



# NAVAJO NATION WOOD AND COAL STOVE CHANGEOUT PROJECT

Residential Wood Smoke Workshop  
March 6-8, 2018 | Nashville, TN

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*Photo Credit: Woodstock Soapstone*

# *So Many Partners, I'm probably forgetting some...*

**Navajo Nation EPA:** Eugenia Quintana, Tennille Begay, Michael King, Sky Izzo, Chris Yazzie, Nolan Hoskie, Kayleen Pino

**Diné College:** Perry Charley, Dr. Mark Bauer, Barbara Klein, Avery Denny, J. Mackenzie, Amber Crotty, Don Robinson, Selina Yazzie, Linda Garcia, Frederick Lee, Myra Bedonie, Jalissa Roy, Chad Randall

**Shiprock Chapter:** Duane Chili Yazzie (President)

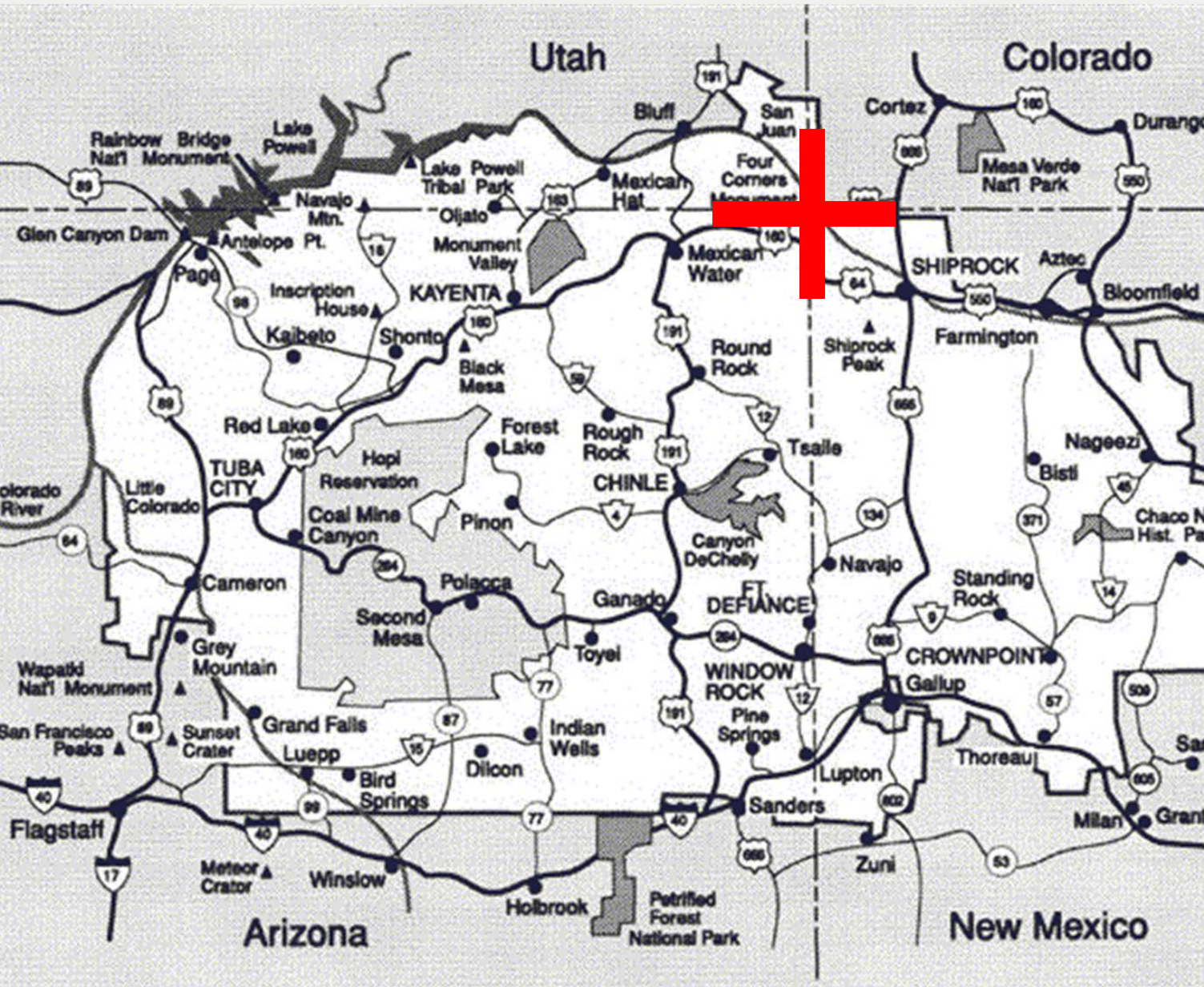
**University of Colorado, Boulder:** Dr. Lupita Montoya, Wyatt Champion, Naomi Cheng

**University of Montana, Missoula:** Dr. Tony Ward

**NESCAUM:** Lisa Rector, George Allen

**Industry:** Woodstock Soapstone (Tom Morrissey, Lorin Day, Will Jeffries, Glenn Sperry, Roy Hatch, Leif Engstrom), US Stove Company (Brandon Berry, Paul Williams), Arada (John Butterworth), Ferguson Anders (Bob Ferguson), National Fireplace Institute (Rick Vlahos), Hearth Patio and BBQ Association (John Crouch), Alliance for Green Heat (John Ackerly), Zohnnie Construction Industries (Etta Zohnnie), Selkirk, Arizona Public Service, Southern California Edison.

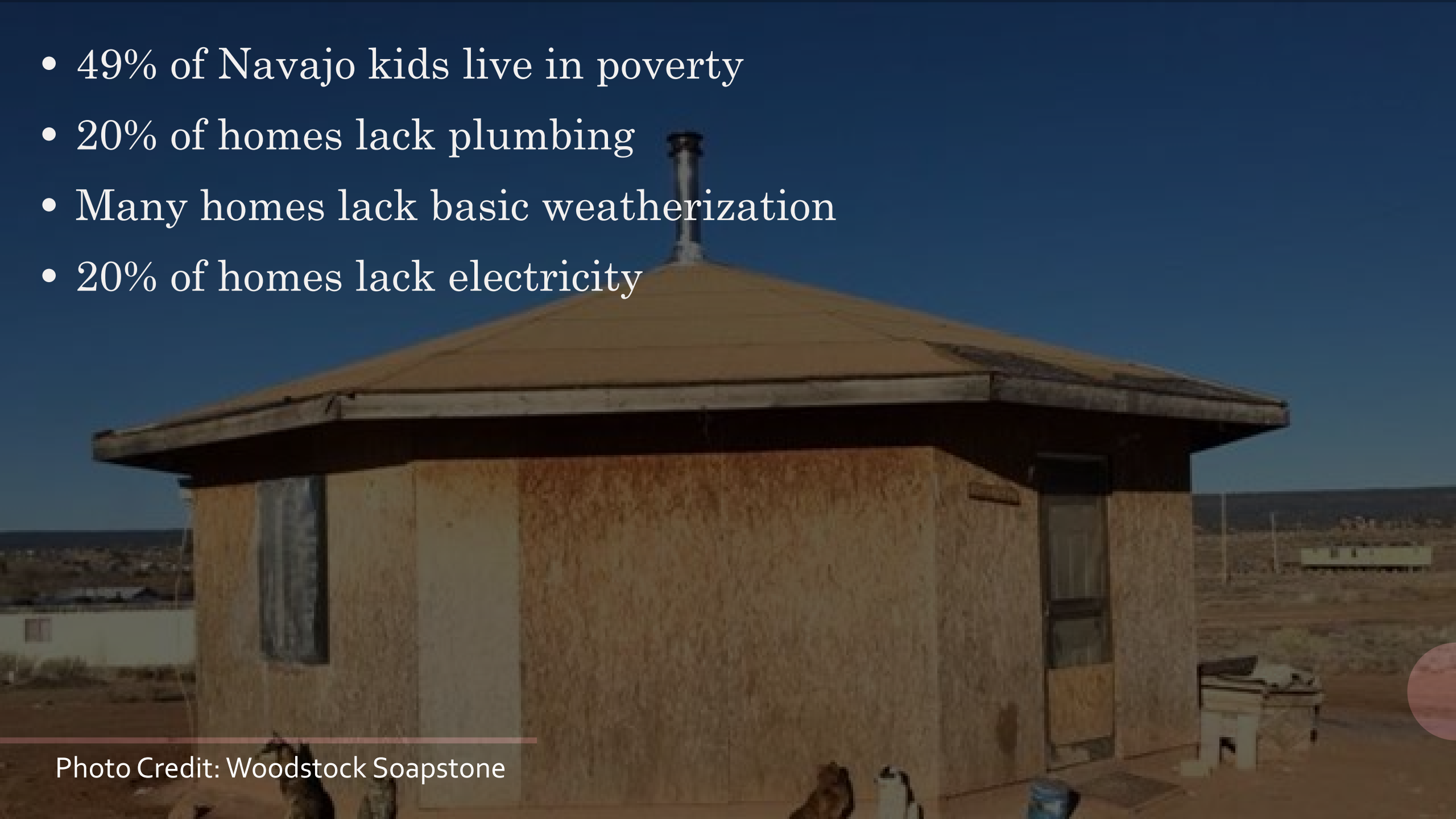
**US EPA:** Region 9, Burnwise Program, Office of Enforcement and Compliance Assistance, Office Regional and General Counsel, Office of Radiation and Indoor Air, Office of Research and Development, Tribal Air Monitoring Support Center



- Four Corners region where Utah, Colorado, Arizona, and New Mexico meet
- Largest Native American Reservation at 27,000 square miles
- Size of West Virginia, Delaware, Rhode Island, & Washington D.C. combined!
- Population = 177,000
- Number of homes = 49,907

- 49% of Navajo kids live in poverty
- 20% of homes lack plumbing
- Many homes lack basic weatherization
- 20% of homes lack electricity

Photo Credit: Woodstock Soapstone



# *High Desert Climate*

- Some parts >10,000 feet elevation
- Mesas are heavily forested
- Trees tend to be small in diameter





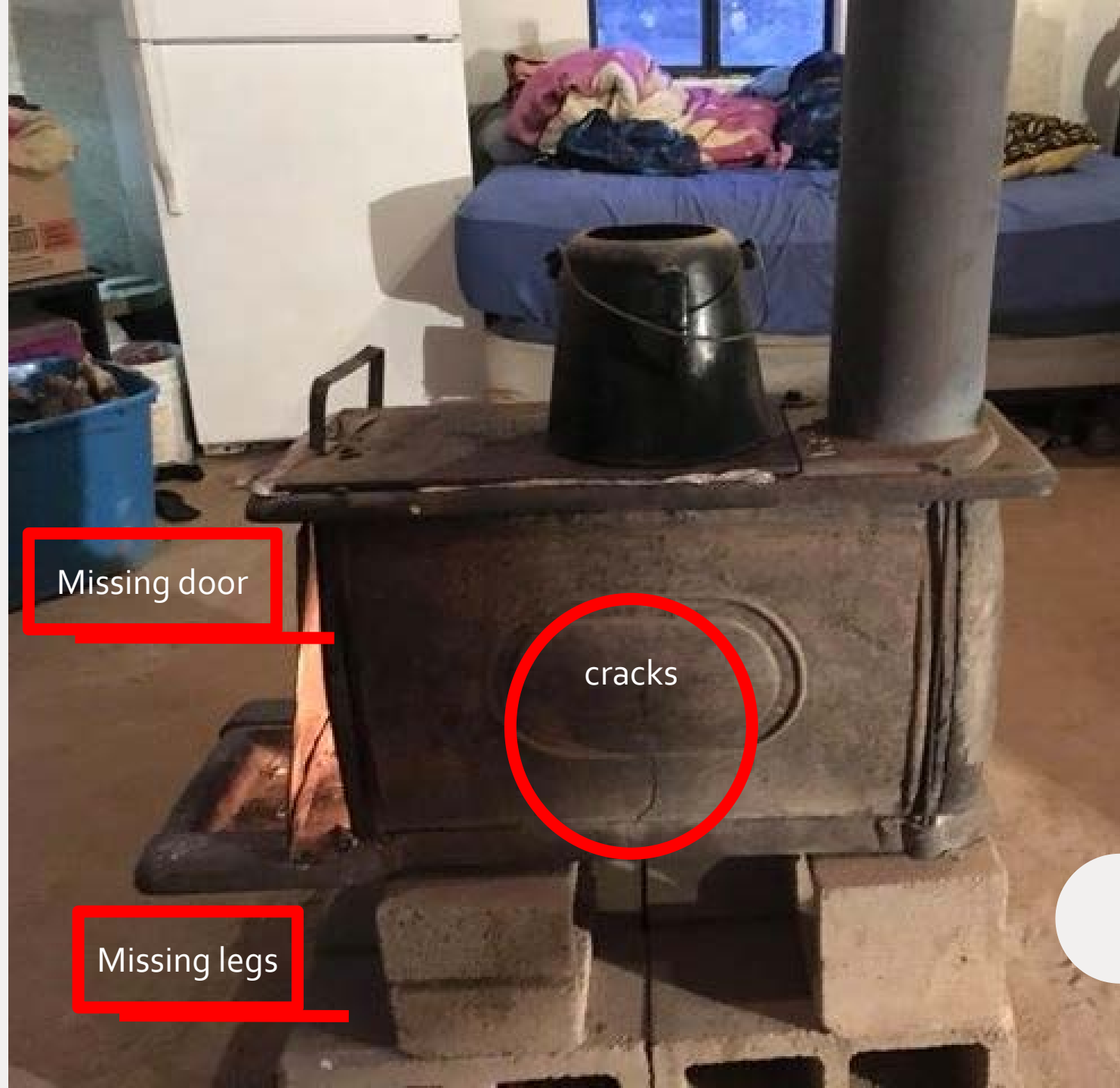
*Coal is readily available and in some cases provided for free under historic coal mining lease agreements.*

- About 66% of Navajo homes (~29k homes) heat with wood as the primary fuel source.
- Many supplement with coal on very cold days and at night.
- Natural gas and propane available in some areas but not preferred culturally or economically.
- Studies have found increased risk of respiratory illness in Navajo children heating with wood (and likely coal).

# *Stoves are very old and in disrepair*

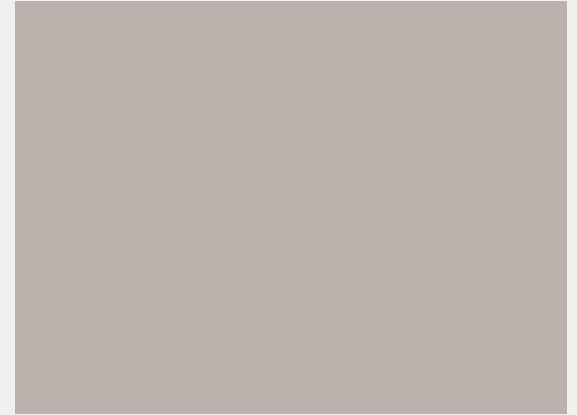
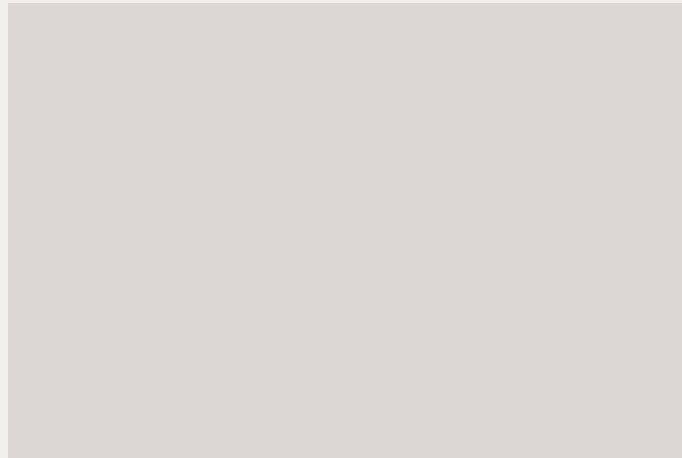
- Nearly 33% of stoves are more than 10 years old
- 16% are 20 years or older
- Most are not designed for the fuels used (wood + coal) = inefficient, dirty, + unsafe
- Very inefficient stoves + lack of weatherization leads to increased use of coal as people attempt to keep the house warm overnight

Photo Credit: Woodstock Soapstone



*Homemade  
stoves are  
common*

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Hazardous venting and installation common. 11% have NO venting.

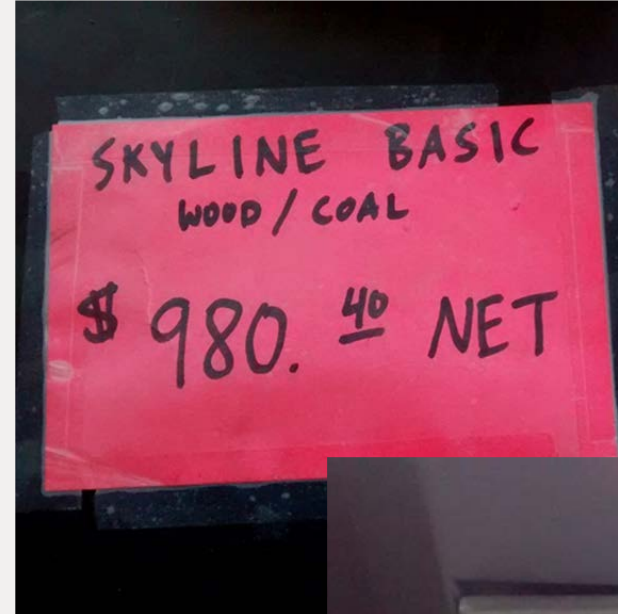


Photo Credit: Navajo Nation EPA (left) Woodstock Soapstone (right)

# Challenge:

- Huge need – at least 5000 stoves need replacing
  - No funding
  - No dedicated staffing
  - No cleaner burning stove that can meet the needs of Navajo Nation households
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Stoves sold as “wood and coal” are not certified and do not burn either fuel well



# First Opportunity:

## Research Funds

- Opportunity to apply for small pot of research funds from EPA = \$45k
- Allowed us to establish strong partnerships and community buy-in
- Understand community preferences and cultural, economic, and technology barriers
- Provided solid understanding of problem and viable fixes

<http://www.sciencedirect.com/science/article/pii/S0048969716324925?via%3Dihub>



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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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Graphical abstract





## 4 Tips for Cleaner Stoves and Healthier Homes

Fire is sacred and should be treated with respect inside Navajo homes. Follow these guidelines to minimize smoke and protect your health when using the family stove.

- 1 Clean and repair your stove and chimney.**  
Repair cracks or gaps and clean your stove and chimney regularly to ensure a safe fire and to keep your family warm.
- 2 Burn the right fuel.**  
Burn only dry, seasoned wood in a wood-burning stove and clean, high-quality coal in a coal stove. Never burn trash, tires, or combustible liquids like gasoline or lighter fluid.
- 3 Ensure proper ventilation.**  
Ensure that your stove pipe and chimney vent properly so smoke is directed outdoors. Keep the stove door closed tightly when a fire is burning to avoid releasing harmful smoke into your home.
- 4 Use smoke detectors and carbon monoxide alarms.**  
These devices help make your home safer for you and your family. Test regularly to ensure proper functioning.



For more information on how to heat your home safely, go to [NavajoNationEPA.org/AirQuality](http://NavajoNationEPA.org/AirQuality).

# *Enhancing Education and Outreach through the Navajo Nation EPA's Air Program*

- Navajo Nation EPA incorporated an indoor air program into their Clean Air Act program
- Includes:
  - indoor air measurements
  - education
  - community events
  - training
  - development of custom clean burning tips
  - Clean Burning videos
  - Multiple research studies
- Funding through Clean Air Act grants, Discretionary Burn Wise funds

# *Four Corners Power Plant Settlement Agreement Funds \$4.7M in stove changeouts and home weatherization*



**Four Corners Power Plant**



- Coal-fired power plant on the Navajo Nation
- 2015 Clean Air Act settlement between EPA and Four Corners Power Plant co-owner
- Provides \$3.5M for stove replacements and \$1.2M for home weatherization on Navajo Nation
- Estimate enough for 500-700 homes
- Included option to fund testing of dual-fuel stoves (NTE \$160,000)
- Also allows funding of moisture meters, ash buckets, CO detectors

# *Training Contractors*

- Settlement requires employment of Navajo workers
- Very few contractors trained in stove installation
- Partnered with Navajo Nation EPA to host and advertise training
- Heath Patio and BBQ Education Foundation Provided two 2-day classroom trainings to 43 contractors
- Will offer hands-on training when full changeout program begins
- Funding: discretionary program funding from Indoor Air and Burn Wise programs



# Developing a Cleaner Dual-Fuel Stove

## GOAL -- DEVELOP AND CERTIFY A STOVE THAT CAN:

- Reduce emissions while burning coal
  - Meet NSPS standards while burning wood
  - Provide an efficient over-night burn
  - Withstand the high temperatures, ash, and pollutants associated with burning subbituminous coal used on the Navajo Nation
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## STEPS:

1. Identify commonly used stove types on the Navajo Nation
2. Perform emissions tests on these stoves to understand “baseline” emissions for comparison
3. Work with stove manufacturers to develop and test pilot dual-fuel stoves
4. Certification of viable dual-fuel stoves

# Baseline Emissions Testing

- Identified 3 commonly used stoves on the Navajo Nation: US Stove's Boxwood model, US Stove's Wonderlux model, and the "Skyline" stove
- Developed Navajo test method that reflects real world use patterns with wood and coal
- Tested new, unused models
- 4 test runs on wood, 2 runs on Fruitland coal, 2 runs on Black Mesa coal
- Funded by discretionary Burn Wise funds (contract with Ferguson Anders + Co)



Low Fire Test Run – Fruitland Coal –  
Test Model 2  
Photo #

1. Pre-burn Kindling and Start-up Fuel in stove
2. Test Load, 3 Pieces Fruitland, 10.84 lb.
3. Pre-burn Fuel Load in Stove
4. Pre-burn Fuel Load at 48 min. after adjustment
5. Test fuel load in stove.
6. Smoke plume 30 feet from dilution tunnel exit
7. Unburned coal and ash at end of test run - 0.0 lb indicated on scale, 305 min.

Ferguson, Anders & Company  
P.O. Box 676, South Royalton, VT 05693 • 802-763-2339

Photo Credit: Bob Ferguson  
Boxwood (left) Skyline (middle) Wonderlux (right)





# *New Stove Development*

- Three manufacturers participated:
    - US Stove Co (Shiloh model)
    - Arada (UK Company) (Farringdon model)
    - Woodstock Soapstone (Navajo model)
  - Existing models of US Stove and Arada stoves underwent “pilot” emission testing using Black Mesa coal at Ferguson Anders.
    - Paid for by Settlement Agreement
  - Woodstock Soapstone developed a new stove custom designed for this purpose.
    - Testing in Woodstock’s manufacturing facility (paid for by Woodstock)
    - Beta testing in the field (5 Navajo homes early 2017) followed by product improvements (paid for by Woodstock)
    - Certification testing October 2017 (Paid for by Settlement)
    - Certified December 2017
  - US Stoves preparing for certification testing
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# *Beta Testers for Woodstock Soapstone's Navajo Stove*



Photo Credit: Woodstock Soapstone

# *Changeout Plans*

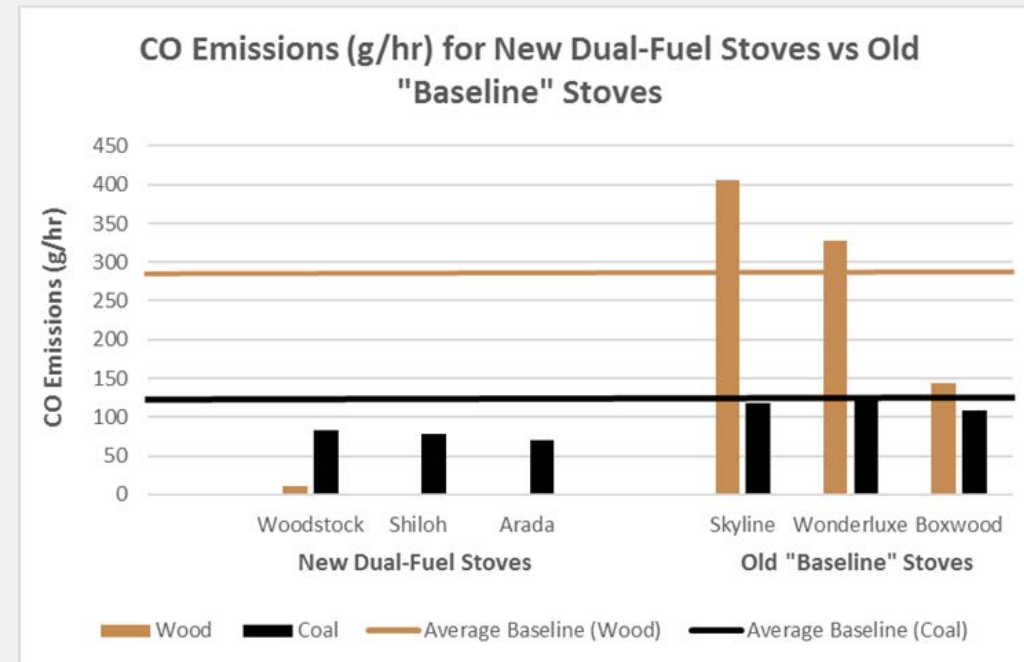
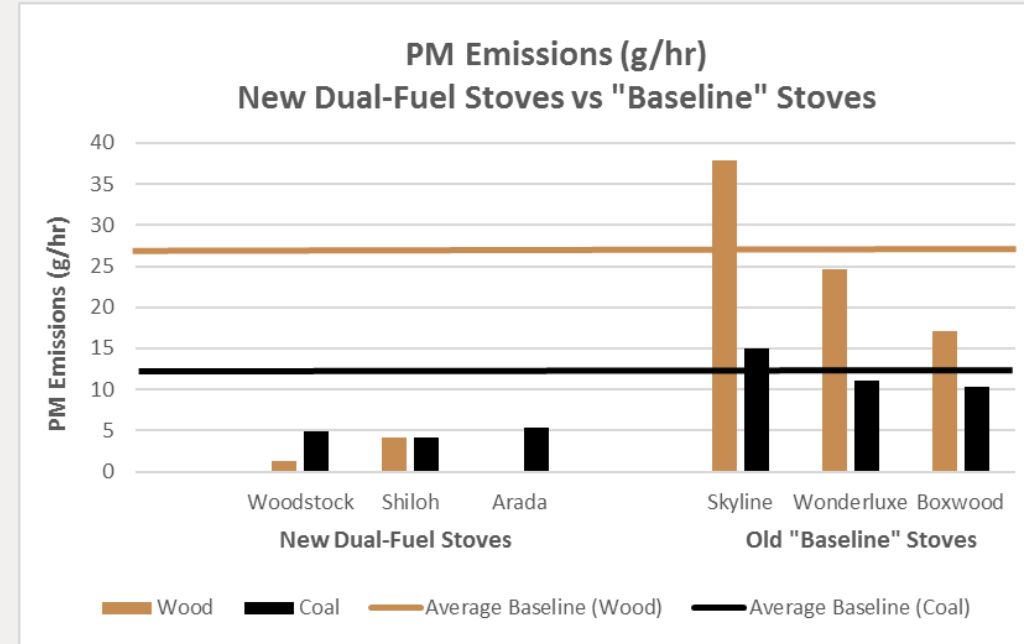
- Pilot phase to replace stoves in 20 homes – week of March 12
- Woodstock Soapstone will fly out to train contractor and assist
- Full changeout and weatherization to begin later this year
- Anticipate ~500-700 homes over 5 years
- New stove plus basic weatherization
- Options to replace existing wood or coal stove with EPA-certified wood, wood/coal, pellet, natural gas, propane, or other cleaner appliance
- Includes CO/Smoke detector, wood moisture meter, ash bucket



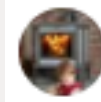
# Are the new dual-fuel stoves an improvement over baseline stoves?

Percent Reductions in Emissions

Stoves	PM Emissions		CO Emissions	
	Wood	Coal	Wood	Coal
Woodstock compared to baseline	-95%	-59%	-97%	-30%
Woodstock compared to Skyline	-97%	-67%	-98%	-30%
Shiloh compared to baseline	-84%	-66%	NA	-33%
Shiloh compared to Skyline	-89%	-73%	NA	-34%
Average Woodstock and Shiloh compared to Average Baseline	-90%	-63%	NA	-32%
Average Woodstock and Shiloh compared to Skyline	-93%	-70%	NA	-32%



# Feedback from the field



Woodstock Soapstone Co added 3 new photos.

January 18 · 🌐

Final reflections on the Hogan install, January 9, 2018:

We went back to the Navajo Hogan on Friday (3 days after the installation), to see how the Owen's family was doing, and to answer any questions before we headed back home. We immediately found that installing the new stove, and plugging the hole at the top of the Hogan with a new Selkirk chimney, had had a series of remarkable effects:

The installation had these concrete material benefits

- The Hogan was warm and cozy.
- No more rain, snow or wind came in around the hole where the single wall pipe went through the roof, and replacing the scorched wood around the old pipe eliminated the immediate safety concern.
- The fire lasted all night, resulting in a better night sleep for the entire family.
- The family's monthly wood expense will be drastically reduced, we anticipate by half. We recommended using some of the money saved to insulate the ceiling, which would then result in an even greater fuel/cost savings.
- Smoke and stove odors have been eliminated from the house.

More importantly, it had these unanticipated personal effects

- Mom got several full nights of sleep - her first since the onset of cold weather. No more getting up to feed the stove to help keep the Hogan warm.
- Mom's voice had completely cleared up in three days. She has a respiratory condition, and her voice was rough, raspy, and barely audible when we arrived on Tuesday, but clear as a bell on Friday. So clear in fact, that Lorin thought she must be another family member, but quickly realized her mistake! The air in the Hogan was clean.
- The kids slept better too. The Hogan was warm and comfortable, and the kids didn't fight for blankets – and went from using four blankets down to one per child!

# *Air Monitoring Study*



- Navajo Nation EPA is monitoring air quality in 9 homes this week prior to receiving a new stove, and again four weeks after receiving a new stove
- Measuring PM<sub>2.5</sub>, CO, and CO<sub>2</sub> indoors; PM<sub>2.5</sub> outdoors
- Qualitative health assessments for recipients with asthma or COPD (GlaxoSmithKline standardized assessments)
- Plans in place to expand to an additional 5-10 homes later this year
- Seeking large grants to monitor in up to 200 homes over five year period
- Required human subjects approval from 4 institutions
- Funding: Office of Radiation and Indoor Air (EPA) paid for monitoring equipment (will belong to TAMS center after study); Tribal Clean Air Act grant funds portion of NNEPA field work; in-kind contributions of time and equipment (NESCAUM, U Colorado, Diné College); next phase funded in part by EPA Research funds.

# *Lessons Learned*

*This project started with nothing except awareness of a public health issue with no obvious solution*

1. Grab every opportunity and partner that comes along.
  2. Talk about the issue incessantly.
  3. Study the problem: learn what will work and what will not work in the community, and understand.
  4. Think and plan ahead, even if there is not yet funding. It may be just around the corner.
  5. Settlements can fund stove replacements, but also other components of a stove changeout program that can achieve further emission reductions, such as weatherization, CO detectors, moisture meters, stove thermometers, and ash buckets.
  6. Other sources of funding for side-components can include EPA grants and contract and in-kind donations.
  7. Nothing happens without sustained and expanding partnerships.
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