

Cookstove Research Introduction



Jim Jetter

Chiapas, Mexico, October 2018

U.S. EPA Quick Facts

- Mission: Protect human health and the environment
- Founded: December 2, 1970
- Headquarters: Washington, D.C.
- Acting Administrator: Andrew Wheeler
- Number of employees: Approximately 15,000
- More than 1/2 of employees are engineers, scientists, and environmental protection specialists; other groups include legal, public affairs, financial, and information technologists
- Number of laboratories: 27

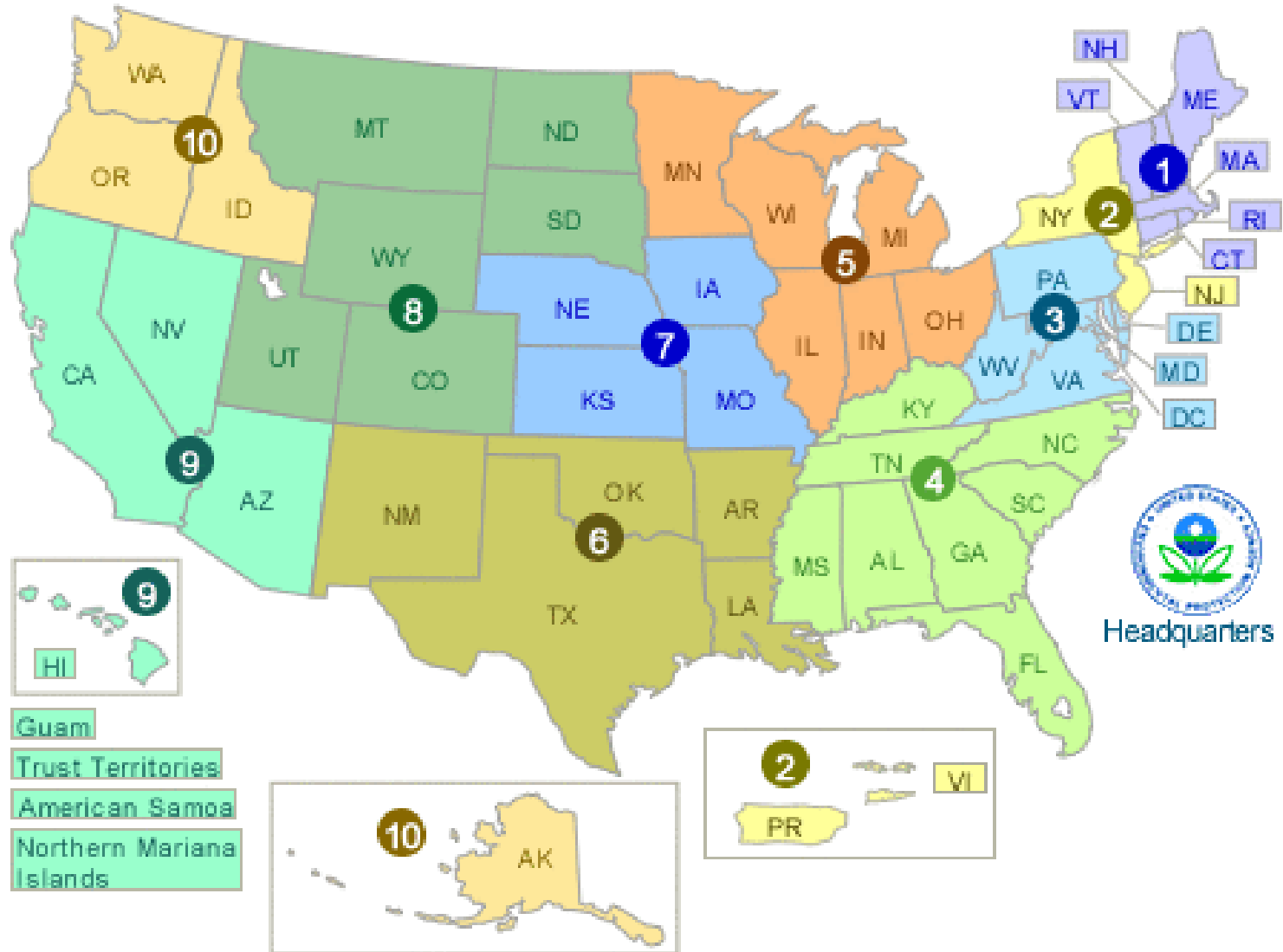
U.S. EPA Activities

- Environmental assessment, research, and education
- Developing national standards on air and water quality, etc., to protect human health and the environment, and then developing rules and regulations to attain those standards
- Maintaining and enforcing national standards under a variety of environmental laws, in consultation with state, tribal, and local governments
- Delegating some permitting, monitoring, and enforcement responsibility to U.S. states and the federally recognized tribes
- Enforcement powers include fines, sanctions, and other measures
- Working with industries and all levels of government in a wide variety of voluntary pollution prevention programs and energy conservation efforts

U.S. EPA Offices

- Administration and Resources Management
- Air and Radiation
- Chemical Safety and Pollution Prevention
- Chief Financial Officer
- Enforcement and Compliance Assurance
- Environmental Information
- General Counsel
- Inspector General
- International and Tribal Affairs
- Land and Emergency Management
- **Research and Development**
- Water
- 10 Regional Offices in U.S.

EPA Regions



Office of Research and Development

Deputy Assistant Administrator for Management

- › National Center for Computational Toxicology (NCCT)
- › National Center for Environmental Assessment (NCEA)
- › National Center for Environmental Research (NCER)
- › National Exposure Research Laboratory (NERL)
- › National Health and Environmental Effects Research Laboratory (NHEERL)
- › National Homeland Security Research Center (NHSRC)
- › National Risk Management Research Laboratory (NRMRL)

Deputy Assistant Administrator for Science

National Research Programs:

- [Air, Climate, and Energy](#)
- [Chemical Safety for Sustainability](#)
- [Human Health Risk Assessment](#)
- [Homeland Security](#)
- [Safe and Sustainable Water](#)
- [Sustainable and Healthy Communities](#)

Office of Science Policy (OSP)

[About OSP](#)

Associate Assistant Administrator

- Office of Science Information Management (OSIM)
- Office of Program Accountability and Resource Management (OPARM)
- Office of Administration and Research Support (OARS)

A Little Perspective on Air Quality (PM_{2.5} as an indicator)



Chicago, IL: August 16, 2000

PM_{2.5} < 10 µg/m³



Chicago, IL: August 26, 2000

PM_{2.5} = 34 µg/m³



Home with Open Fire (Guatemala)

Peak PM_{2.5} = 8670 µg/m³

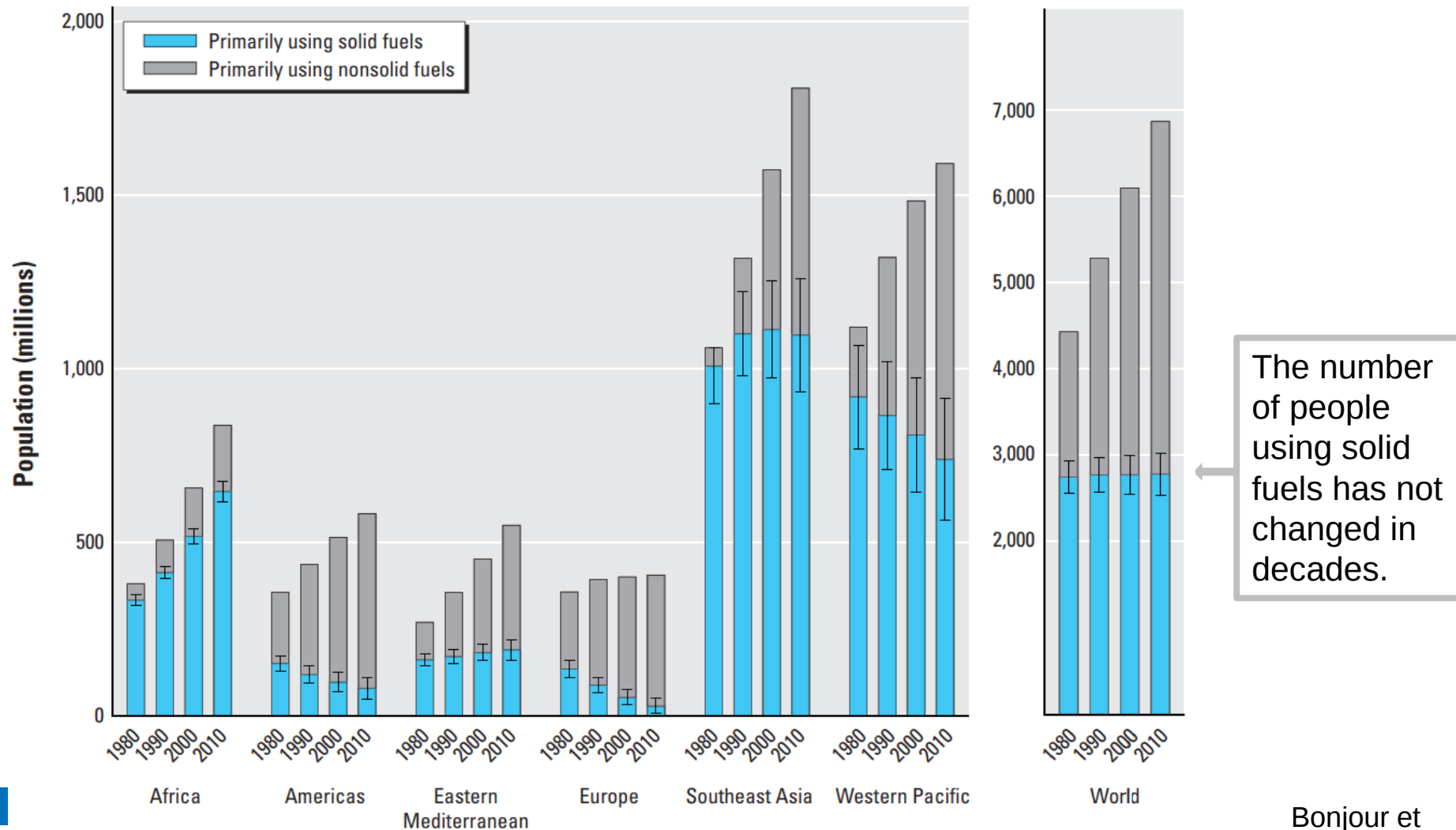
Typical 24-hr : 100s-1000 µg/m³

Some Pollutants in Indoor Smoke

Criteria Pollutants: PM_{2.5}, CO, NO₂,
Toxics: formaldehyde, benzene, 1-3 butadiene, benzo[α]pyrene
For Coal: SO₂, As, Pb, Hg, & F

	Annual		24-hour	
	EPA Standard	WHO Guideline	EPA Standard	WHO Guideline
PM _{2.5}	12.0 µg/m ³	10.0 µg/m ³	35 µg/m ³	25.0 µg/m ³

Percentage of Population Using Solid Fuels Over Time



Background on Cookstoves

- WHO estimates 3 ~ 4 million premature deaths annually due to household air pollution from cooking with solid fuels – *more deaths than HIV/AIDS, malaria, and TB combined*
<http://www.who.int/mediacentre/factsheets/fs292/en/>
- Recent studies show cookstoves are a large source of global black carbon emissions
<http://onlinelibrary.wiley.com/doi/10.1002/jgrd.50171/abstract>
- Clean cookstoves have potential multiple benefits, but present obstinate challenges
<https://pubs.acs.org/doi/10.1021/es304942e>
- Global Alliance for Clean Cookstoves is leading a multi-national multi-disciplinary effort
<http://cleancookstoves.org/>

Background – EPA Stove Activities

- **1980s** Conducted research on coal-burning stoves in China
<http://www.sciencemag.org/content/235/4785/217>
- **1980s to present** Developed regulatory program for certifying wood-burning heating stoves in the U.S.
<http://www.epa.gov/burnwise/index.html>
- **1990s** Sponsored cookstove research led by Kirk Smith
<http://www.kirksmith.org/publications/>
- **2003** Launched PCIA (Partnership for Clean Indoor Air) at the Johannesburg World Summit on Sustainable Development
PCIA Legacy Web Site:
<http://www.pciaonline.org/>

ES&T Articles

- *ISO International Workshop Agreement 11, Guidelines for Evaluating Cookstove Performance*, metrics and tier levels were based on EPA data published in journal article¹
- Feature cover article² on *Cleaner Cooking Solutions to Achieve Health, Climate, and Economic Cobenefits* – awarded Best Feature Article by *ES&T* for 2013

1. Jetter J, Zhao Y, Smith KR, Khan B, Yelverton T, DeCarlo P, Hays MD. *ES&T* 46 pp 10827-34, 2012.

<https://pubs.acs.org/doi/10.1021/es301693f>

2. Anenberg S, Balakrishnan K, Jetter J, Masera O, Mehta S, Moss J, Ramanathan V. *ES&T* 47 pp 3944-52, 2013.

<https://pubs.acs.org/doi/10.1021/es304942e>

Pollutant Emissions and Energy Efficiency under Controlled Conditions for Household Biomass Cookstoves and Implications for Metrics Useful in Setting International Test Standards

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[‡]Arcadis U.S. Inc., 4915 Prospect Drive, Durham, North Carolina 27713, United States



EPA Current Household Energy Activities

- U.S. government coordination, advocacy, training, and capacity building

John Mitchell, U.S. EPA

<http://www.pciaonline.org/webinars>

- Wood and coal heating stoves – Navajo Nation

Kathleen Stewart, U.S. EPA

<https://blog.epa.gov/blog/2016/06/ej-cleanstoves/>

Champion W.M., Charley P.H., Stewart K., Klein B., Solomon P.A., Montoya L.D. (2017). “Perception, culture, and science: A framework to identify in-home heating options to improve indoor air quality in the Navajo Nation.” *Science of the Total Environment*, 580:297-306.

<http://linkinghub.elsevier.com/retrieve/pii/S0048969716324925>

Science To Achieve Results (STAR) Grants

- Experimental Stove Interventions in Northern and Southern India

Rob Bailis, Stockholm Environment Institute

- Health Impacts of Household Energy Intervention in Tibet

Jill Baumgartner, University of Minnesota / McGill University

- Mapping Feasible Residential Solutions for Cooking and Heating

Tami Bond, University of Illinois, Urbana-Champaign

- Cooking and Lighting in Ghana

Michael Hannigan, University of Colorado, Boulder

- Household Sources of Primary and Secondary PM in Northern India

Kirk Smith, University of California, Berkeley

- Quantifying Cookstove Emissions Relevant for Impact Assessment

John Volckens, Colorado State University



RTP (Research Triangle Park) Activities

- ISO laboratory testing standards leadership and support
- Testing centers – capacity building
- Emissions characterization, *Guofeng Shen*
 - PAHs (polycyclic aromatic hydrocarbons)
<http://pubs.acs.org/doi/10.1021/acs.energyfuels.6b02641>
 - UFPs (ultra-fine particles)
<http://pubs.acs.org/doi/abs/10.1021/es304351p>
 - LPG (liquefied petroleum gas) stoves
<http://pubs.acs.org/doi/10.1021/acs.est.7b05155>
- Mutagenicity and health effects research
David DeMarini and Jan Dye
 - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4937857/>
 - <https://doi.org/10.1016/j.envres.2017.10.043>
- Cookstoves/fuels emissions and efficiency testing
 - <https://cfpub.epa.gov/si/>
- LCA (life cycle assessment) studies, *Susan Thorneloe*
 - https://cfpub.epa.gov/si/si_public_record_report.cfm?dirEntryId=322551
 - https://cfpub.epa.gov/si/si_public_record_report.cfm?dirEntryId=337079
- More info – webinar <http://www.pciaonline.org/content/findings-recent-us-epa-cookstove-research>

ISO Standards Development



ISO TC (Technical Committee) 285, Clean Cooking Solutions

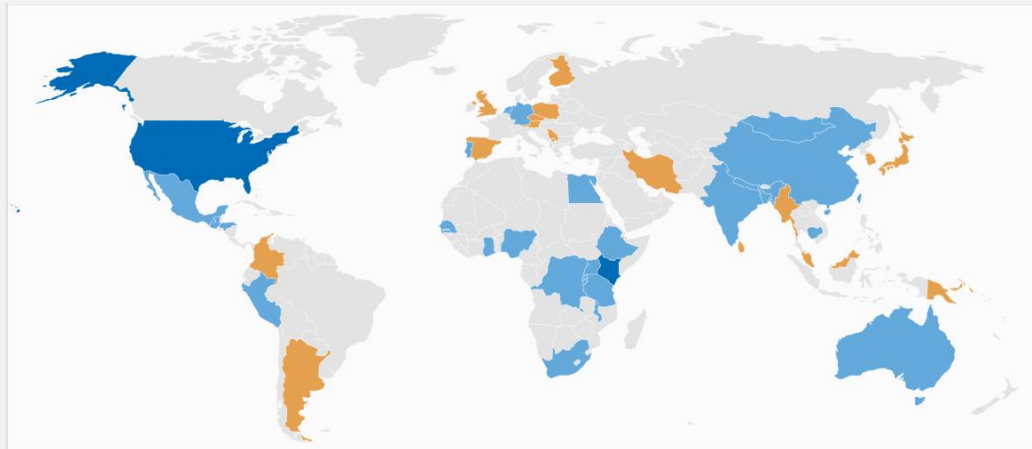
ISO (International Organization for Standardization)

TC (Technical Committee) 285

Clean Cookstoves and Clean Cooking Solutions

Ranyee Chiang, Chair

- Twin Secretariat
 - ANSI (American National Standards Institute)
 - KEBS (Kenya Bureau of Standards)
- 29 participating member countries
- 16 observing member countries



ISO TC 285

- Working Group 1 – Conceptual Framework
- Working Group 2 – Laboratory Testing
- Working Group 3 – Field Testing
- Working Group 4 – Social Impact Assessment
- Task Group 1 – Communications
- Task Group 2 – Fuels
- Task Group 3 – Title and Scope



Working Group 2 – Laboratory Testing

- >100 members from 18 countries and 5 liaison organizations
- ISO 19867-1 International Standard
Standard test for emissions, efficiency, safety, durability
- ISO 19867-2 Preliminary Work Item
Contextual test sequences
- ISO 19867-3 Technical Report
Voluntary performance targets



Capacity Building – Regional Testing Centers



Honduras



Uganda



Bolivia



Mexico

UNAM Morelia, Mexico

New research and testing facilities



Plancha Protocol Meeting, Honduras 2013



Plancha Stove Testing Protocol

Nosotros los participantes del SREP Taller para el **Desarrollo de la Propuesta del Protocolo Para la Evaluación de Estufas con Plancha**

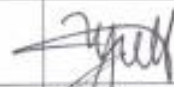
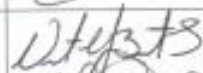
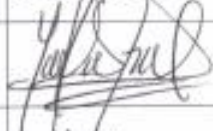
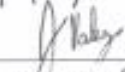
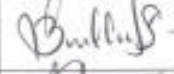
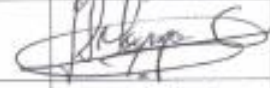
29 – 31 octubre 2013 hemos llegado a los siguientes acuerdos:

- El protocolo será una evaluación de laboratorio con el fin de caracterizar el desempeño de los diferentes modelos de estufas.
- El protocolo incluirá las diferentes pruebas aplicables según la tipificación de cada tipo de estufa y su plancha.
- Nuestra intención es tener el protocolo con características suficientes para la incorporación dentro de los estándares de ISO.
- Reconocemos que los resultados de evaluación de laboratorio no implica el mismo desempeño durante el uso en el campo.
- Durante la implementación del protocolo los siguientes factores serán evaluados:
 - Eficiencia térmica y consumo de leña
 - Emisiones al ambiente (CO, CO₂, PM_{2.5})
 - Contaminación intramuros (CO, PM_{2.5})
 - Caracterización doméstica
 - Hirviendo Agua
 - Cocción de tortillas
 - Perfil de temperatura de la plancha
- El protocolo de plancha debe tomar en cuenta las actividades de hervir agua y/o hacer tortillas.
- Inicialmente la seguridad del modelo será evaluado utilizando el protocolo de ISO.
- Estamos comprometidos a participar en la revisión de dicho protocolo de seguridad con las actividades de GACC para mejorarlo en el contexto de estufas de planchas.
- El WBT es adecuado para simular la tarea de cocinar en ollas.
- El CCT es reconocido como una manera para evaluar la preparación de alimentos en las estufas con plancha, pero a su vez reconocemos la necesidad de desarrollar nuevas metodologías.
- Hay que tomar en cuenta el área disponible para cocinar en la evaluación de la transferencia de calor hacia la plancha.
- En caso de modelos de estufas con planchas, hornos y calentador de agua, este protocolo aplica únicamente a la evaluación de plancha sin tomar en cuenta el potencial de calor de otros usos.
- Este protocolo es un esfuerzo en proceso y será abierto para el mejoramiento sistemático, en coordinación con La Alianza Global para Estufas Limpias.

Por lo tanto es nuestra recomendación que la propuesta de protocolo de evaluación de estufas con planchas consiste en las siguientes fases:

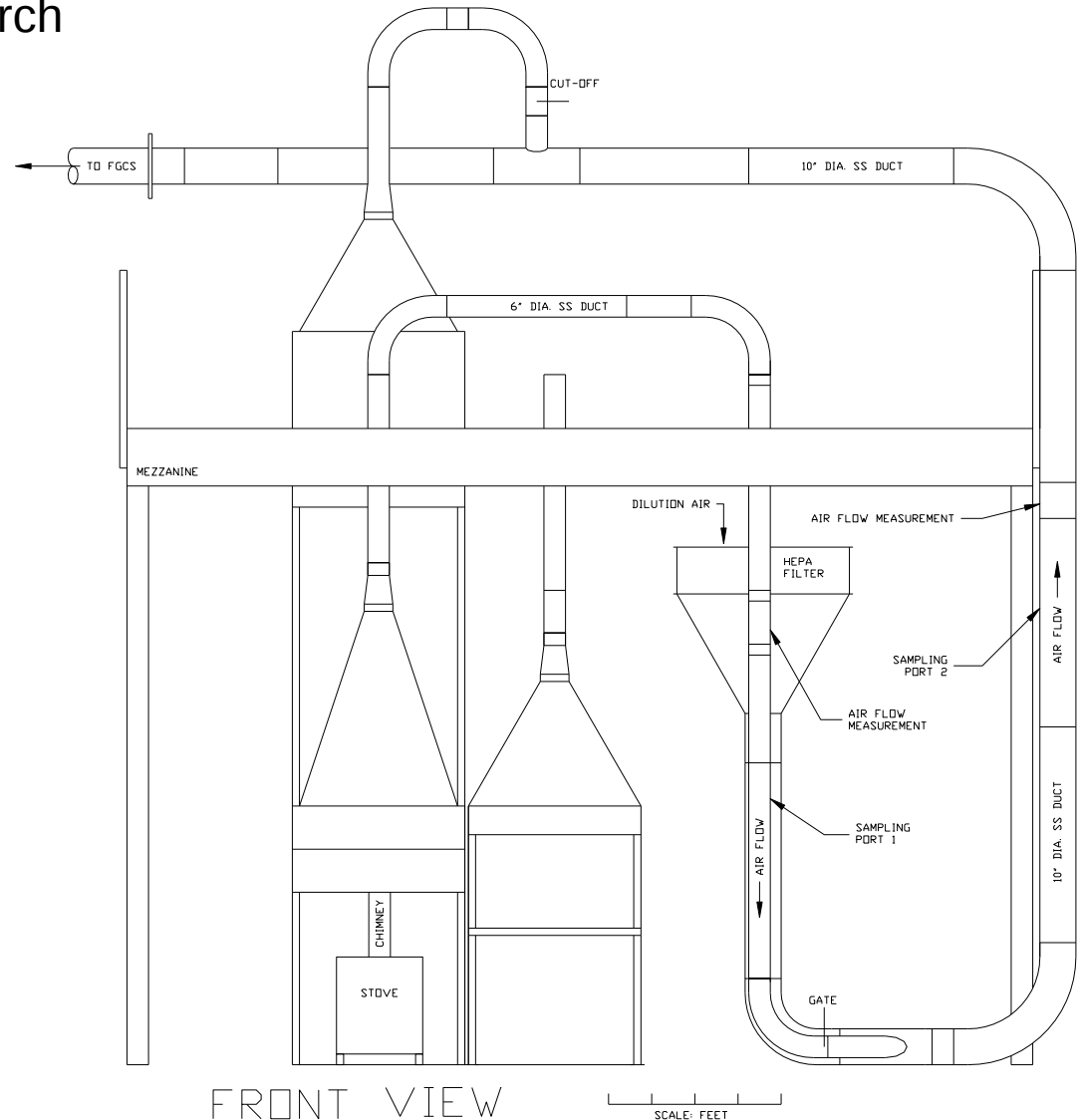
1. Aplicación de WBT 4.2.2 utilizando múltiples ollas.
2. Evaluación del modelo con planchaollas (fabricación de paredes de metal en la superficie de la plancha que serán usadas como ollas) o utilizando mylar que cubra un 60% y otra que cubra el 100% de la superficie de la plancha, utilizando la metodología del WBT.
3. Implementación, si fuera el caso, de una Prueba Controlada de Cocina para tortillas u otro alimento preparado directo en planchas.
4. Evaluación de seguridad utilizando el protocolo del ISO.

Plancha Stove Testing Protocol

NOMBRE	ORGANIZACIÓN	PAÍS	FIRMA
Rogério Carneiro de Miranda	PROLENHA	Brasil	
Marcelo Gorritty	Centro de Pruebas de Cocinas	Bolivia	
Oscar de León	Helps International	Guatemala	
Victor Berrueta	GIRA-UNAM	México	
Yarhy Flores	EnDev-GIZ	Honduras	
Jorge Valenzuela	FUNDEIH	Honduras	
José Bernilla	EnDev-GIZ	Perú	
Elder Mendoza	Proyecto MIRADOR	Honduras	
Carlos Pinel	AHDESA	Honduras	
Liza Madrid	SEPLAN/OHN	Honduras	
Jim Jetter	US-EPA	U.S.A.	
Leonardo Mayorga	PROLEÑA	Nicaragua	
Timothy Roy Longwell	Zamorano CCEM	Honduras	
Gracia Flores	Zamorano CCEM	Honduras	
Reyna Guzmán	Zamorano CCEM	Honduras	

Cookstove Testing Facilities in Research Triangle Park, NC, USA

A leading independent research
laboratory for cookstoves

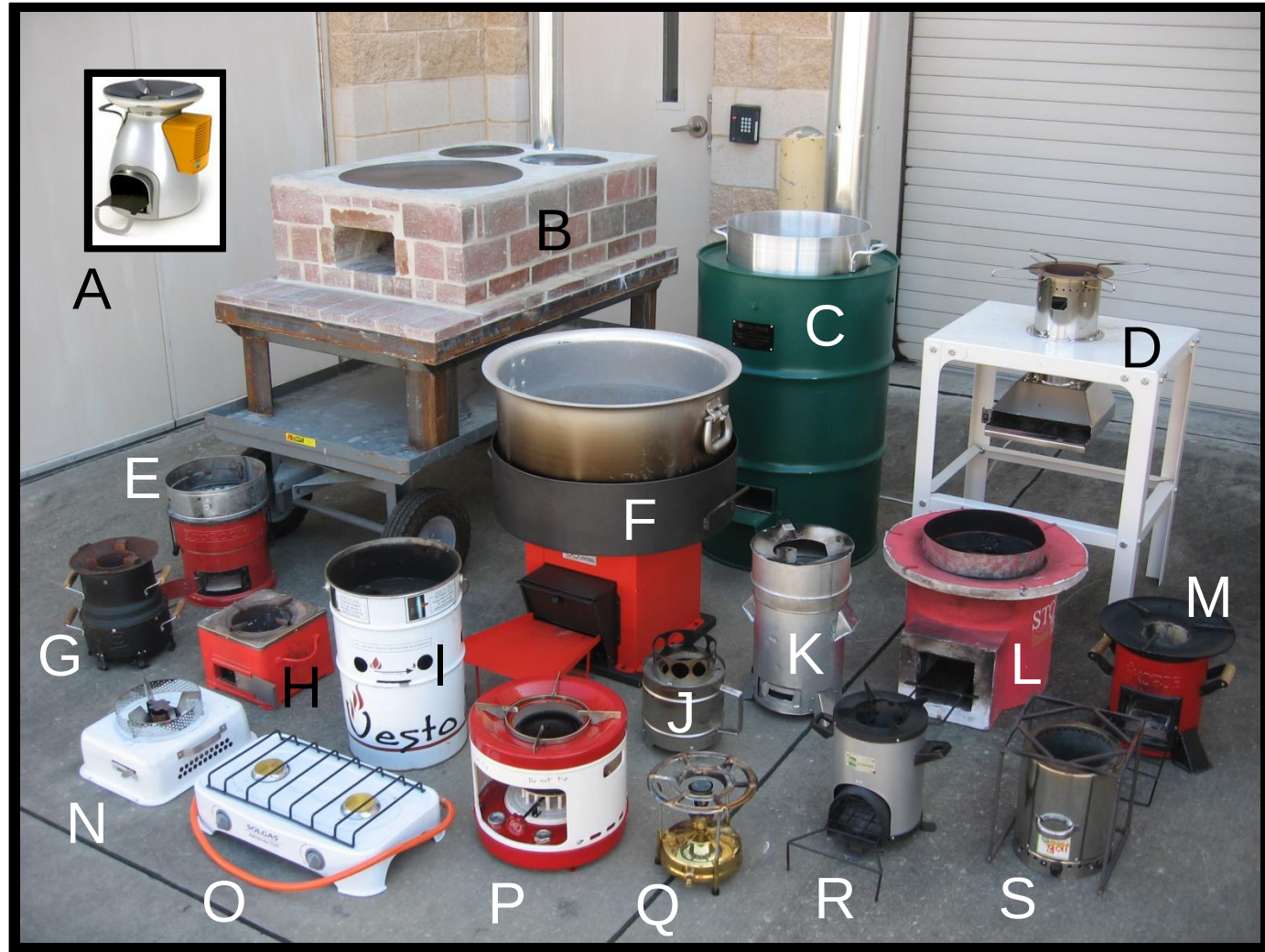


Laboratory Test Parameters

- Fuel consumption, energy efficiency, power
- PM (particulate matter), integrated samples: gravimetric
- PM, real-time: SMPS, APS
- CO (carbon monoxide), CO₂(carbon dioxide): infrared analyzers
- CH₄ (methane), THC (total hydrocarbons): FID analyzers
- NO_x (nitrogen oxides): chemiluminescence analyzer
- Black carbon: aethalometer, transmissometer
- Organic carbon, elemental carbon: thermal-optical analysis
- Aerosol light absorption and scattering, *in situ*: PASS-3 and nephelometer

Stoves/Fuels Testing

- A. BioLite HomeStove, wood
- B. Patsari, wood
- C. InStove 60L, wood
- D. Turbococina, wood
- E. Ecozoom Jet, charcoal
- F. Prakti – institutional, wood
- G. Envirofit CH-4400, charcoal
- H. Prakti Leo, charcoal
- I. Vesto, wood
- J. Peko Pe (TLUD), wood
- K. Mwoto (TLUD), wood
- L. Ecocina, wood
- M. JikoPoa, wood
- N. CleanCook, alcohol
- O. Solgas/Repsol, LPG
- P. Butterfly Model 2668 wick stove, kerosene
- Q. Butterfly Model 2412 pressure stove, kerosene
- R. Greenway, wood
- S. Eco-Chula XXL, wood



Solar Cooker Testing

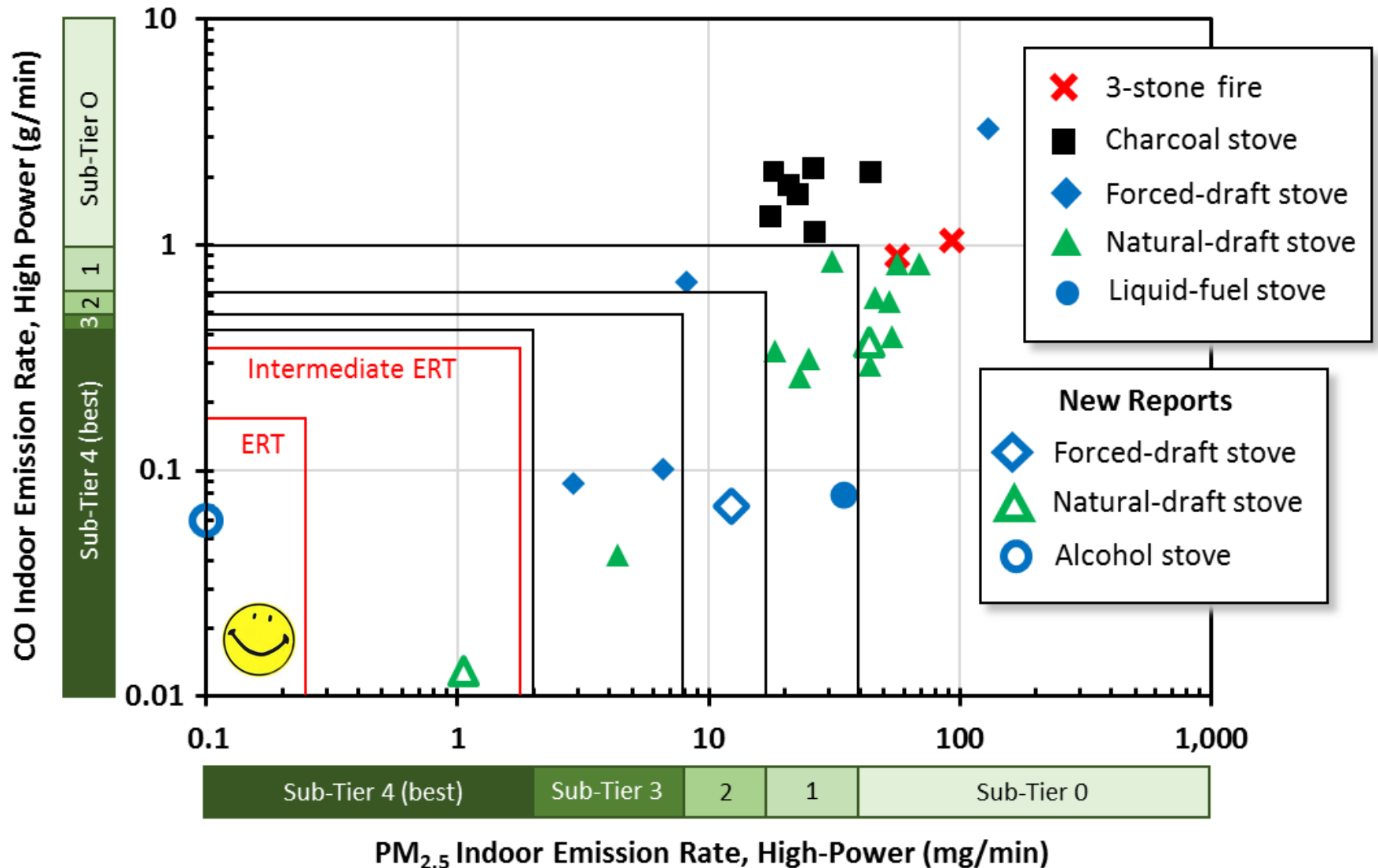
HotPot
Solar Cooker

Global Sun Oven

Sun Parabolic Solar Cooker

WHO Emission Rate Targets (ERTs)

Unvented (no chimney)



Acknowledgements (alphabetical)

- **Seth Ebersviller**, EPA Post-Doctoral Fellow
- **Jerry Faircloth**, Jacobs, Inc. laboratory operations
- **Dale Greenwell**, EPA instrumentation
- **Michael Hays**, EPA OC/EC analysis
- **Amara Holder**, EPA aerosol instrumentation
- **Laura Nessley**, EPA quality assurance
- **Bakul Patel**, EPA OC/EC analysis
- **Guofeng Shen**, EPA/ORISE Post-Doctoral Fellow
- **Michael Tufts**, Jacobs, Inc. metrology laboratory
- **Richard Valentine**, EPA facilities
- **Craig Williams**, Jacobs, Inc. laboratory operations
- **Robert Wright**, EPA quality assurance

Contacts

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Terry Keating keating.terry@epa.gov
- Health effects research
Ian Gilmour gilmour.ian@epa.gov
- Life cycle assessment of fuel options
Susan Thorneloe thorneloe.susan@epa.gov
- Navajo Nation coal stove study
Kathleen Stewart stewart.kathleen@epa.gov
- More info – Webinar: <http://www.pciaonline.org/content/findings-recent-us-epa-cookstove-research>