no heat shield

A cleaner burning and environmental friendly stove



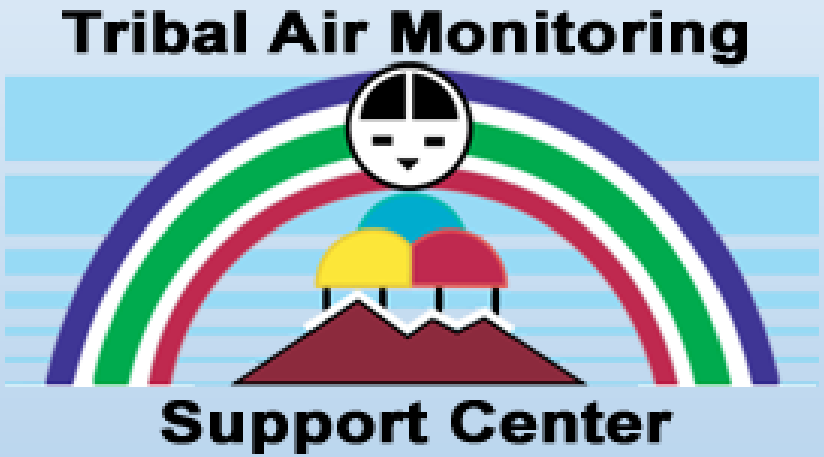
Resources

Tribal Air Monitoring Support Center Resources:

- U.S. EPA Burn Wise
  - https://www.epa.gov/burnwise
- National Fireplace Institute
  - https://www.nficertified.org/

Courses:

- HPB Education Foundation: Woodstove Installation Basics Training
  - https://hpbef.mindflash.com/PublicCoursePage.aspx?c=5059774539631
- NAU ITEP Webinar Trainings
  - https://www7.nau.edu/itep/main/training/training_air



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