Advancing Sustainable Household Energy Solutions (ASHES)

ASHES seeks to help shift the current household energy paradigm to increasingly efficient and sustainable solutions through collaboration between researchers, academics, and practitioners.

ASHES Webinar Calendar

19 November 2020: World Health Organization's Clean Energy Toolkit

14 January 2021: STAR 1 – Cookstove emissions, climate, and health impacts: an integrated lab, field, and modeling study

24 February 2021: STAR 2 – Experimental interventions to facilitate clean cookstove adoption, promote clean indoor air, and mitigate climate change

24 March 2021: STAR 3 – How will cleaner cooking and lighting practices impact regional air quality and climate in the Sahel of Africa?

TBD April 2021: STAR 4

TBD May 2021: STAR 5

TBD June 2021: HAPIN study results sharing

TBD July 2021: Panel discussion: ISO lessons learned from the field

TBD – What would you like to hear about next? Let us know in the post webinar survey!

ASHES Science to Achieve Results (STAR) Webinar Series Presents:

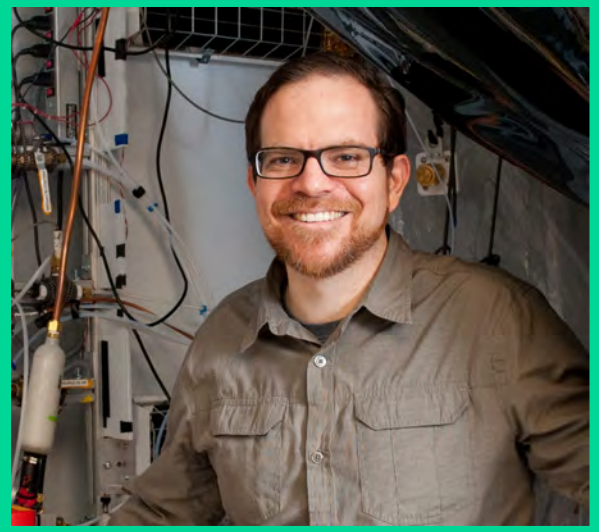
"Experimental Interventions to Facilitate Clean Cookstove Adoption, Promote Clean Indoor Air, and Mitigate Climate Change"

ashes-csu.org

Meet our Presenters:

Rob Bailis is a senior scientist at the Stockholm Environmental Institute's US Center.
rob.bailis@sei.org

Andy Grieshop is an Associate Professor in Civil, Construction and Environmental Engineering at North Carolina State University.
apgriesh@ncsu.edu



Abhishek Kar is a postdoctoral research scientist at Columbia University.
abhishekkar2305@gmail.com

Institutions involved in this STAR grant include:

Stockholm Environment Institute
Yale University
Jagriti
North Carolina State University
SAMUHA
University of British Columbia
University of Exeter
University of Georgia
University of Minnesota
Columbia University
University of Washington

Household Air Pollution: A Global Concern

Exposure to household air pollution is a top-ten risk factor for morbidity and mortality and a leading contributor to the global burden of disease. Access to modern energy has been proposed as a basic human right, yet 3 billion people still rely on traditional energy sources to support household needs like cooking, heating, and lighting. Emissions from traditional energy sources create unhealthy levels of household air pollution and contribute to the earth's radiative energy balance; over the next century, unhealthy levels of air pollution are expected to inflict a major toll on human health.

Want to learn more?
See our website and join the conversation at *ashes-csu.org*

ASHES Webinar Etiquette

During the webinar you will have the opportunity to ask questions and interact with presenters. We encourage wide-ranging discussion and expect civil dialogue. We will answer as many questions, that are appropriate for the presenters, as we can in the given time. When applicable we may combine or rephrase them. Thanks for your cooperation.

Opening Remarks

Image shared by Michael Johnson

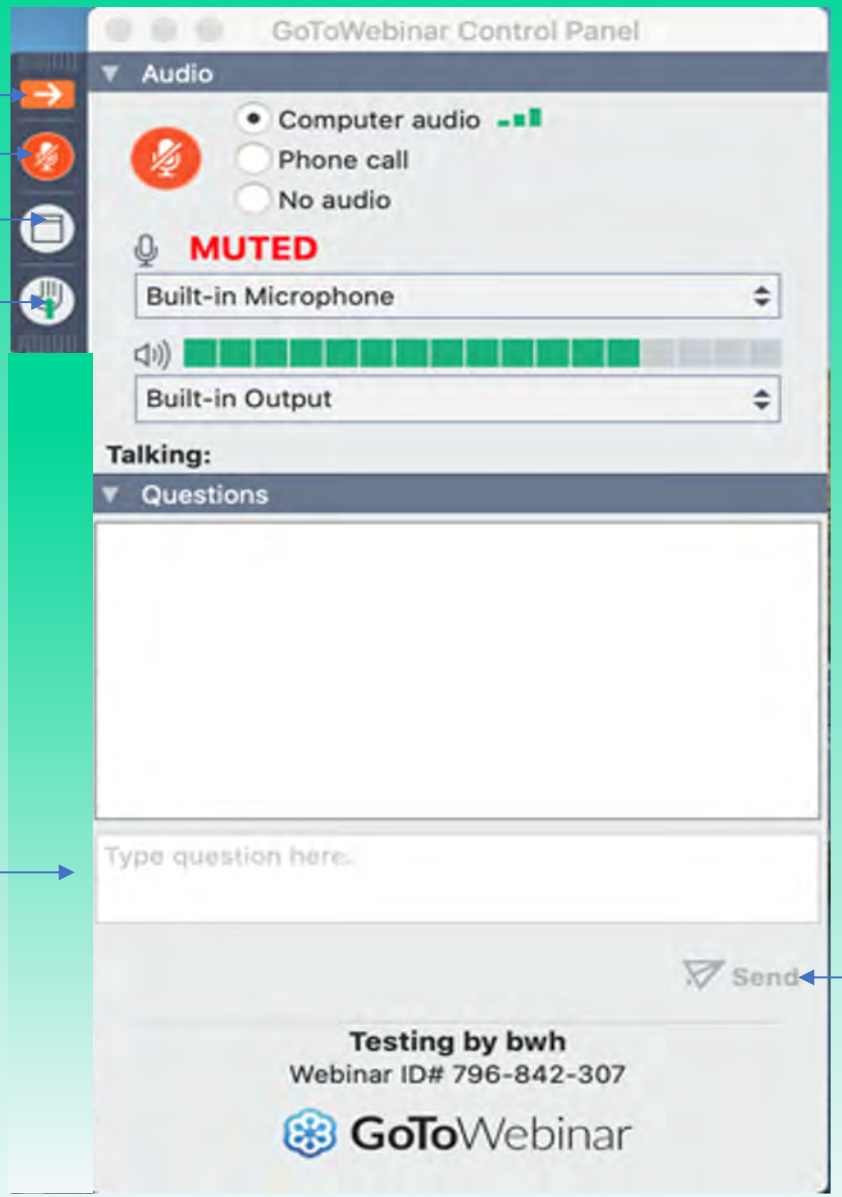
Webinar Control Panel

Minimize and maximize control panel

You are in 'listen only mode

Minimize and maximize screen

We are not using this function today.



Type your question in this box

Submit your question by clicking 'Send'

Science To Achieve Results (STAR) Extramural Research Grants

Measurements and Modeling for Quantifying Air Quality and Climatic Impacts of Residential Biomass or Coal Combustion for Cooking, Heating, and Lighting

- How would a feasible set of interventions for residential cooking, heating, or lighting in a developing part of the world impact air quality and climate?
- What is the realistic range and timeframe of foreseeable benefits to air quality and climate of various interventions in cooking, heating, or lighting practices in a developing part of the world, considering regional constraints (e.g., acceptability and availability of different technologies or fuels) and sustainability of alternate fuels or technologies?

RFA Published 2012, Projects Funded 2013/4 – 2018/9
Link to additional information and publications list:
https://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/recipients.display/rfa_id/563
Terry Keating, EPA Project Officer, keating.terry@epa.gov

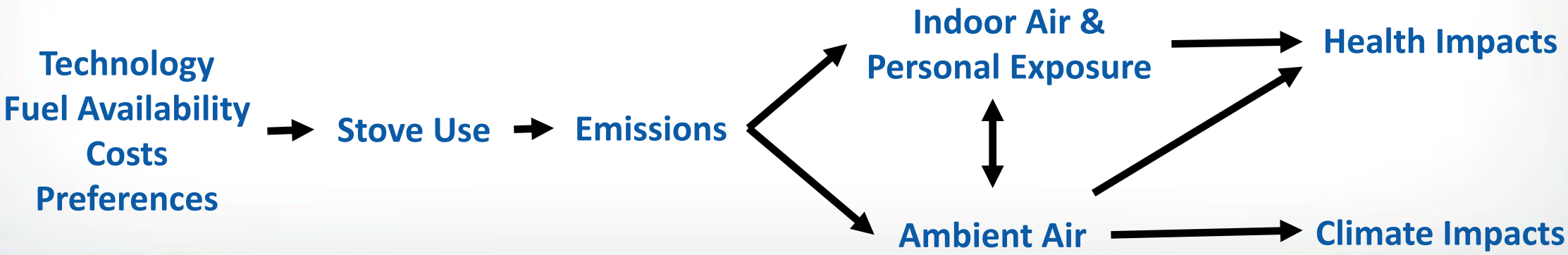
Science To Achieve Results (STAR)
Extramural Research Grants

6 teams

8 countries

13 field locations

>70 Publications



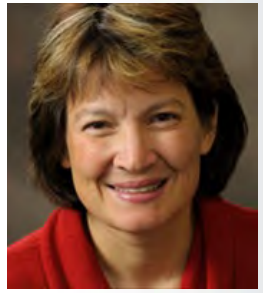
Science To Achieve Results (STAR) Extramural Research Grants

- Quantifying the Benefits of Improved Cookstoves: An Integrated Lab, Field, and Modeling Study
  John Volckens, Colorado State University

- Impacts of Cooking & Lighting Emissions in the African Sahel
  Michael Hannigan, Univ of Colorado, Boulder

- Health Impacts of Household Energy Intervention in Tibet
  Jill Baumgartner, Univ of Minnesota/McGill University

- Mapping Feasible Residential Solutions for Cooking and Heating
  Tami Bond, Univ of Illinois/Colorado State University



- Household Sources of Primary and Secondary PM in Northern India
  Kirk Smith, UC Berkeley; Ajay Pillarisetti, Emory University

- Experimental Stove Interventions in Northern and Southern India
  Rob Bailis, Yale Univ/Stockholm Environment Institute

Experimental Interventions to Facilitate Clean Cookstove Adoption, Promote Clean Indoor Air, and Mitigate Climate Change

Rob Bailis – Stockholm Environment Institute
Andrew Grieshop – NC State
Abhishek Kar – UBC/Colombia U

ASHES Seminar
Science to Achieve Results #2
24 Feb, 2021

The full team

Co-PIs

Rob Bailis – Yale/Stockholm Env't Institute
Andrew Grieshop – NC State
Mamta Chandar – Jagriti Kullu
Pradeep Talashery – Samuha
S Narayanswamy – Samuha
Nadine Unger – Yale/Exeter University
Puneet Dwivedi – Yale/University of Georgia
Julian Marshall – U Minnesota/U Washington
Hisham Zerriffi – UBC

PhD Students and Post-docs

Abhishek Kar – UBC (now at Colombia U)
Vikas Menghwani – UBC
Devyani Singh – UBC (now at Harrisburg University)
Arundhati Jagadish – UGA (now at Conservation Int'l)
Deepti Chatti – Yale University (now at Humboldt State)
Yaoxian Huang – Yale University (now at Wayne State)

Research managers

Karthik Sethuraman
Grishma Jain

Research assistants

Carlos Gould
Roshan Wathore
Adam Walters
Ryan Repoff

Supplemental co-Funding

Clean Cooking Alliance (formerly GACC)
UBC
Yale University
NC State

Overview

Rob

- Research questions & study design
- Stove choice and stove adoption

Andy

- Emissions and exposures

Abhishek

- LPG adoption through PMUY

From the EPA's RFP released in March 2012…

- How would **a feasible set of interventions** for residential cooking, heating, or lighting in a developing part of the world impact air quality and climate?
- What is **the realistic range and timeframe** of foreseeable benefits to air quality and climate of various interventions in cooking, heating, or lighting practices in a developing part of the world…

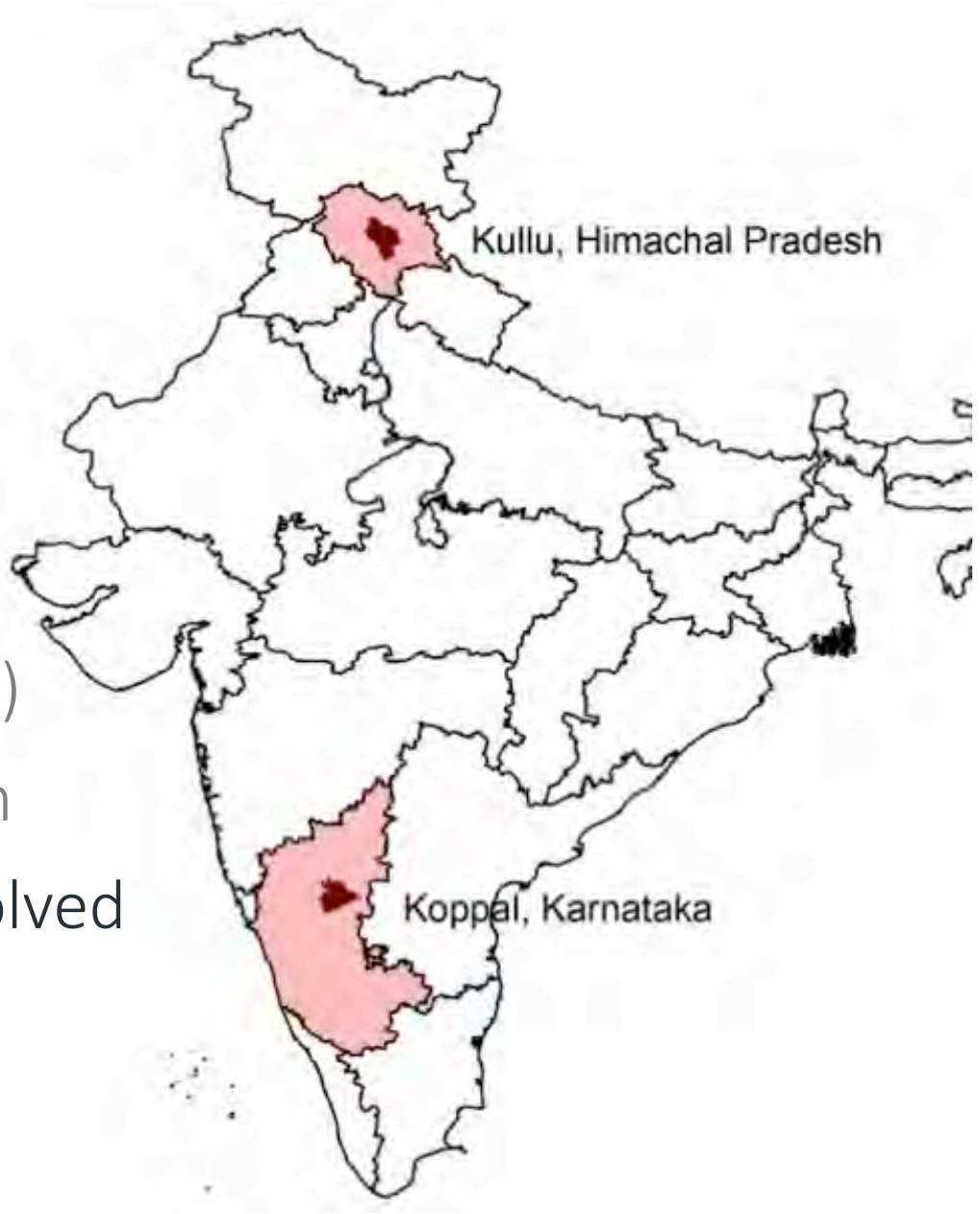
From: http://www.epa.gov/ncer/rfa/2012/2012_star_cook_heat_light.html

Research Objectives

1) assess the availability and acceptability of clean cooking technologies and fuels in two Indian states
2) experiment by varying stove price and exchange policies among users to see how they affect:
   - Adoption and long-term use
   - Fuel consumption
   - Emissions and exposures
3) Model impacts of stove adoption on climate through a range of scenarios informed by data from the field

Study design

- Choice exp't with randomized treatments
  - Offer wide range of biomass options
  - LPG and induction (as an afterthought)
- 2 sites / 4 communities in each
  - 480 HHs overall (400 trmnt / 80 controls)
  - Baseline, midline, endline data collection
- Original focus on biomass stoves largely evolved into a study of LPG adoption and impacts



Study design

(replicated in each state)

Factorial design with two treatments

- Randomized by community
- Free vs. Subsidized
- With/without stove exchanges

Geographic context

Himachal Pradesh

- Small mountainous state in N India
- 6.8 million people
- High HDI
- Seasonal heating demand

Karnataka

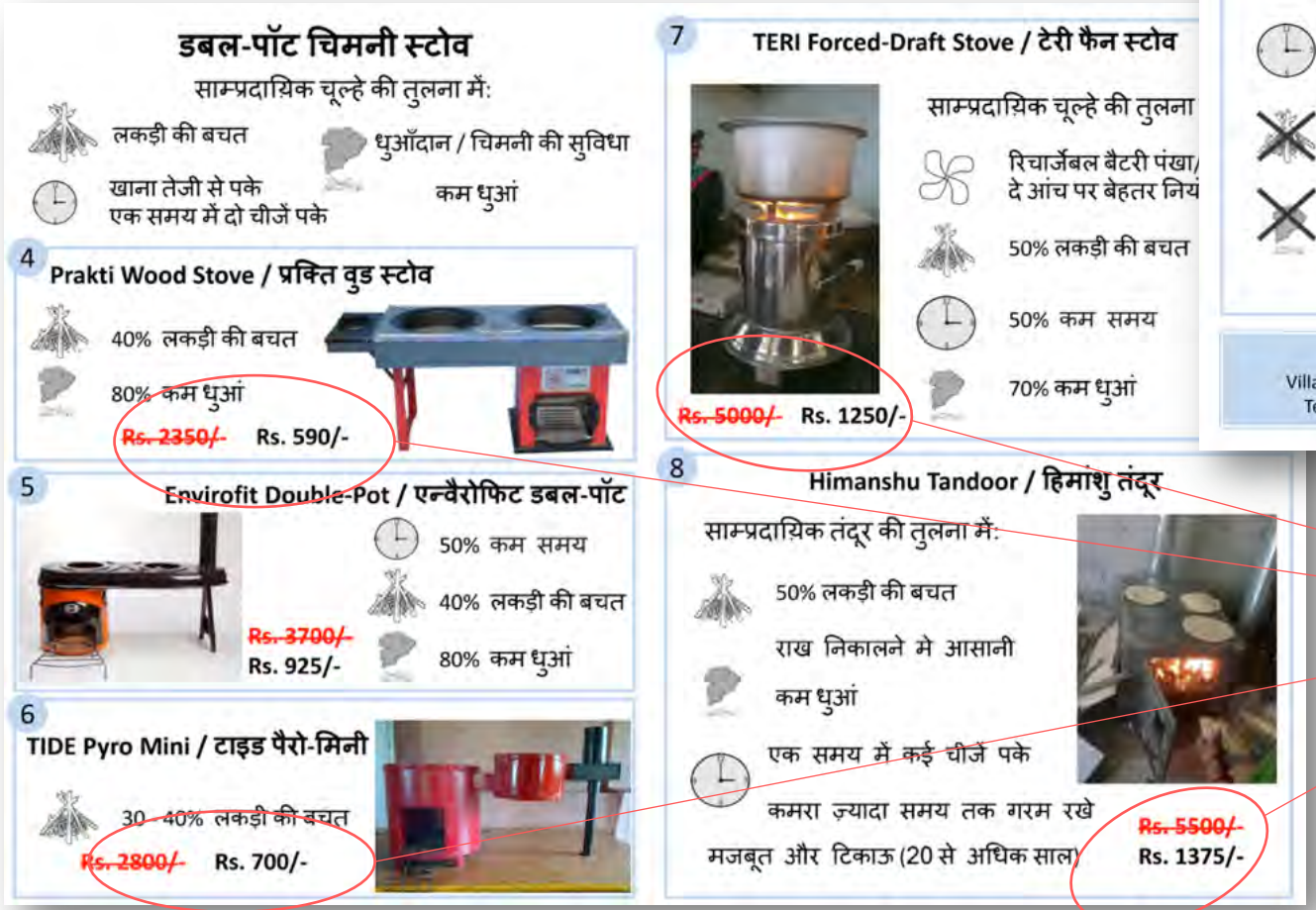
- Large state in S India; varied geography
- 61 million people
- Medium HDI – lower in project HHs
- Hot, semi-arid

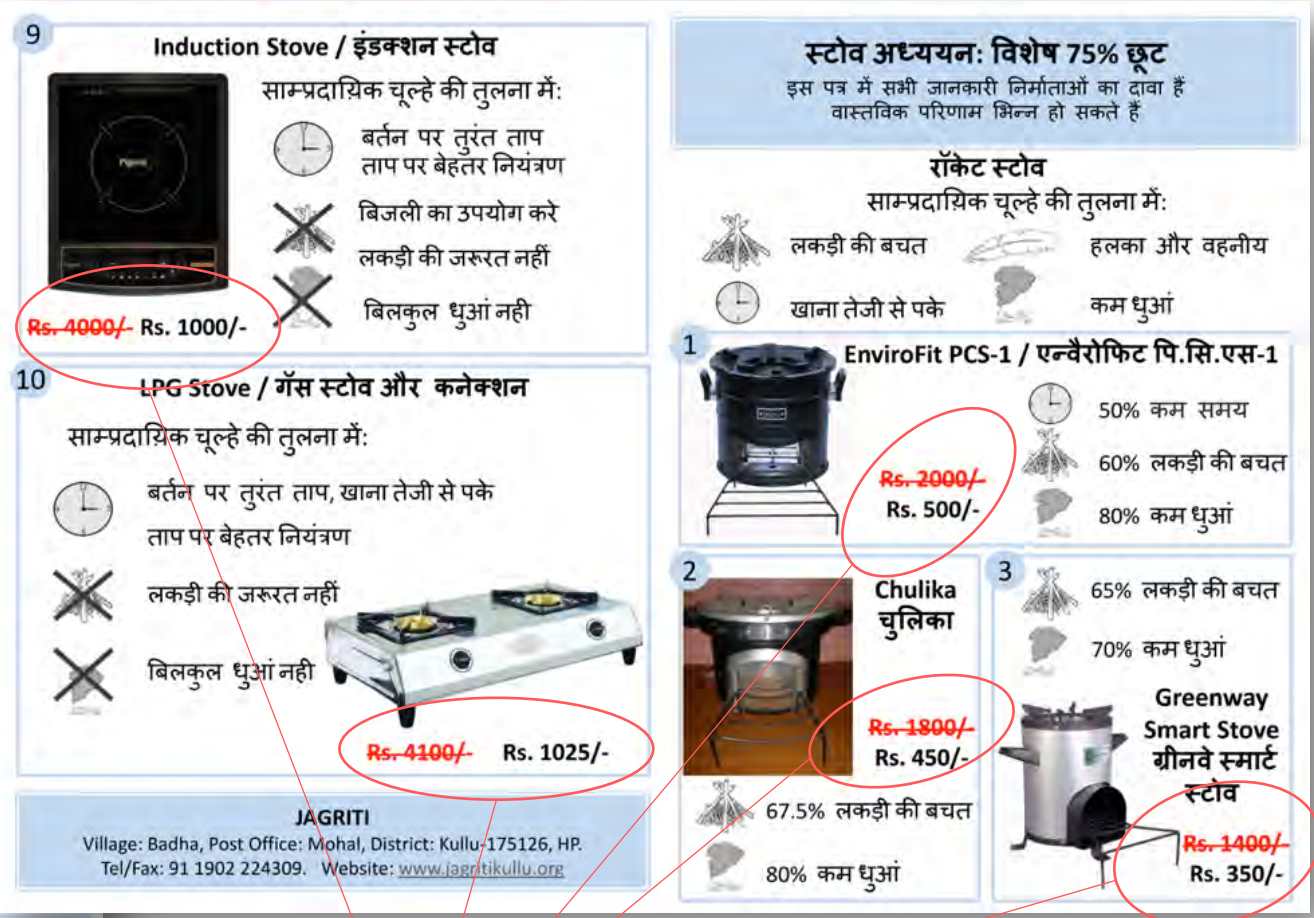
Policy context – LPG in India

- Pre-2012: Longstanding subsidy
  - No limit on eligibility or consumption
- 2012-2015: major reforms
  - Volume limits/Eligibility criteria
  - Voluntary "Give it up" campaign
  - Income threshold
- 2016: PMUY scheme introduced to increase access for poor HHs
  - 80 million connections by Sep 2019

https://twitter.com/piyushgoyaloffc/status/987250128758034434

Stove options





Paying communities were offered stoves at a 75% discount.

Hybrid cooking/heating stoves in Kullu

Chimneys in Koppal

- Not part of our intervention
- Present in ~60% of HHs

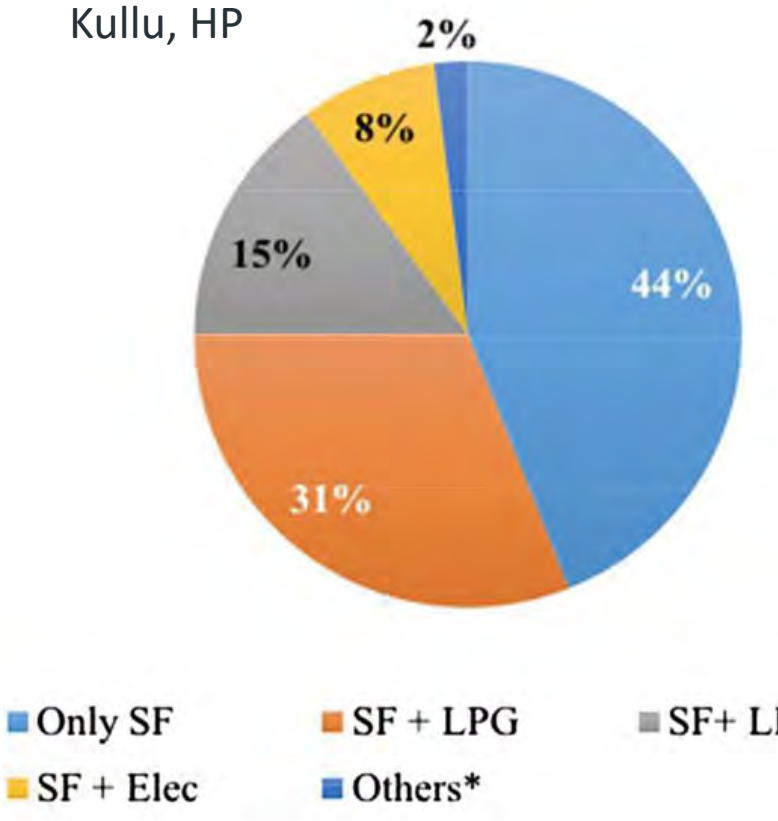
Stove exchanges

- First exchange after baseline data collection for all communities

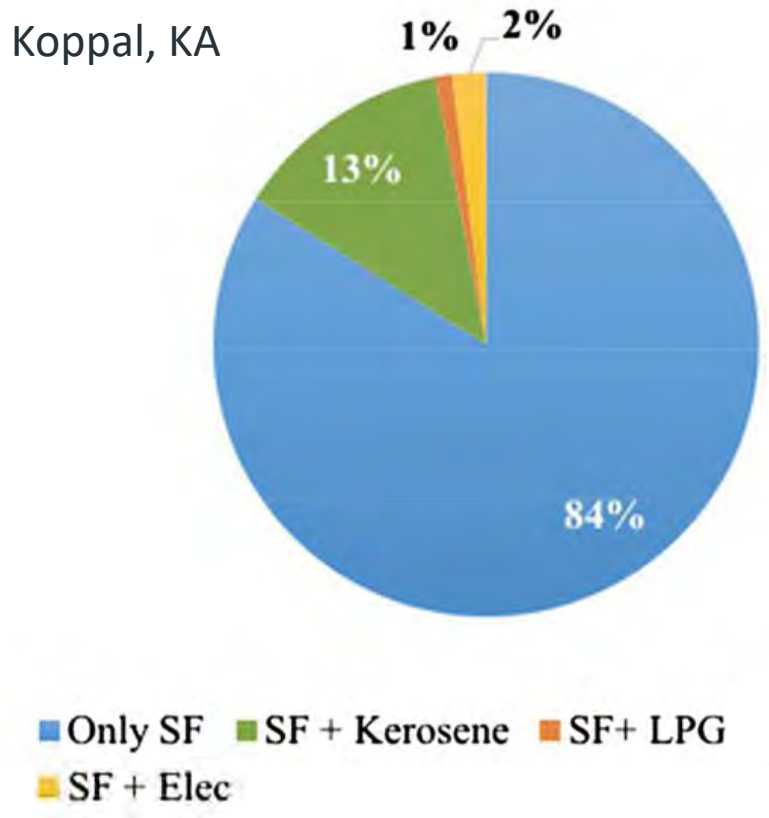
- Subsequently held in 9-12 month intervals in “exchange” communities
- Accompanied by Focus Group Discussions

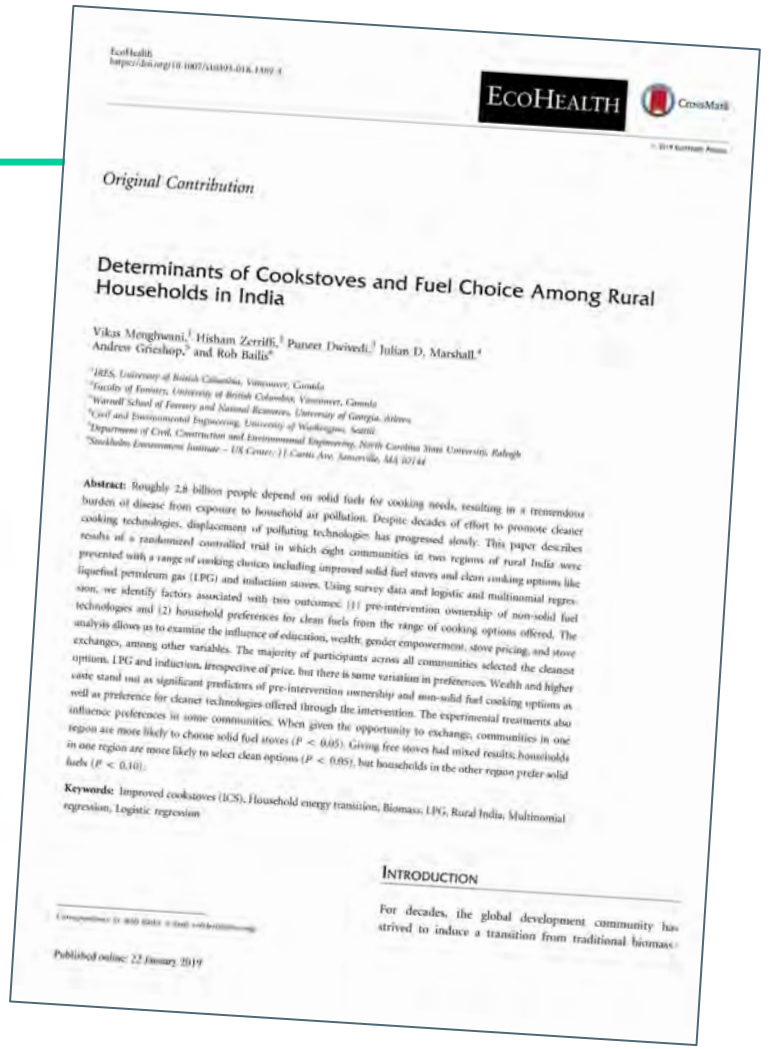
Pre-intervention cooking choices

Kullu, HP



Koppal, KA





EcoHealth
https://doi.org/10.1007/s10393-018-1393-4

ECOHEALTH

Original Contribution

Determinants of Cookstoves and Fuel Choice Among Rural Households in India

Vikas Menghwani,[1] Hisham Zerriffi,[2] Puneet Dwivedi,[3] Julian D. Marshall,[4] Andrew Grieshop,[5] and Rob Bailis[6]

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[2]Faculty of Forestry, University of British Columbia, Vancouver, Canada
[3]Warnell School of Forestry and Natural Resources, University of Georgia, Athens
[4]Civil and Environmental Engineering, University of Washington, Seattle
[5]Department of Civil, Construction and Environmental Engineering, North Carolina State University, Raleigh
[6]Stockholm Environment Institute – US Center, 11 Curtis Ave, Somerville, MA 02144

Abstract: Roughly 2.8 billion people depend on solid fuels for cooking needs, resulting in a tremendous burden of disease from exposure to household air pollution. Despite decades of effort to promote cleaner cooking technologies, displacement of polluting technologies has progressed slowly. This paper describes results of a randomized controlled trial in which eight communities in two regions of rural India were presented with a range of cooking choices including improved solid fuel stoves and clean cooking options like liquefied petroleum gas (LPG) and induction stoves. Using survey data and logistic and multinomial regression, we identify factors associated with two outcomes: (1) pre-intervention ownership of non-solid fuel technologies and (2) household preferences for clean fuels from the range of cooking options offered. The analysis allows us to examine the influence of education, wealth, gender empowerment, stove pricing, and stove exchanges, among other variables. The majority of participants across all communities selected the cleanest options, LPG and induction, irrespective of price, but there is some variation in preferences. Wealth and higher caste stand out as significant predictors of pre-intervention ownership and non-solid fuel cooking options as well as preference for cleaner technologies offered through the intervention. The experimental treatments also influence preferences in some communities. When given the opportunity to exchange, communities in one region are more likely to choose solid fuel stoves ($P < 0.05$). Giving free stoves had mixed results; households in one region are more likely to select clean options ($P < 0.05$), but households in the other region prefer solid fuels ($P < 0.10$).

Keywords: Improved cookstoves (ICS), Household energy transition, Biomass, LPG, Rural India, Multinomial regression, Logistic regression

Introduction

For decades, the global development community has strived to induce a transition from traditional biomass

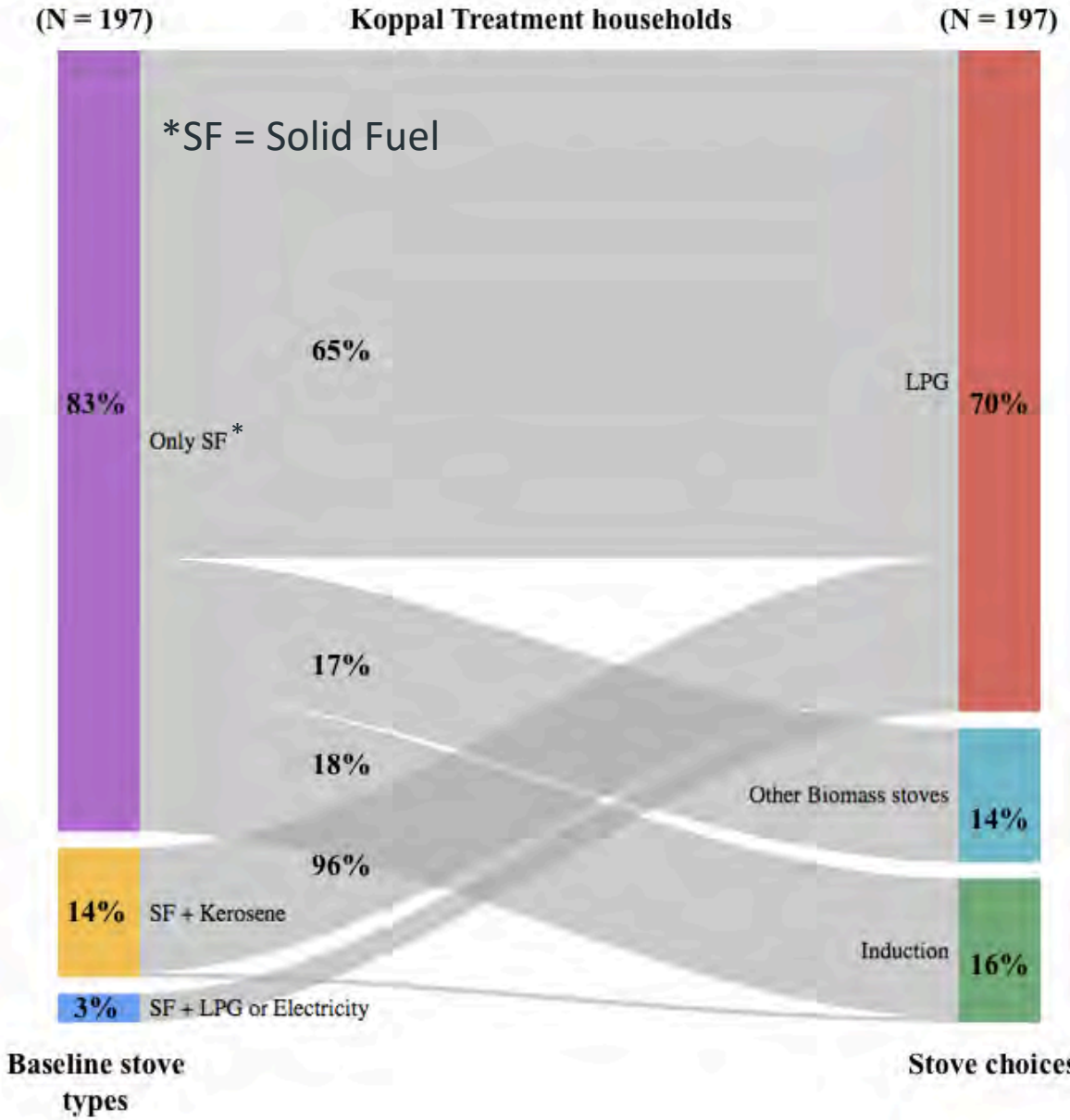
Published online: 22 January 2019

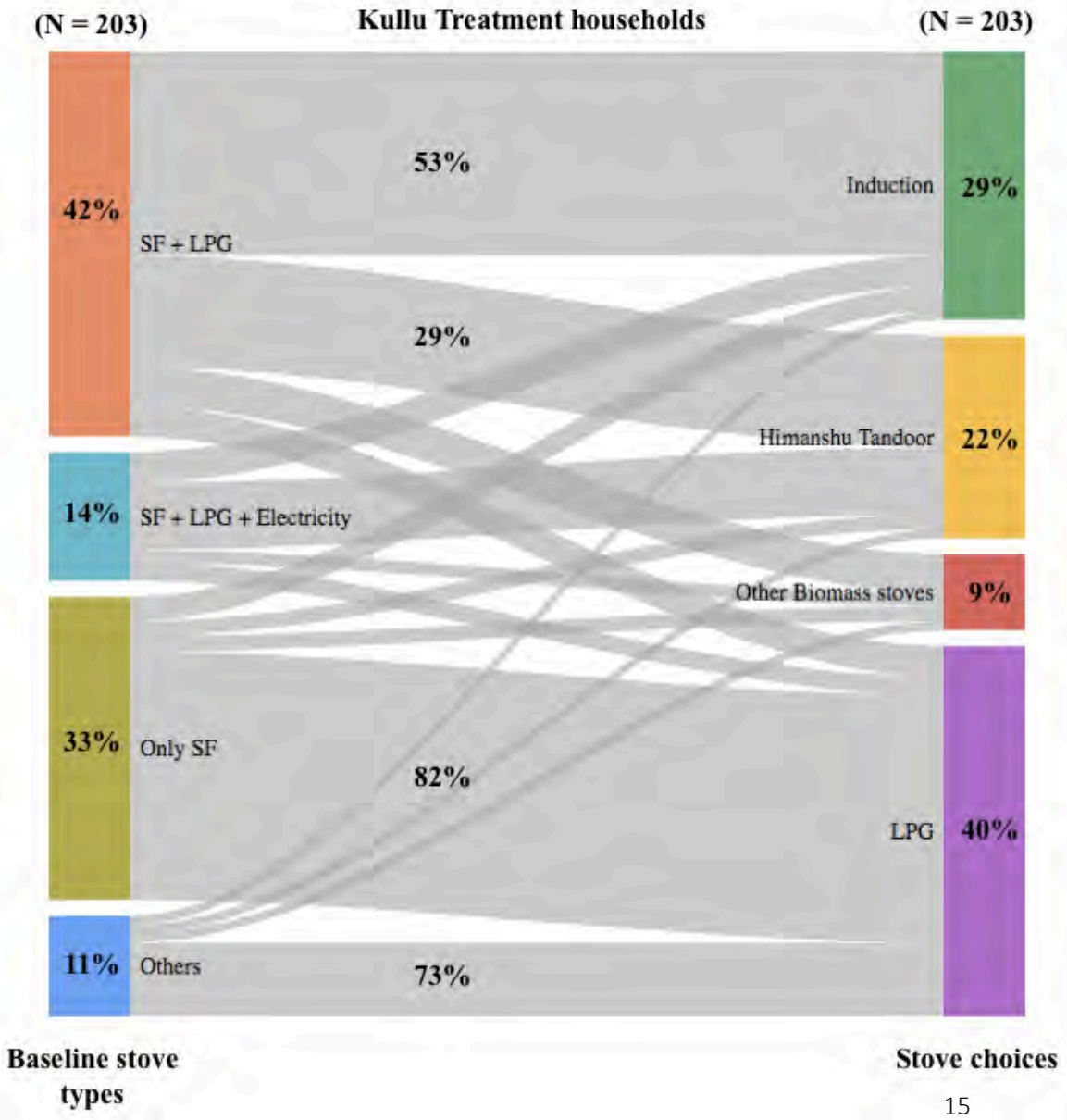
* SF = Solid fuel

(Menghwani et al. 2018)

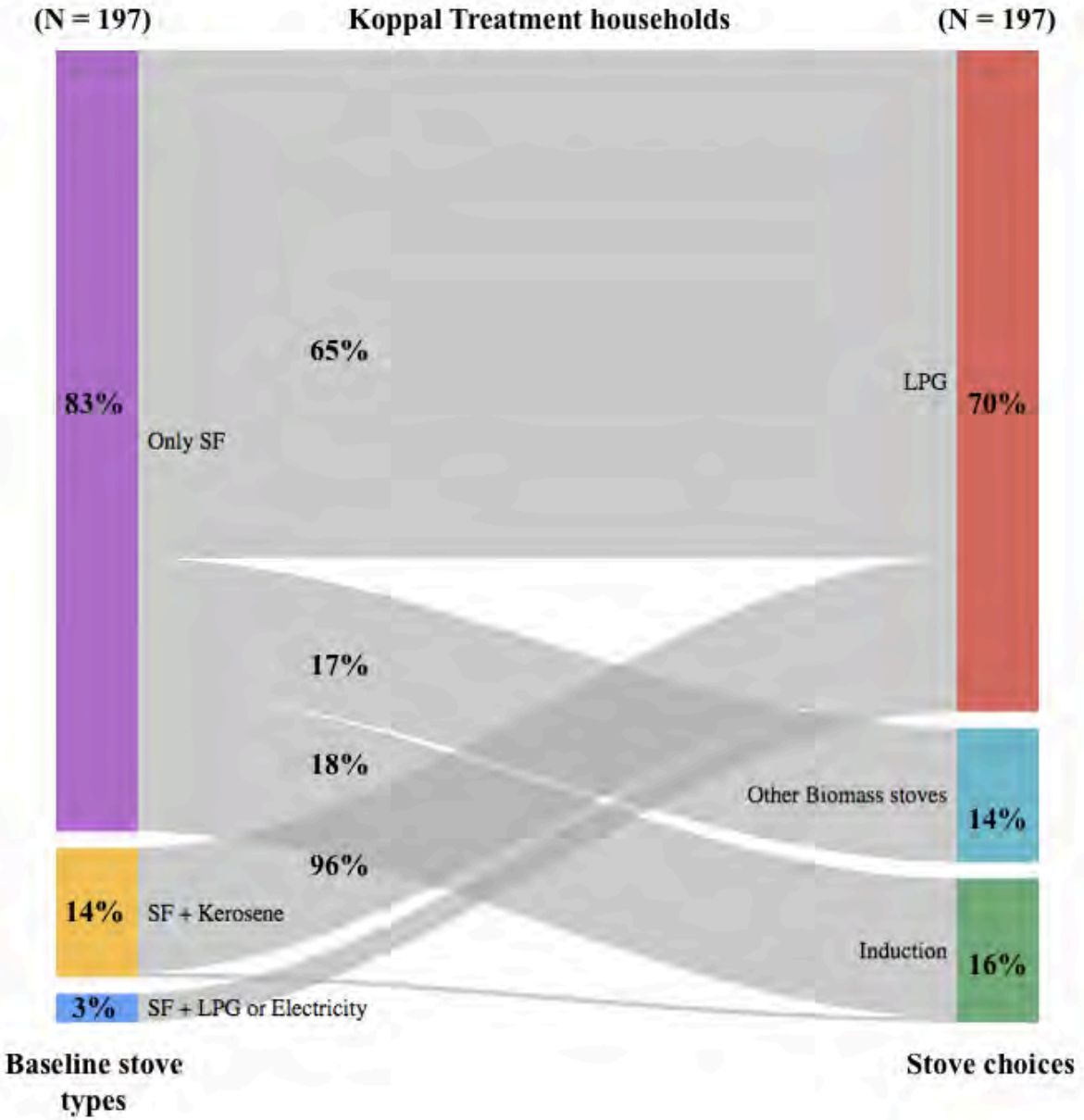
Variation in baseline stove/fuel use explained by wealth and caste (Kullu) ($p<0.01$); gender empowerment ($p<0.05, 0.1$), increasing dist. to wood source ($p<0.1$)

Stove Selections: 1st round both sites





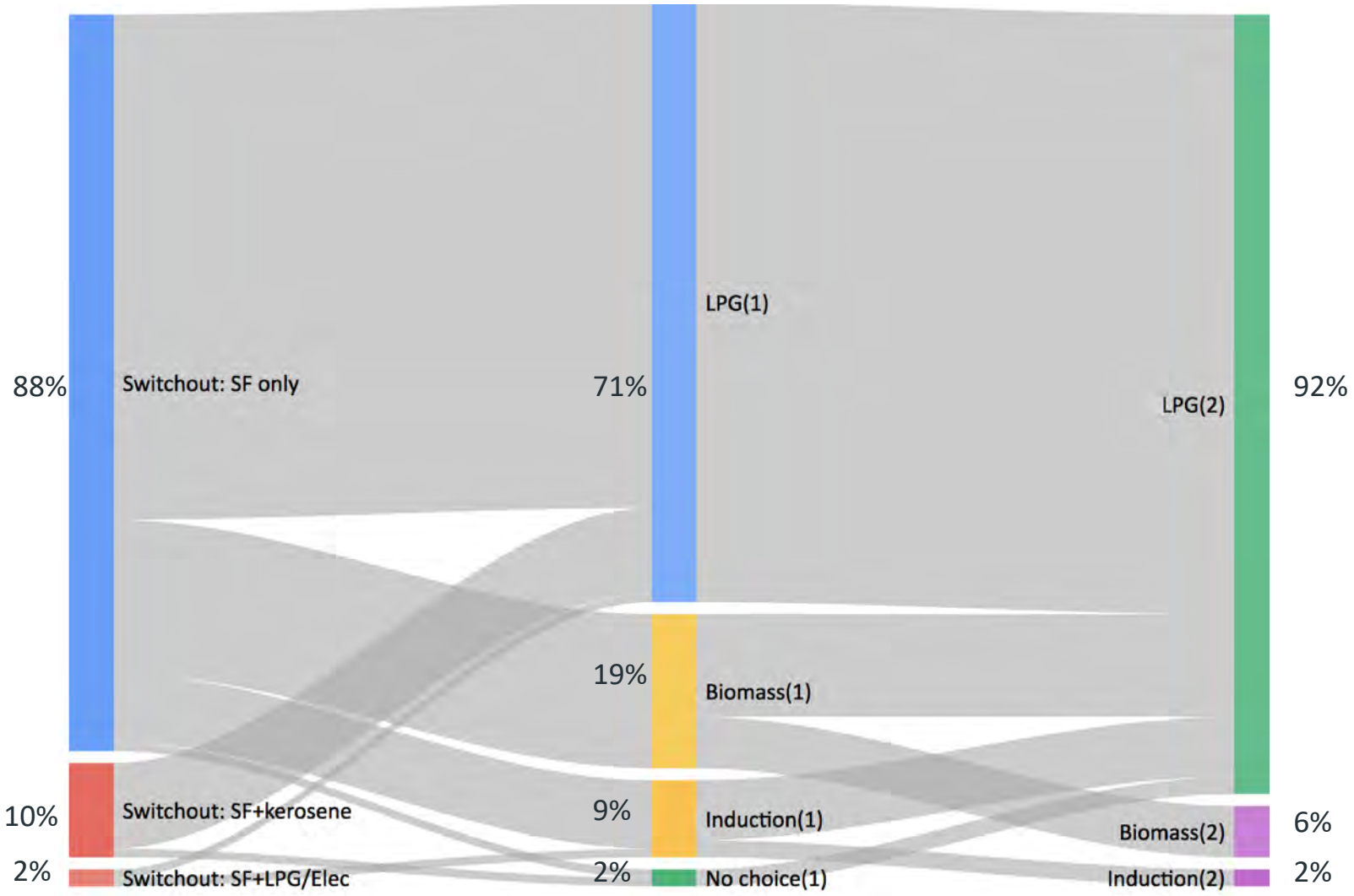
Stove Selections: 1st round in Koppal – (all HHs)



- 86% chose LPG or Induction
  - Wealthier HHs ($p<0.05$)
  - Gender emp. ($p<0.1$; some models)
- **Prior use of non-Solid fuel (elec LPG, or kerosene)** is significant predictor of preference for Induction and LPG over woodstoves
- Treatment effects?
  - HHs with **ability to exchange** more likely to choose LPG over Ind. ($p<0.05$)
  - HHs receiving **free stoves** more likely to choose LPG over Induction ($p<0.1$)

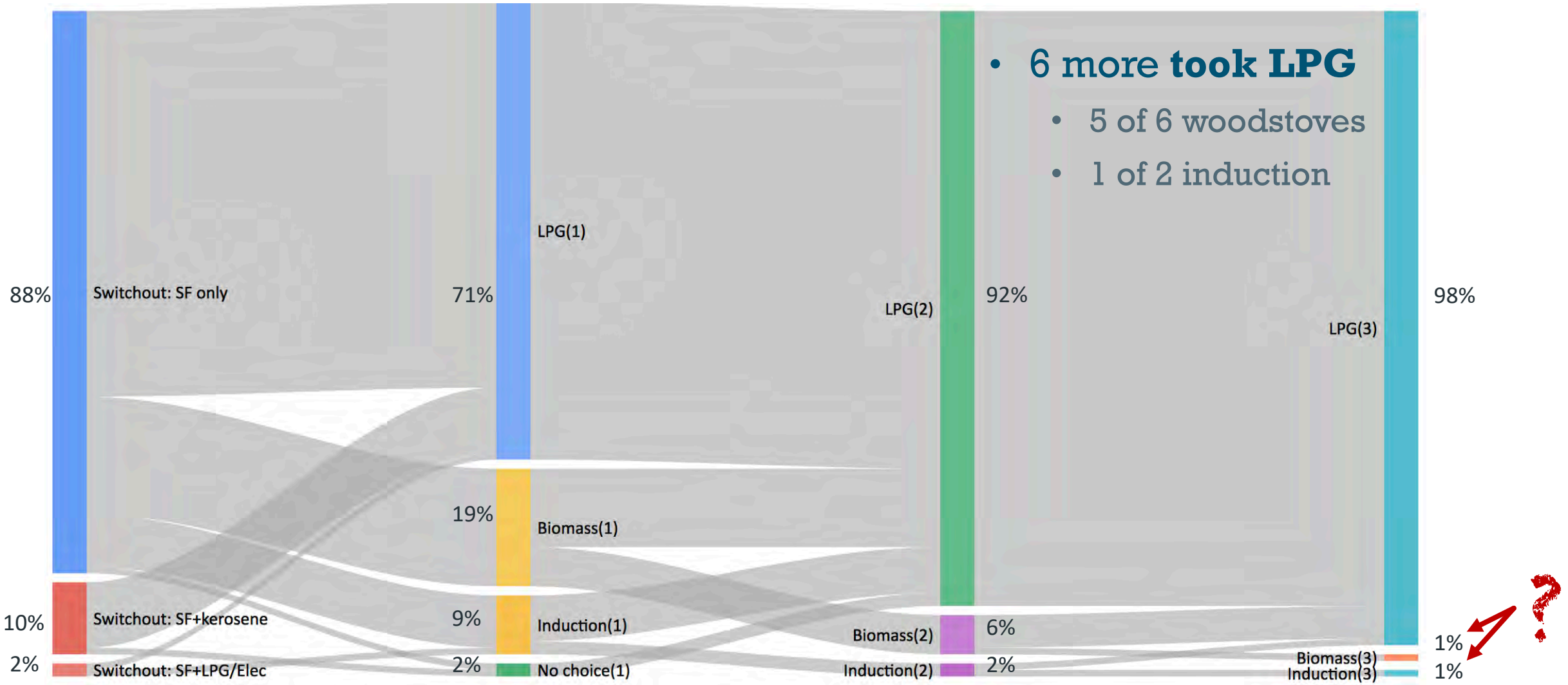
Families in Koppal bringing home LPG

Stove selections in Koppal: 1st switch-out (n=99)



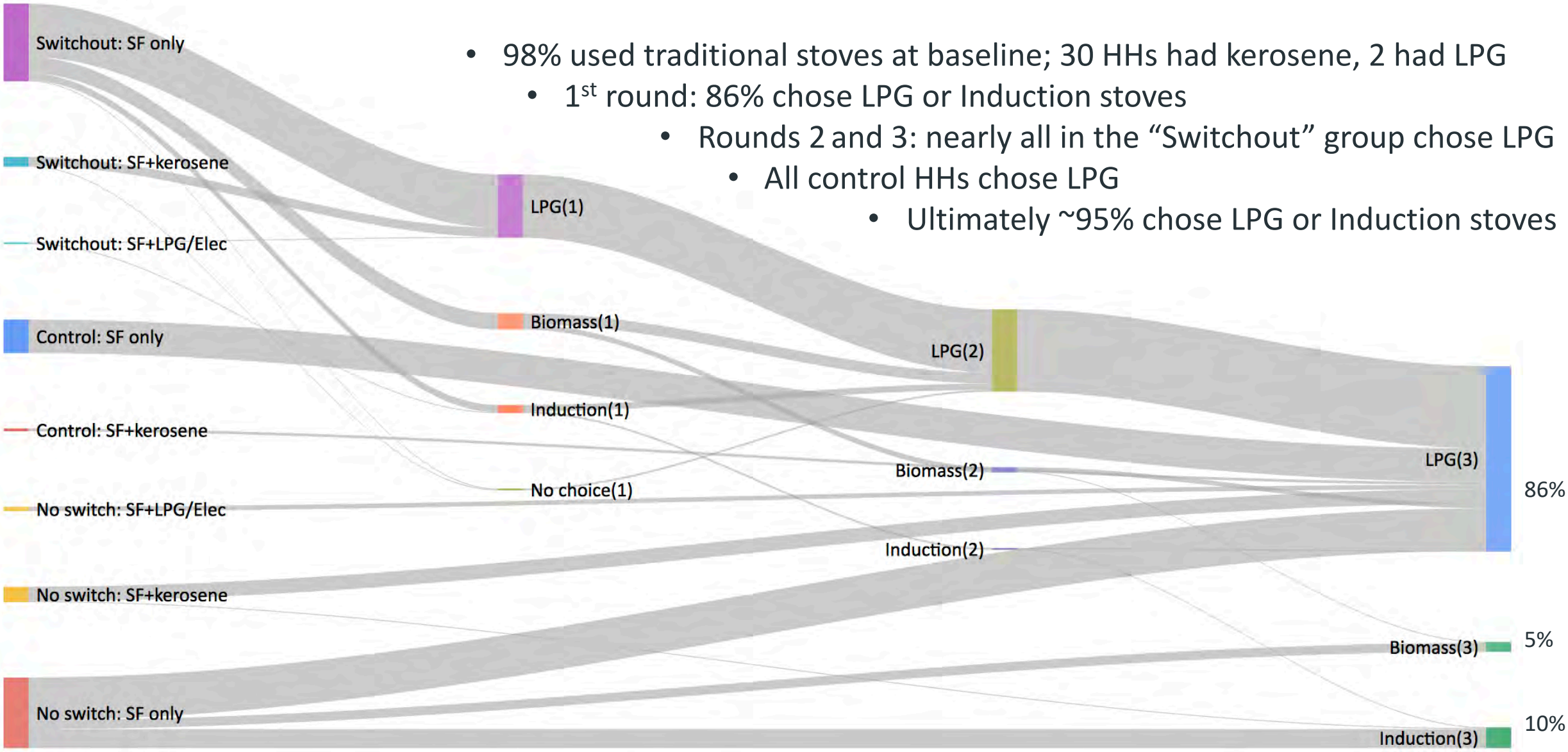
- **Nobody** dropped LPG
- 20 **changed to LPG**
  - 13 of 19 HHs that chose a woodstove
  - 7 of 9 HHs that chose induction

Stove selections: final switch-out (n=99)



Kullu – all HHs full timespan (n = 239)

- 98% used traditional stoves at baseline; 30 HHs had kerosene, 2 had LPG
  - 1st round: 86% chose LPG or Induction stoves
    - Rounds 2 and 3: nearly all in the "Switchout" group chose LPG
      - All control HHs chose LPG
        - Ultimately ~95% chose LPG or Induction stoves



So, nearly everyone wanted an LPG connection

Does LPG deliver "**benefits to air quality and climate**"?

- How much do people use?
- How much solid fuel is displaced?
- What are the impacts on HAP and emissions?

Air pollutant emissions and exposure reductions were primary outcomes of the intervention

- Indoor air quality
  - Indicator of effectiveness of intervention
  - (Imperfect) proxy for exposure by household members
- Emissions:
  - Measure of ‘real world’ performance of devices/fuels
  - ‘Intermediate input’ for estimating exposure
  - Primary input to atmospheric models
- Climate:
  - Fuel use reductions
  - Reduction in short-lived climate forcers (SLCFs)

Maksim Islam

Roshan Wathore

In-home emissions and IAQ measurements

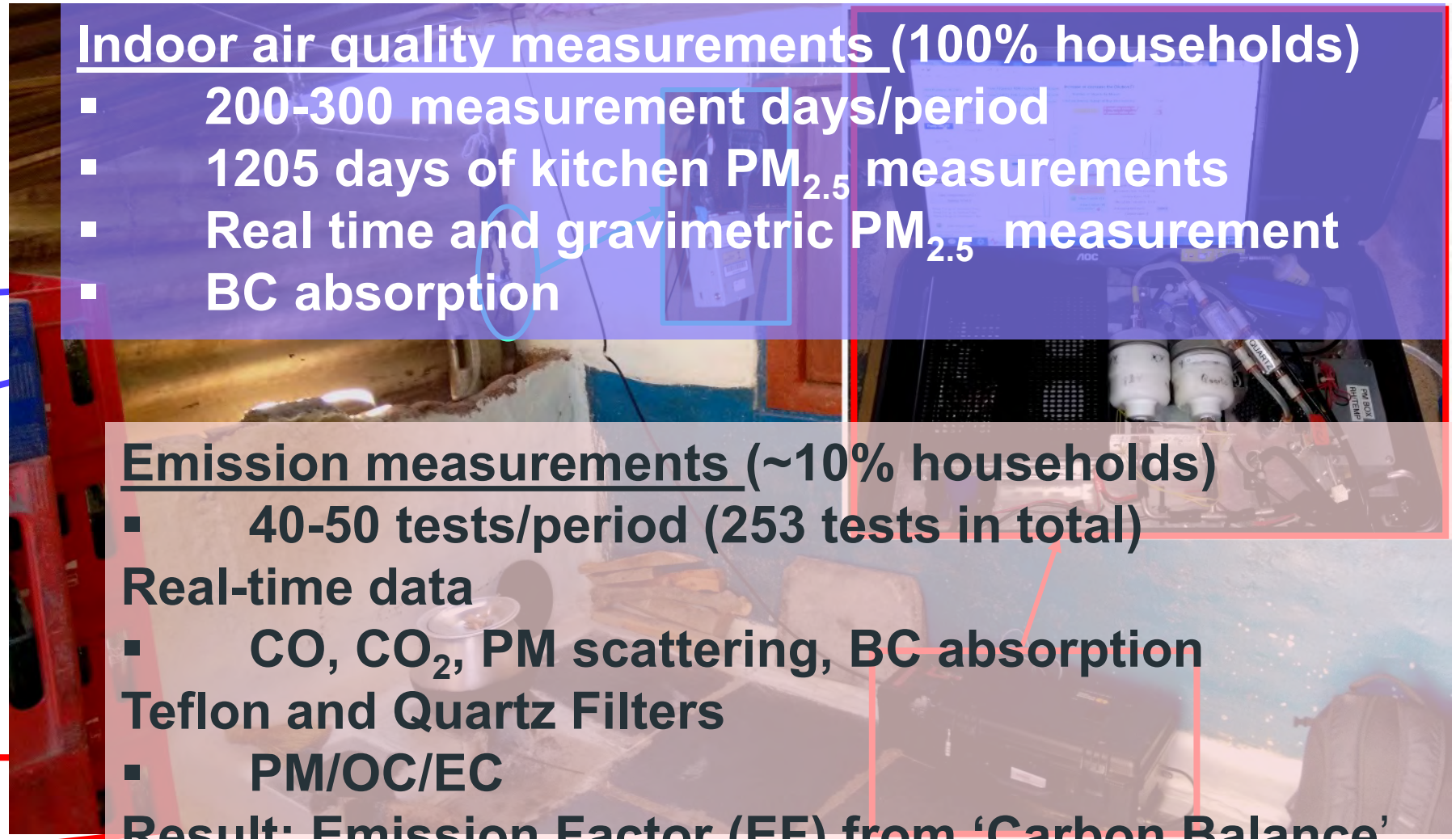
Indoor $PM_{2.5}$ Concentration: RTI microPEM (Personal Exposure Monitor)

Emissions: STEMS (STove Emission Measurement System)

In-home emissions and IAQ measurements

Indoor $PM_{2.5}$ Concentration: RTI microPEM (Personal Exposure Monitor)

Emissions: STEMS (STove Emission Measurement System)



Indoor air quality measurements (100% households)

- 200-300 measurement days/period
- 1205 days of kitchen $PM_{2.5}$ measurements
- Real time and gravimetric $PM_{2.5}$ measurement
- BC absorption

Emission measurements (~10% households)

- 40-50 tests/period (253 tests in total)

Real-time data

- CO, CO_2, PM scattering, BC absorption

Teflon and Quartz Filters

- PM/OC/EC

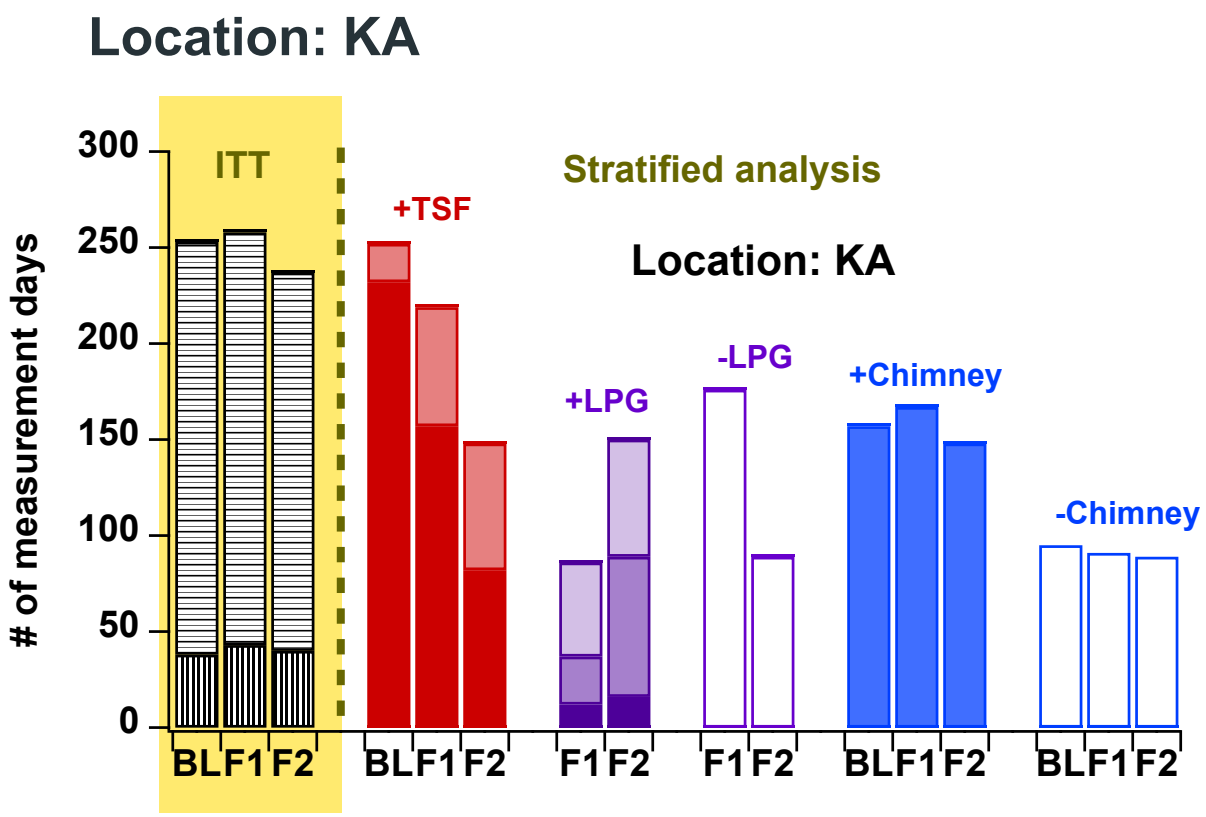
Result: Emission Factor (EF) from 'Carbon Balance'

IAQ data – two ways to analyze

A. ITT: Intent-to-treat

B. Stratified analysis

(i) Stove presence/use (ii) presence of chimney



BL: baseline; F1: Follow-up-1; F2: Follow-up-2

IAQ data – two ways to analyze

A. ITT: Intent-to-treat

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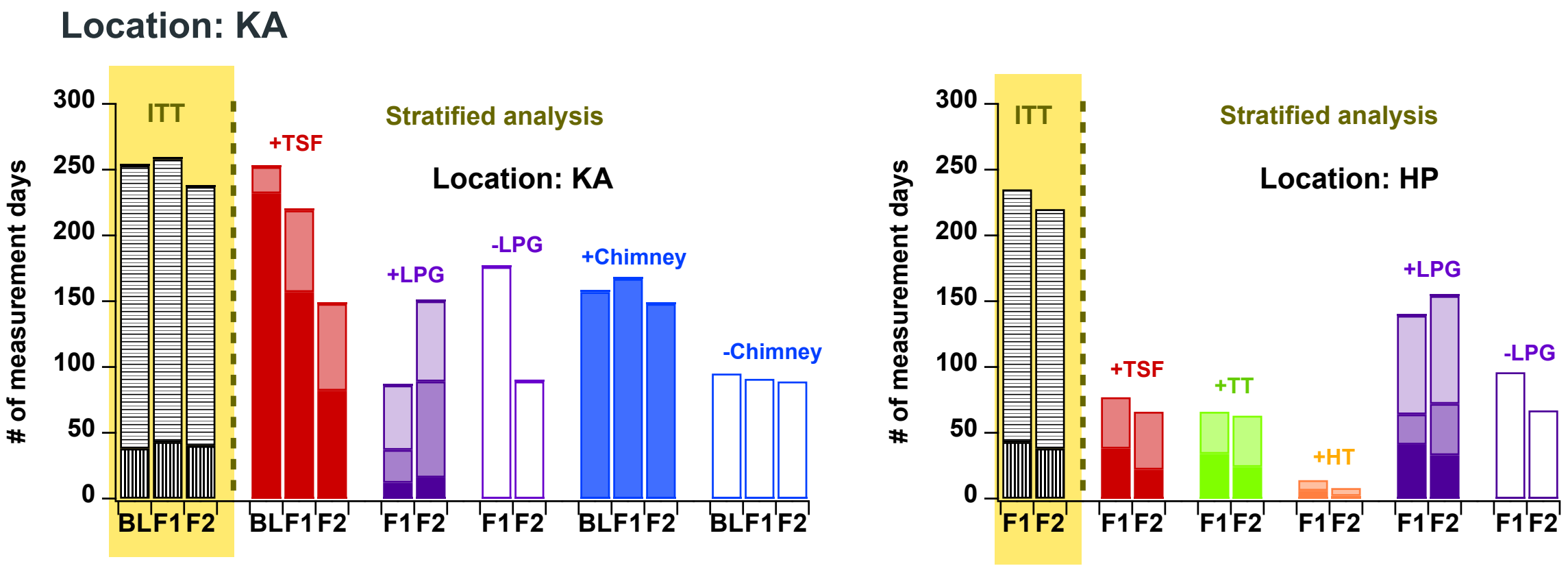
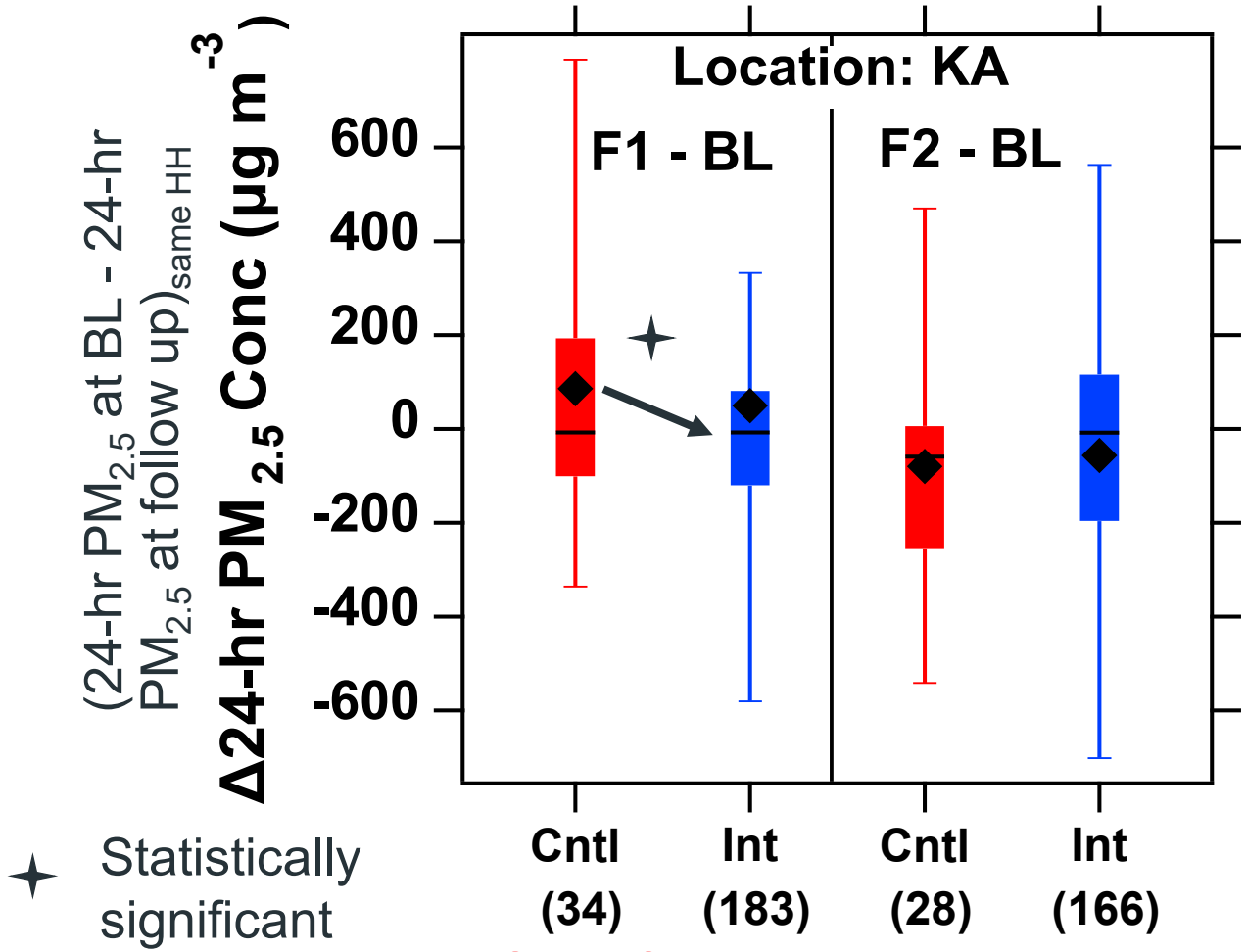


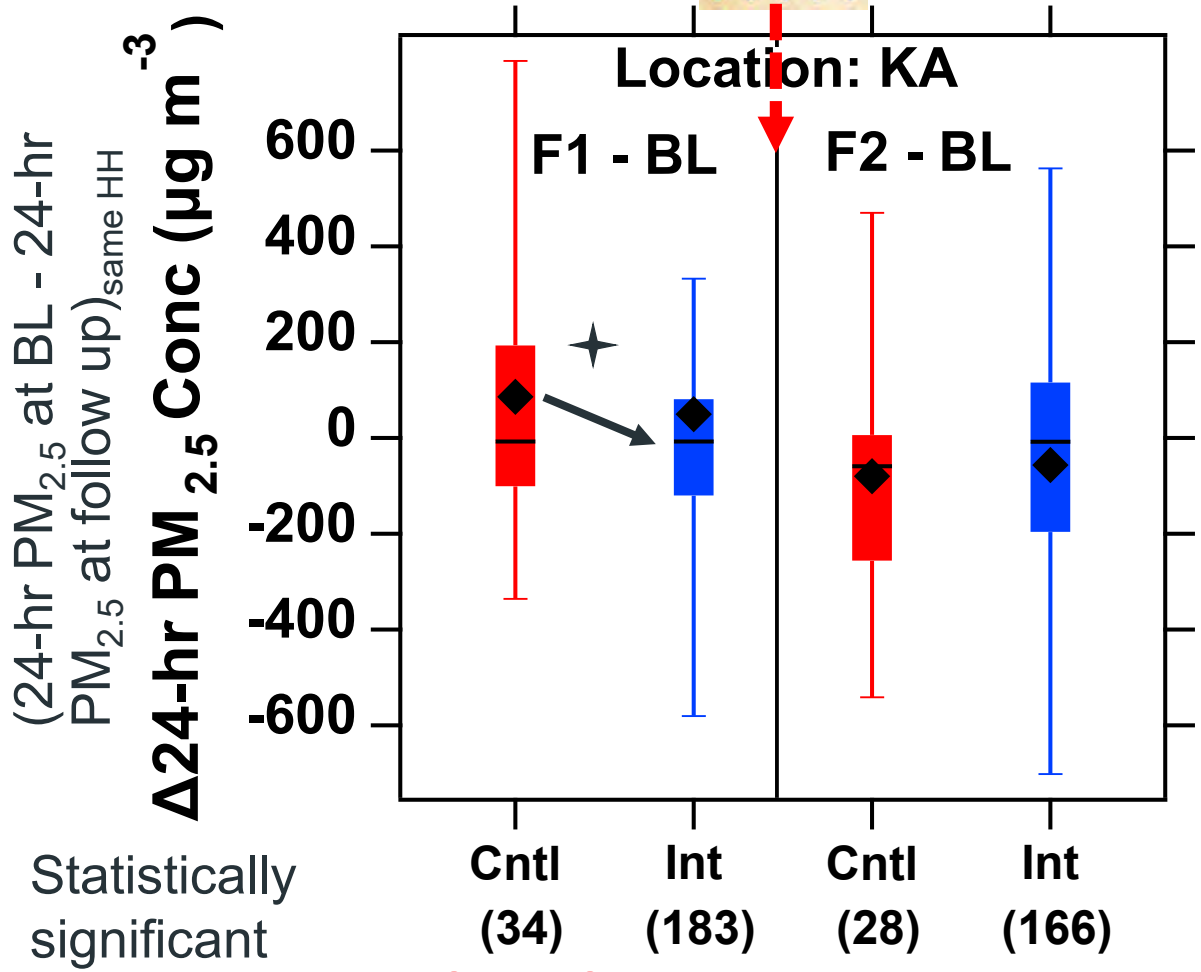
BL: baseline; F1: Follow-up-1; F2: Follow-up-2

Intent to treat: Difference-in-difference shows inconsistent effectiveness of intervention



Intent to treat: Difference-in-difference shows inconsistent effectiveness of intervention

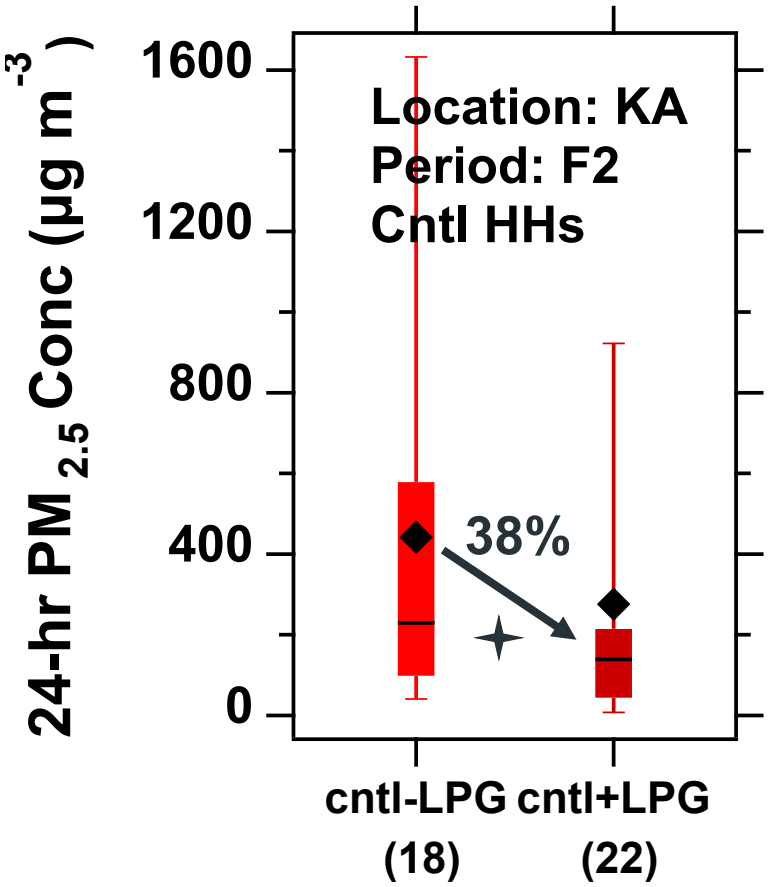
PMUY



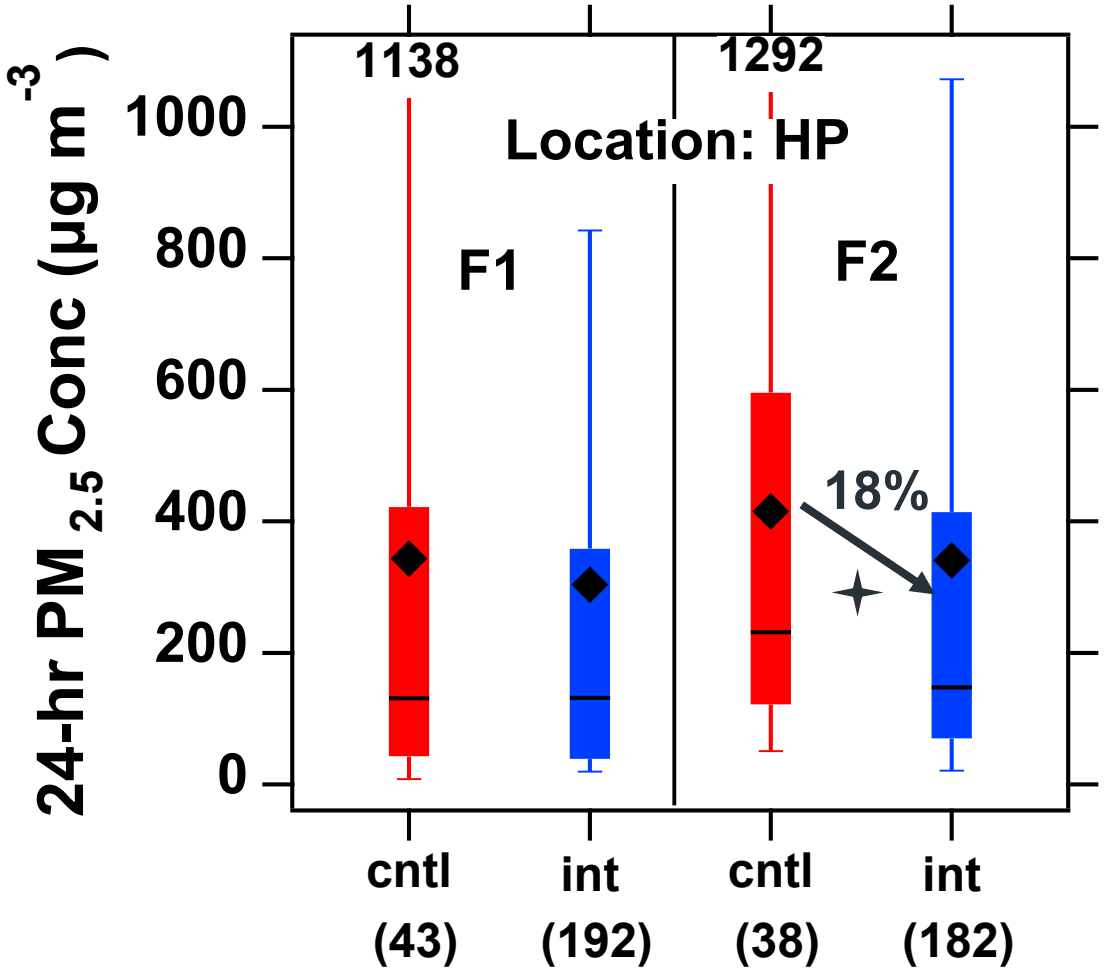
Statistically significant

Cntl: Control; Int: Intervention

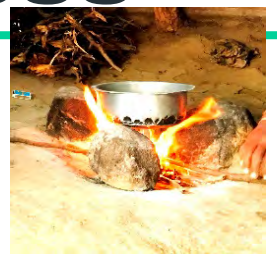
Controls w/out and w/ LPG



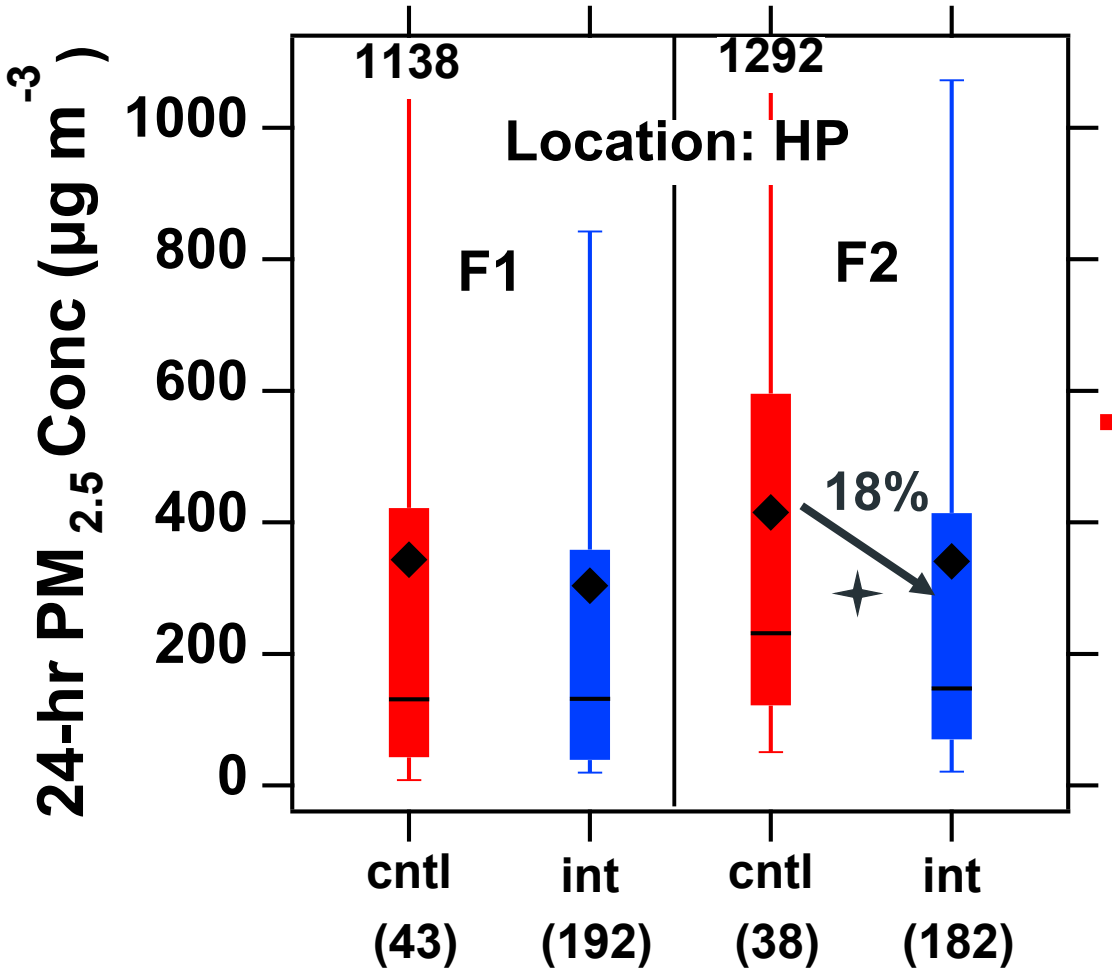
ITT in HP: also indicates mixed intervention effectiveness



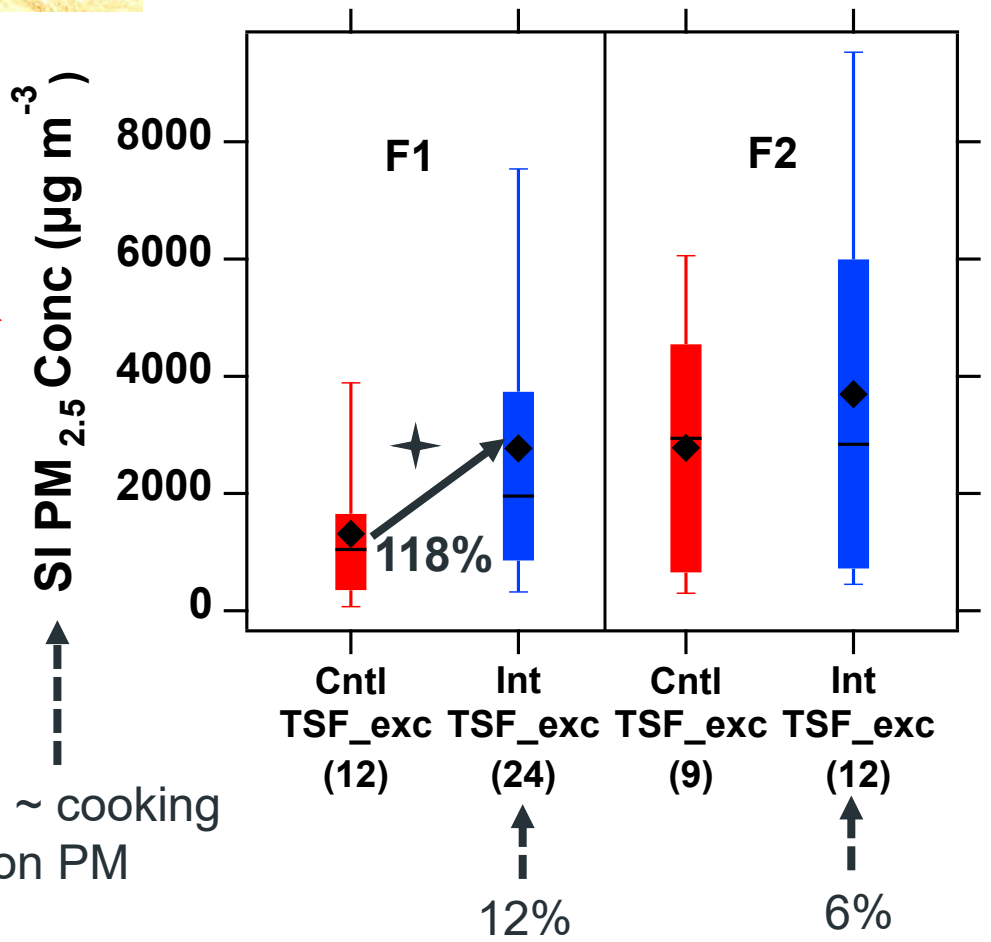
ITT in HP: also indicates mixed intervention effectiveness



Cooking-phase concentration for **Control** and **Intervention** HHs using ONLY TSF

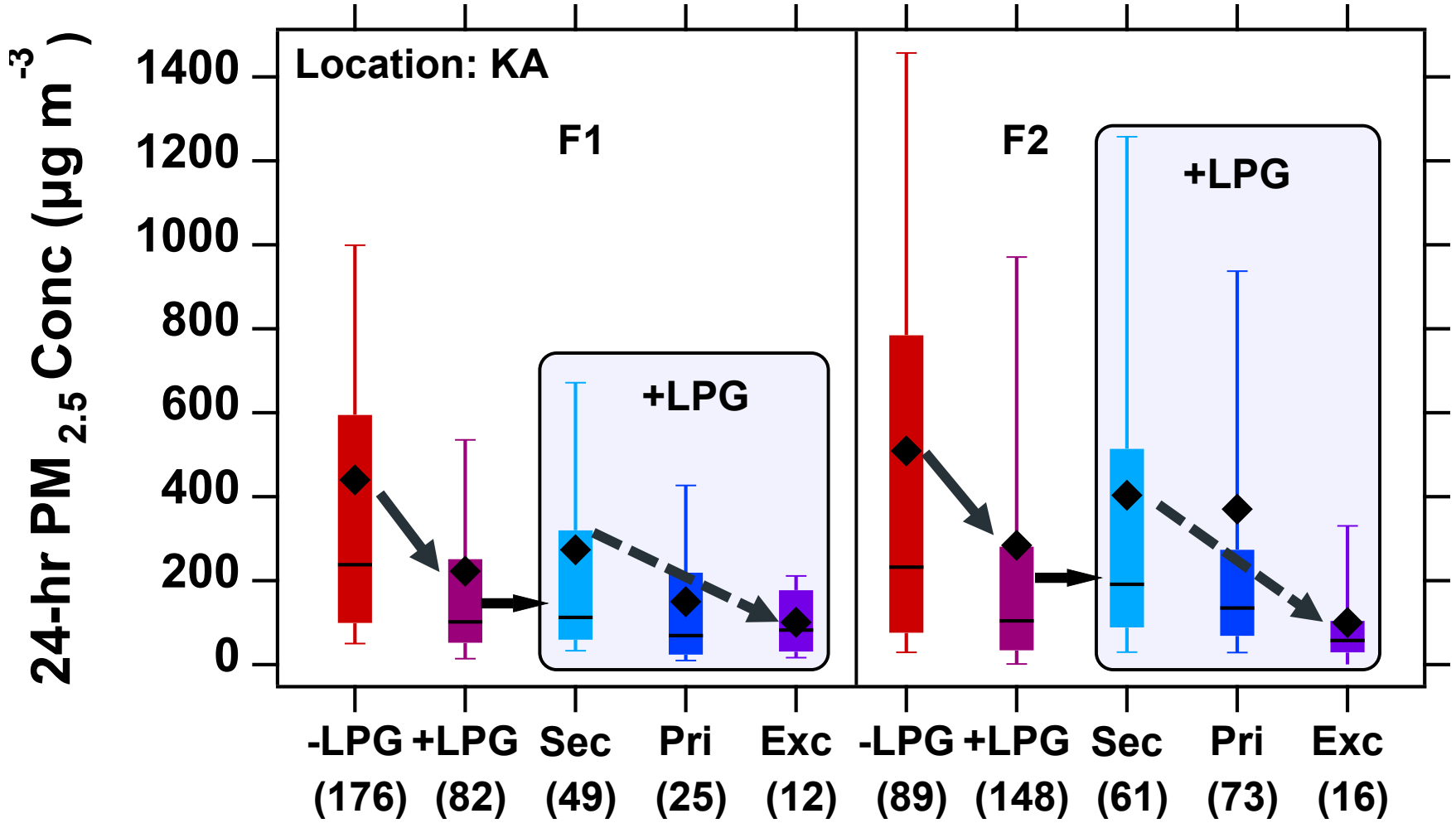


subset

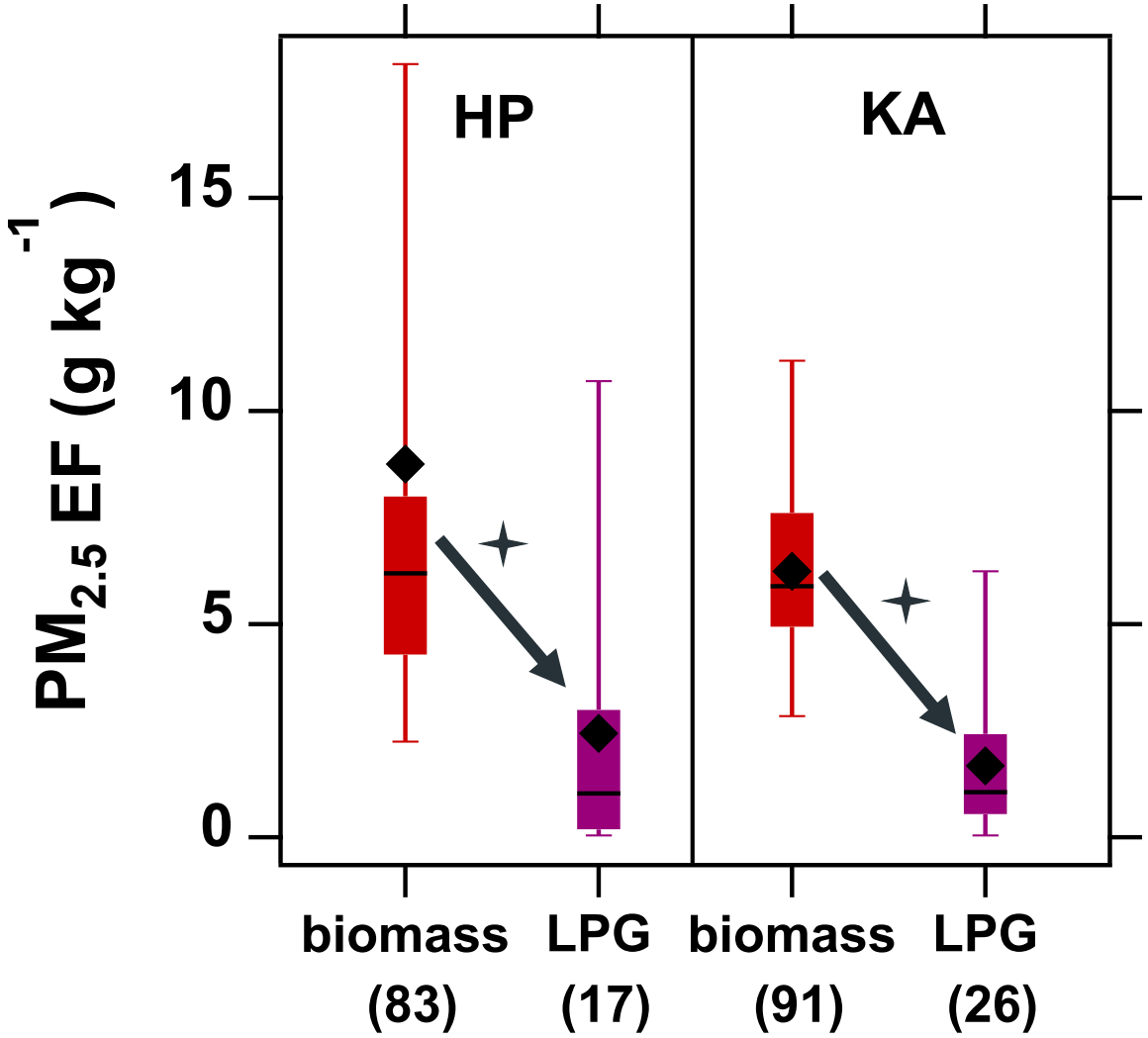


SI PM ~ cooking duration PM

Stratified analysis of IAQ:
LPG made a big difference, especially when used!



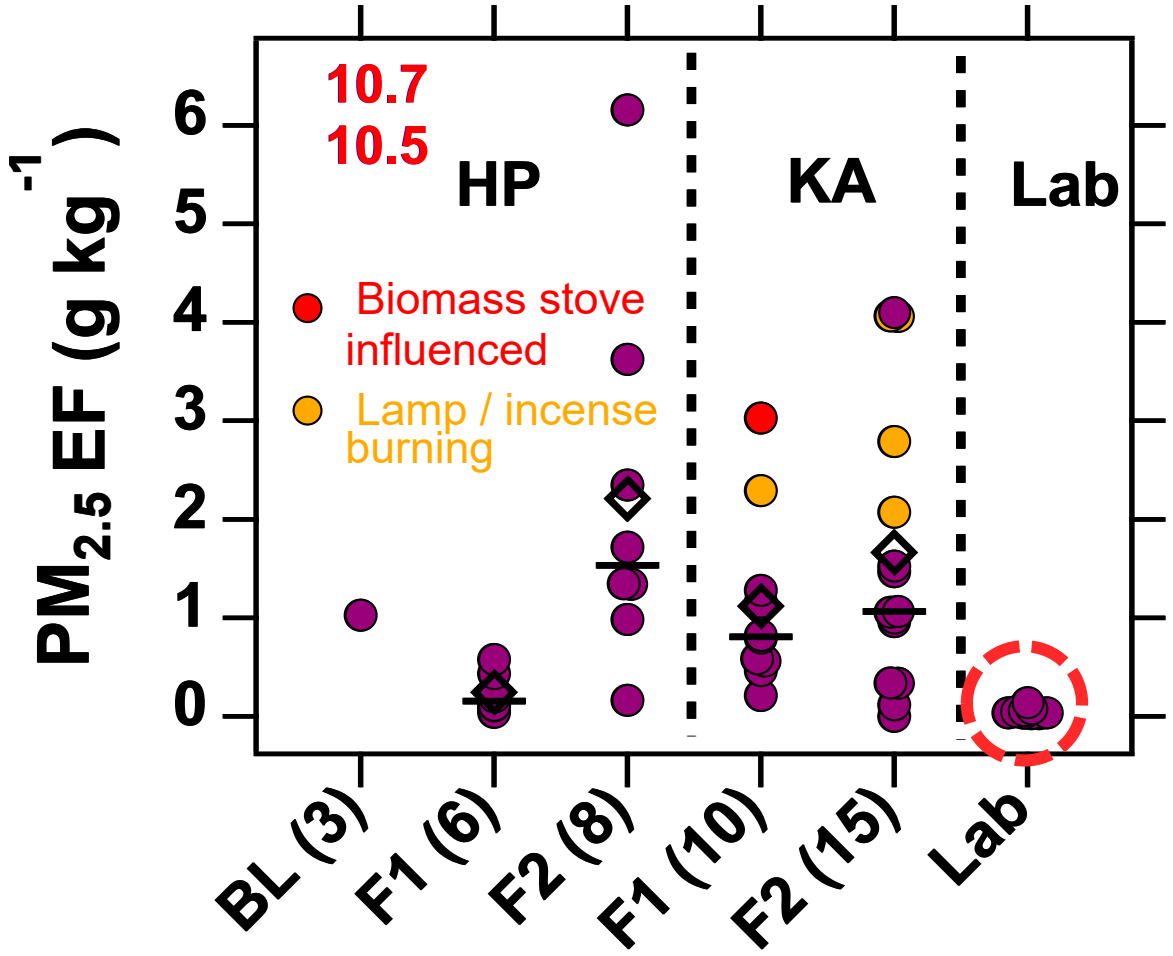
Does source ($PM_{2.5}$ EF) follow the same trend as impact (Indoor $PM_{2.5}$)?



Biomass stoves

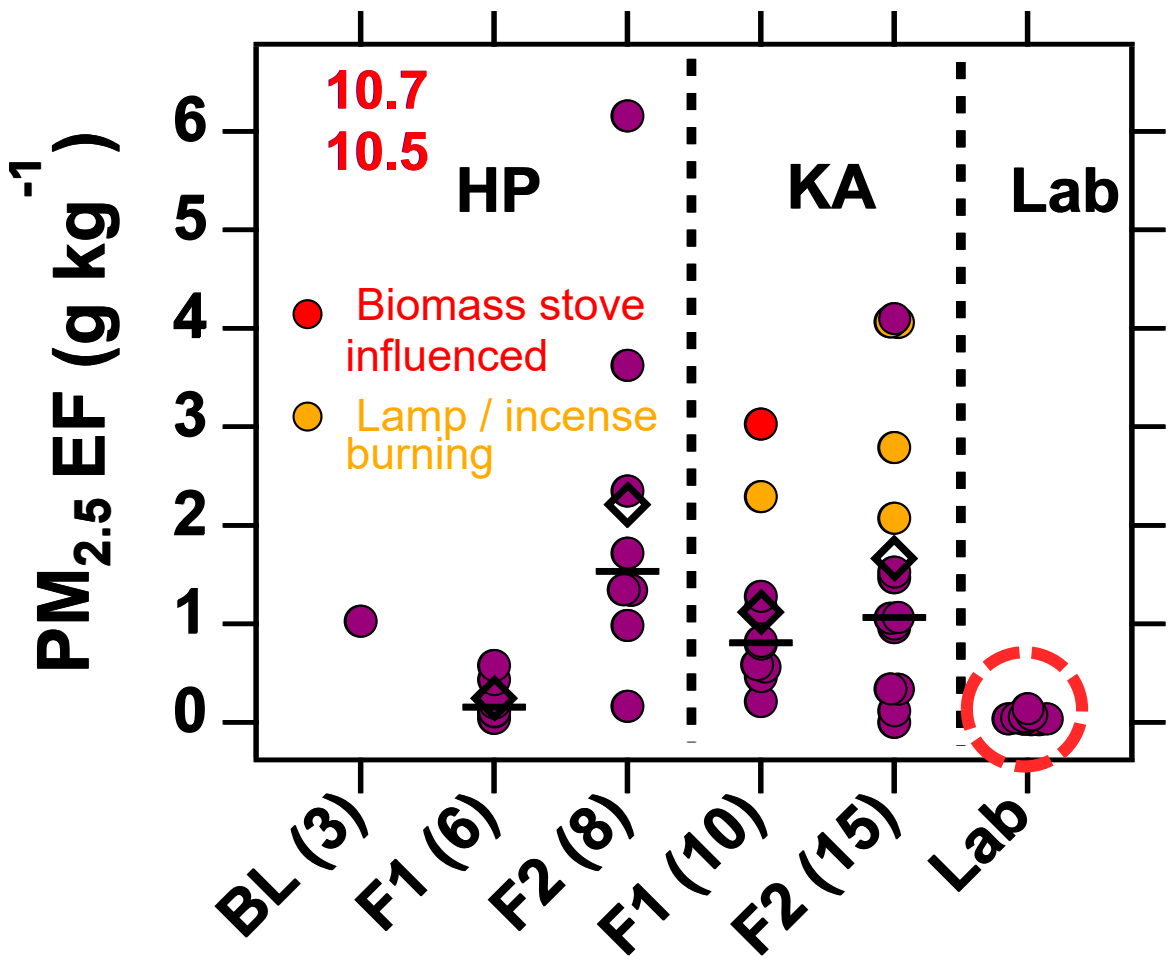
LPG stove

Lab results may underestimate ‘real-world’ LPG emissions (combustion + …)

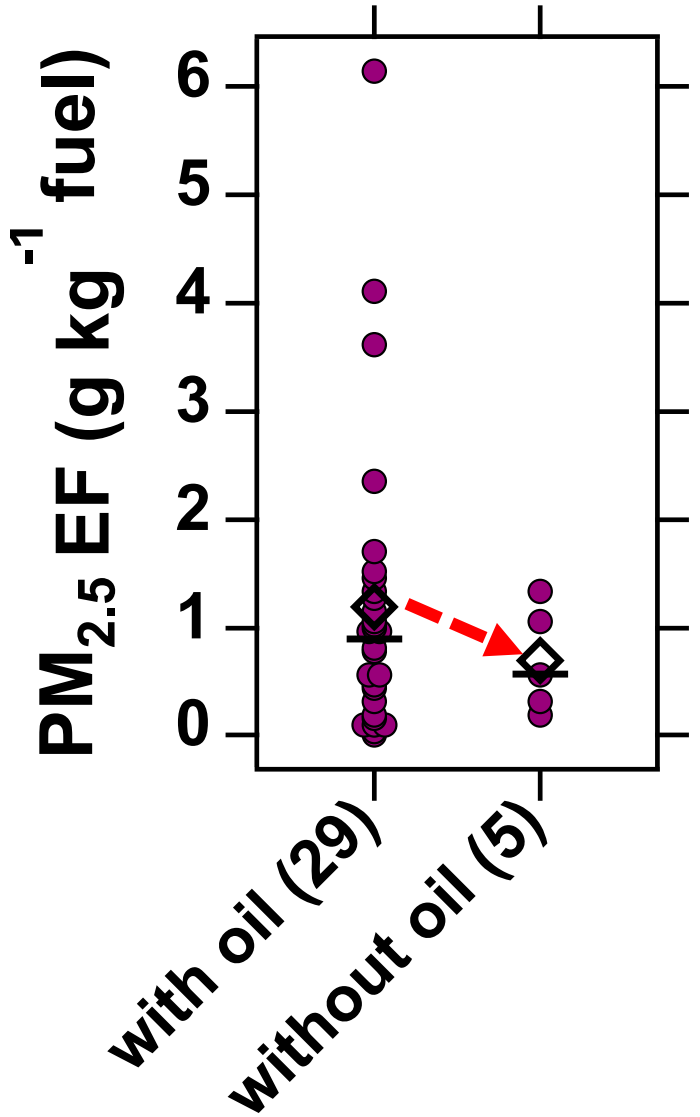


Lab:
Shen et al. 2018

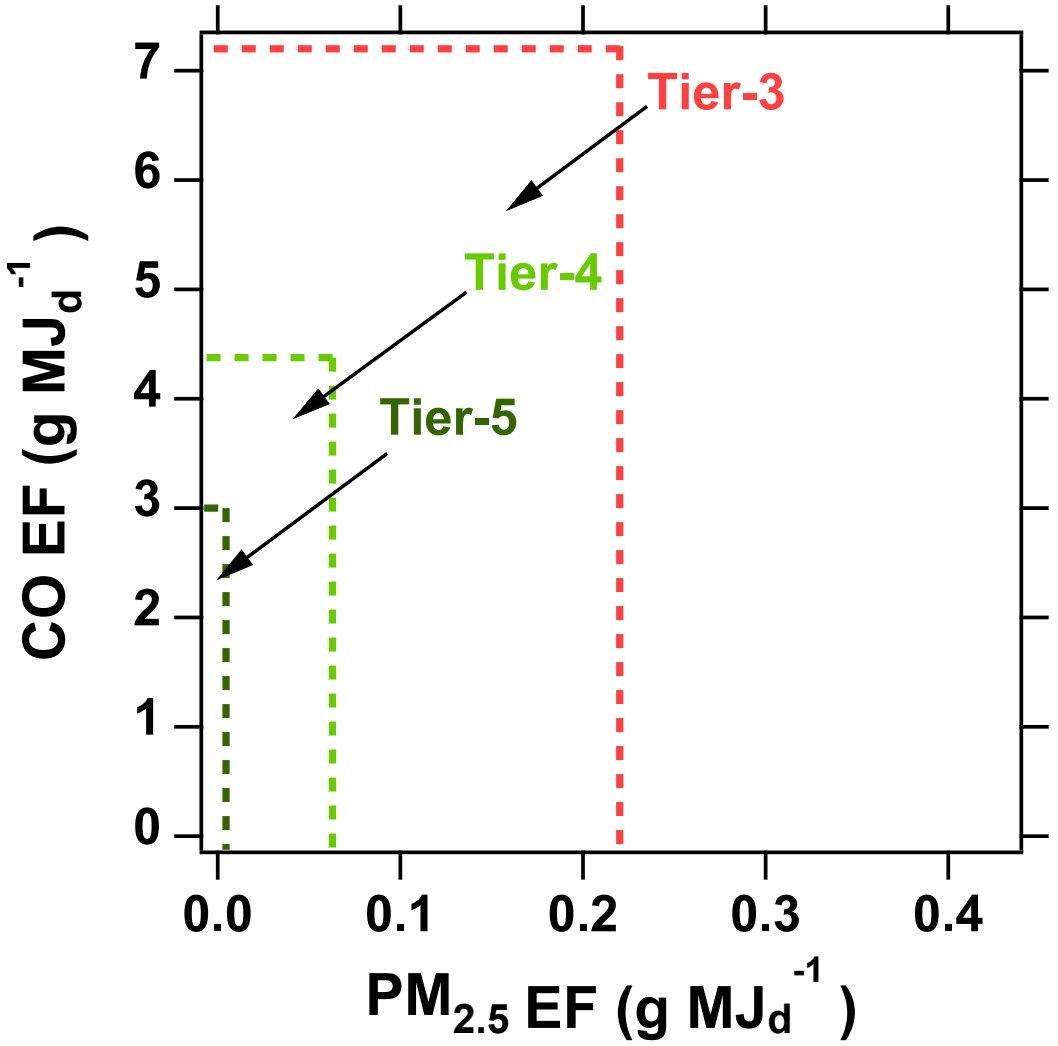
Lab results may underestimate ‘real-world’ LPG emissions (combustion + …)



Lab:
Shen et al. 2018



A clean stove is not always a silver bullet for HAP in the presence of other potential emission sources

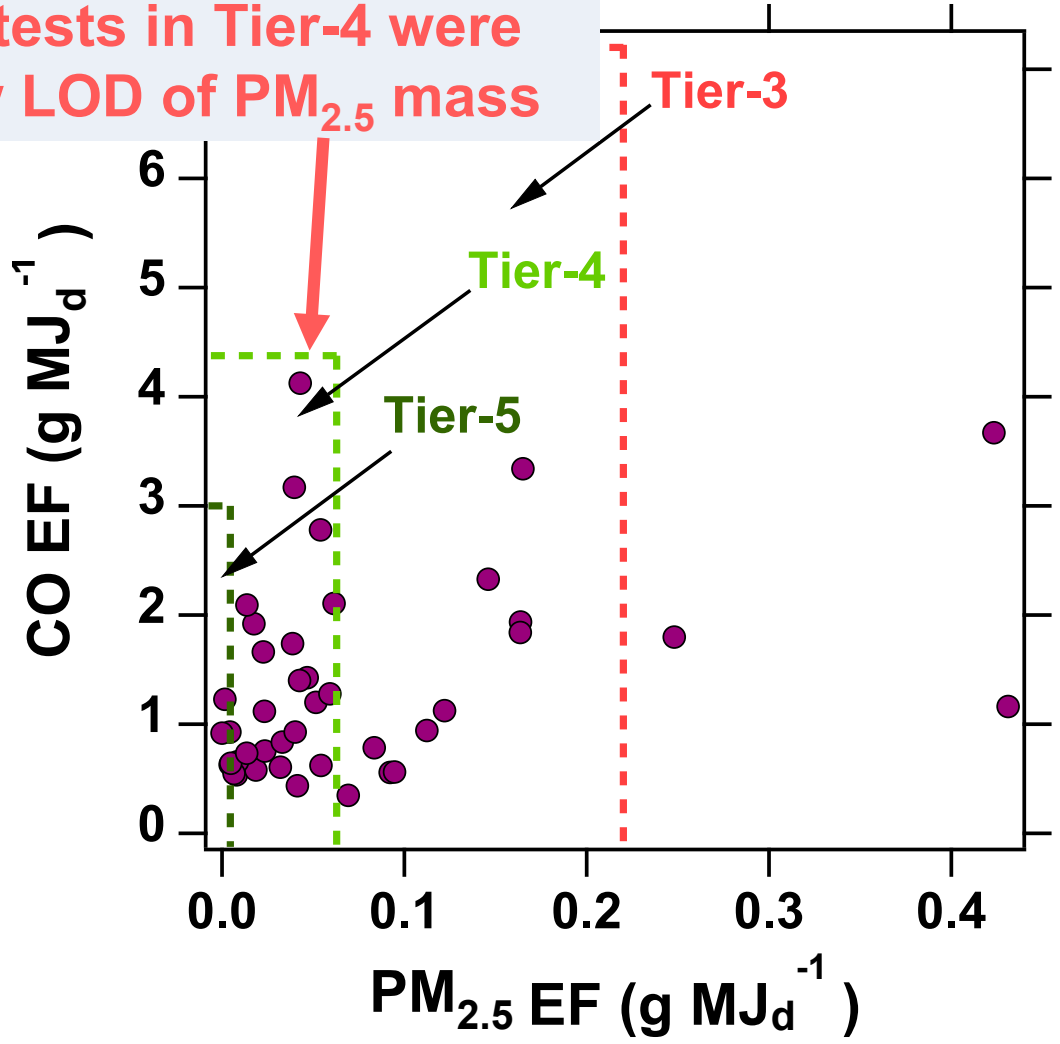


ISO voluntary performance targets

Tier	$PM_{2.5}$ emissions (g MJ^{-1})	CO emissions (g MJ^{-1})
5	≤ 0.005	≤ 3.0
4	≤ 0.062	≤ 4.4
3	≤ 0.218	≤ 7.2
2	≤ 0.481	≤ 11.5
1	≤ 1.031	≤ 18.3
0	>1.031	>18.3

A clean stove is not always a silver bullet for HAP in the presence of other potential emission sources

84% tests in Tier-4 were below LOD of $PM_{2.5}$ mass



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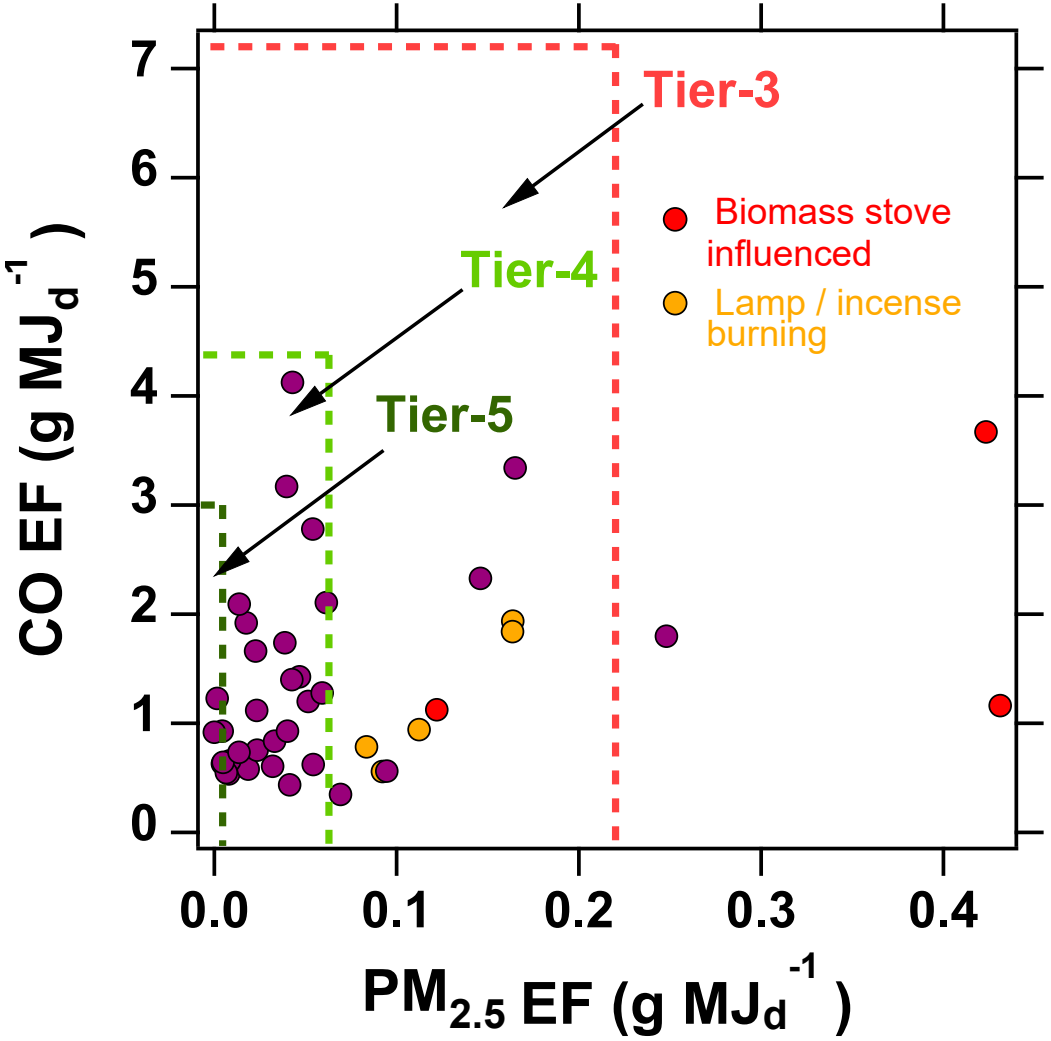


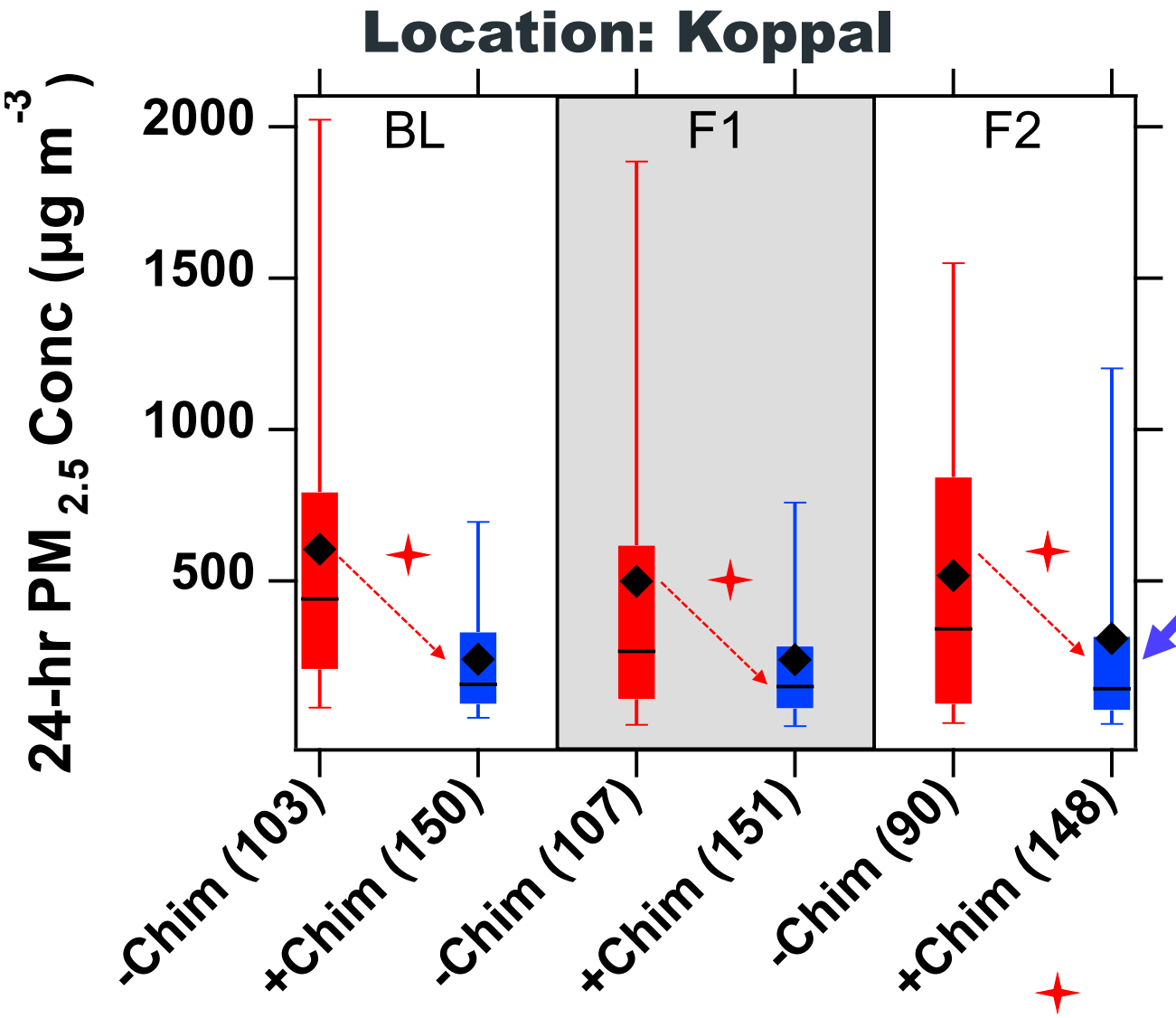
ELSEVIER

Science of The Total Environment
Volume 758, 1 March 2021, 143698

In-use emissions from biomass and LPG stoves measured during a large, multi-year cookstove intervention study in rural India

Mohammad Maksimul Islam [a], Roshan Wathore [a, 1], Hisham Zerriffi [b], Julian D. Marshall [c], Rob Bailis [d], Andrew P. Grieshop [a]

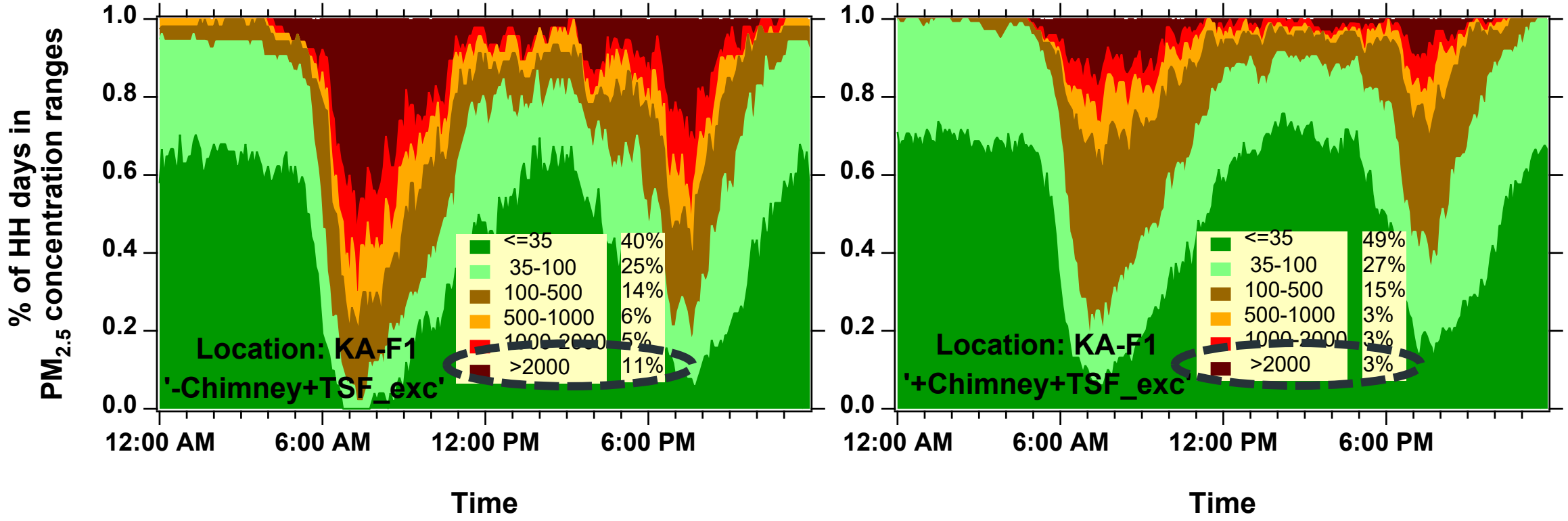
IAQ: Kitchen chimneys help!



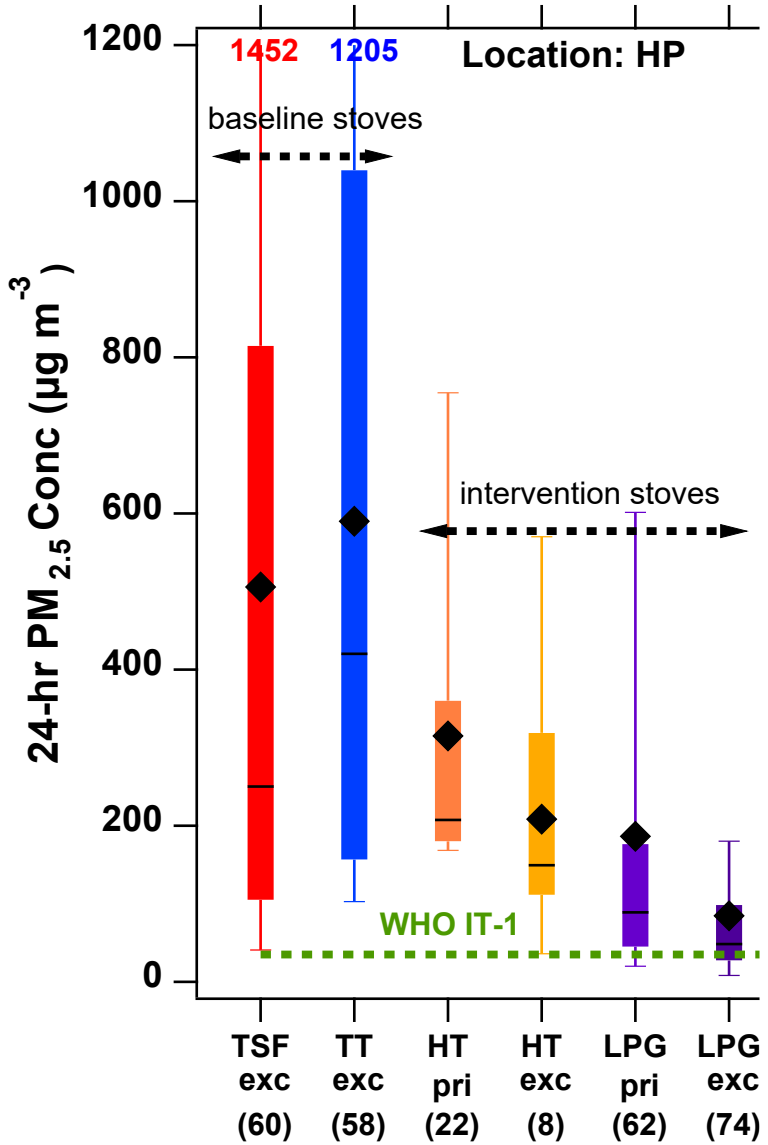
Mean reduction of 55 – 64% relative to non-chimney HHs

Kitchen chimneys were especially effective at reducing peak concentrations (>2000 µg/m^3)

Karnataka: TSF-only HHs without and with Chimney



IAQ Sum-up: a clear hierarchy of effectiveness



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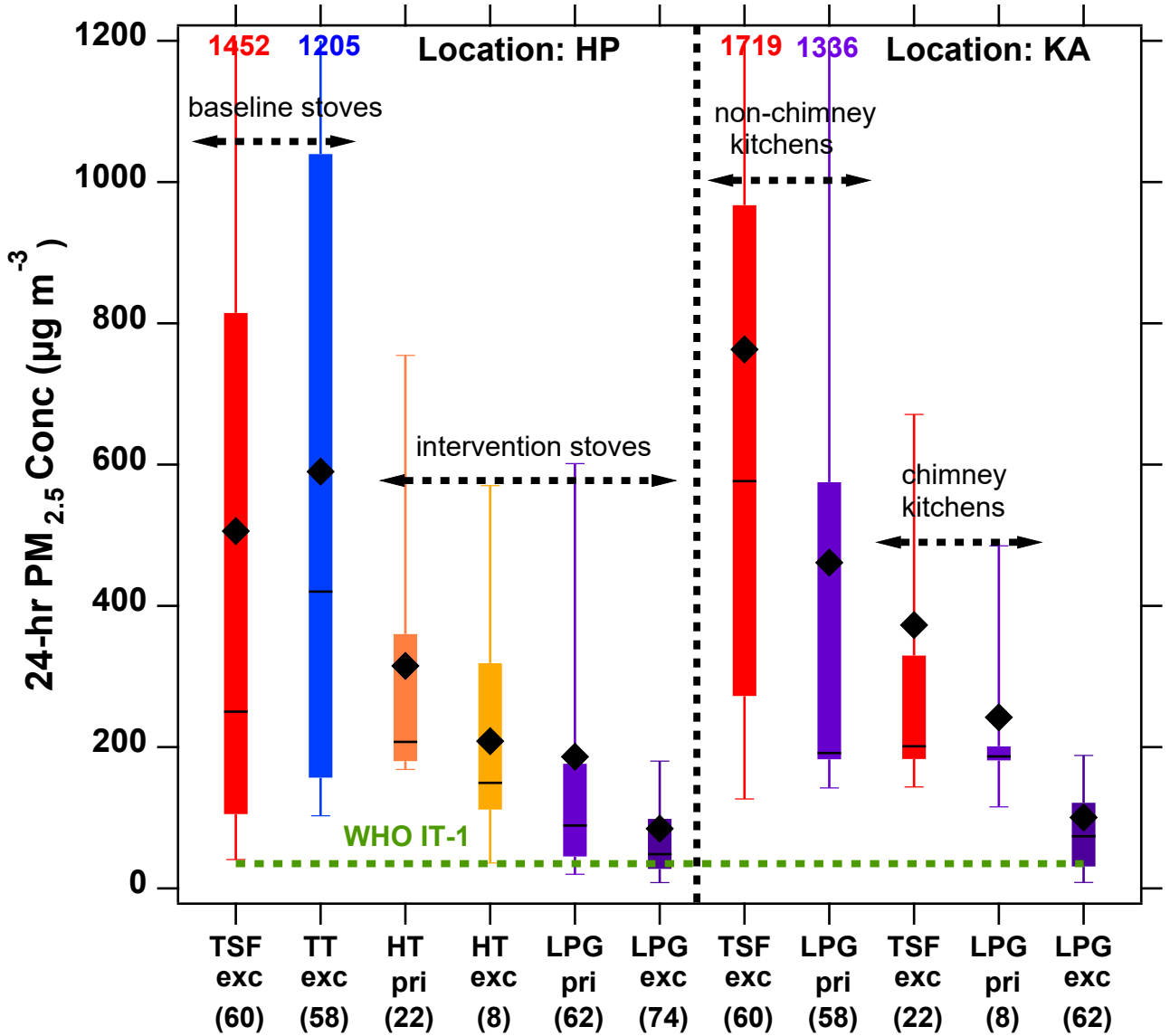
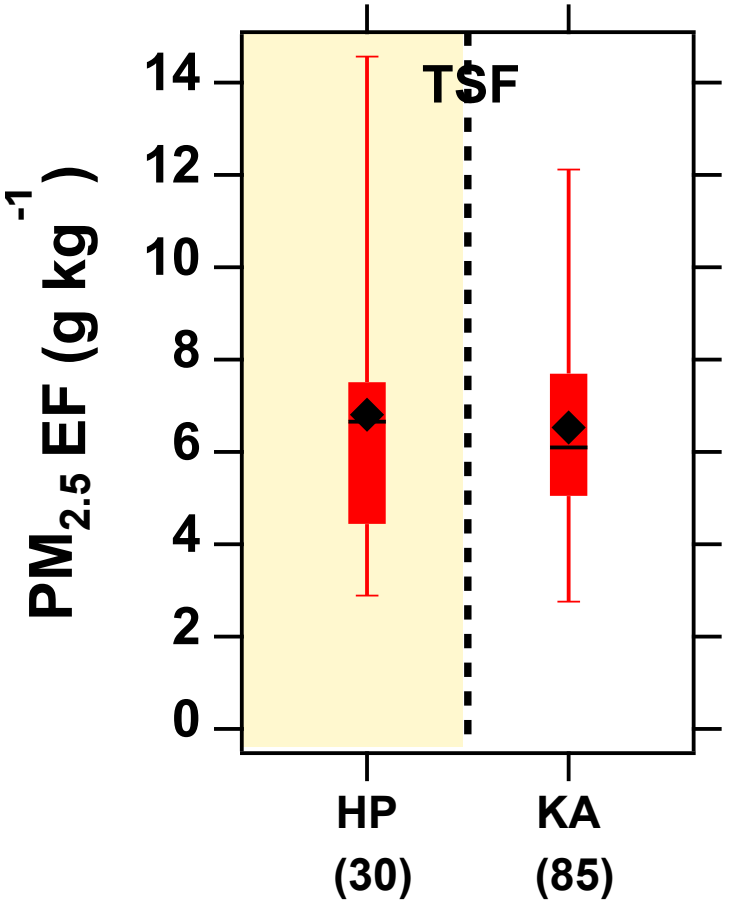


Indoor $PM_{2.5}$ concentrations varied between locations, but $PM_{2.5}$ EF did not… Why?

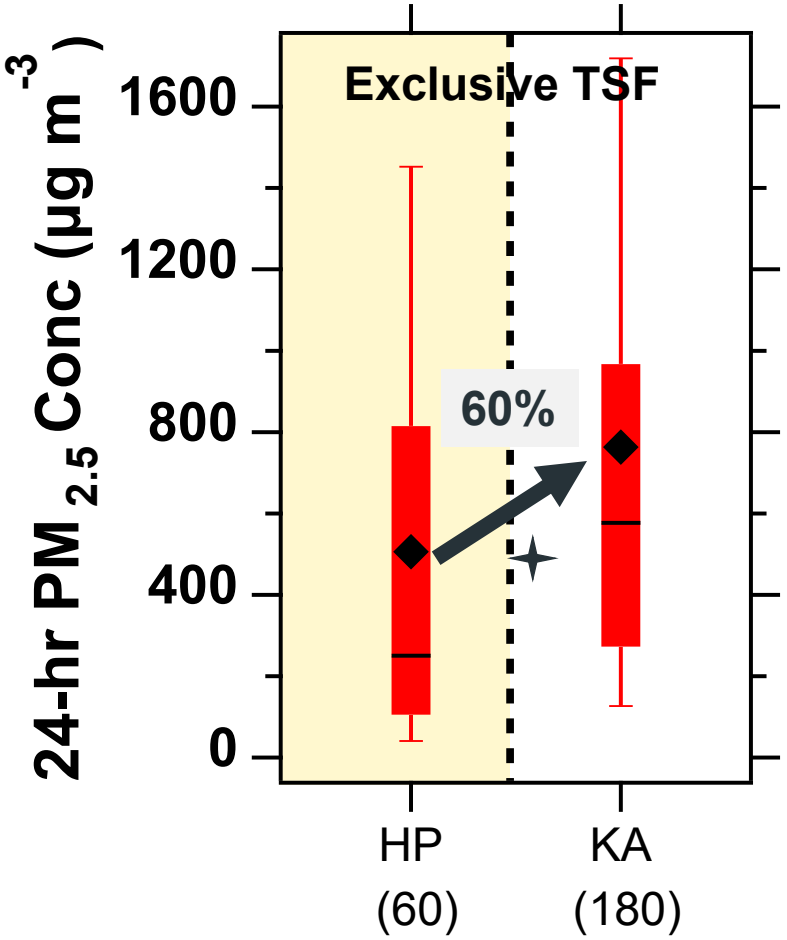
Traditional Stove Emissions

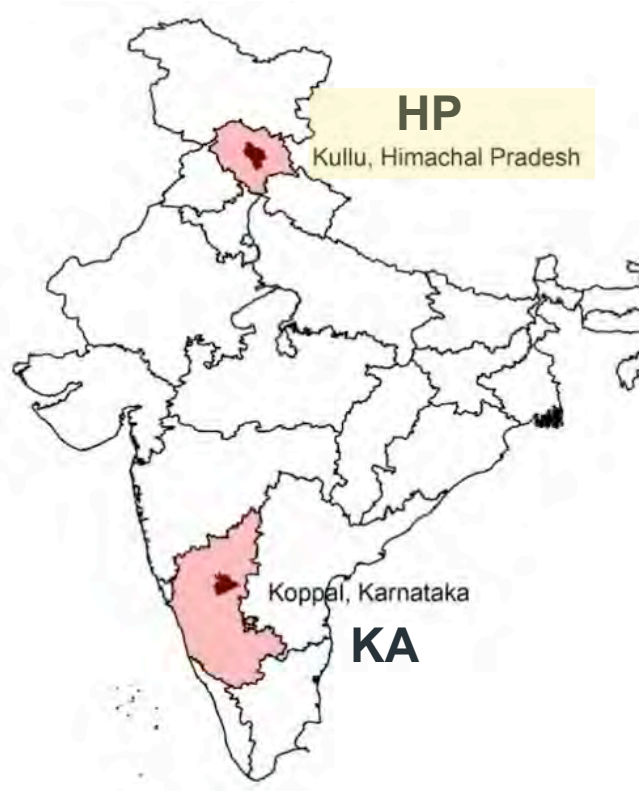
TSF: $PM_{2.5}$ EF



HH IAQ (with TSF)

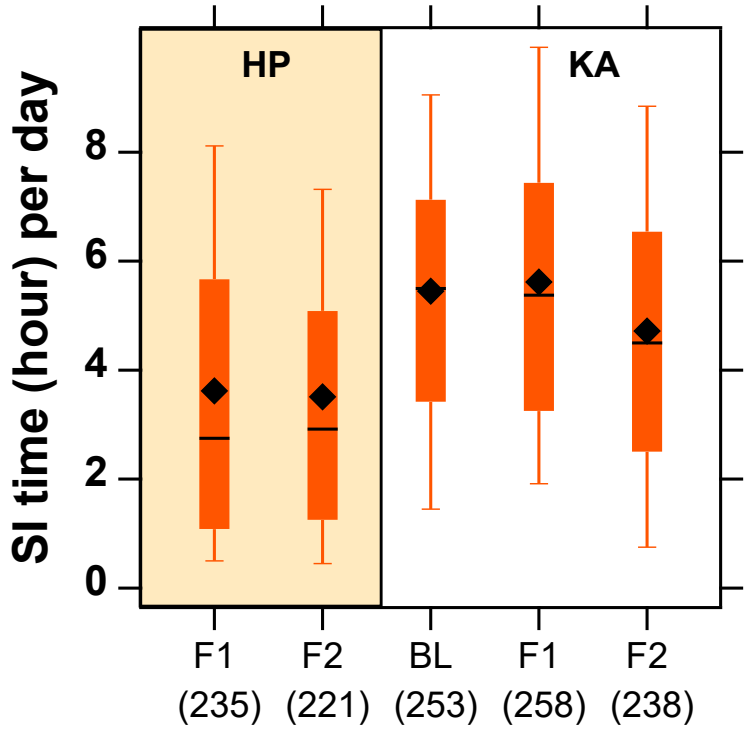
TSF: Indoor $PM_{2.5}$



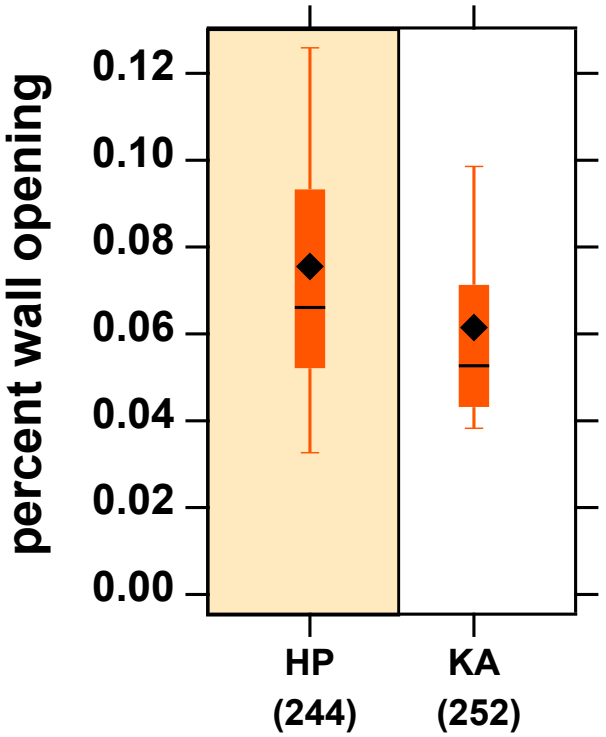


Household cooking and ventilation characteristics seem to drive inter-location variability in indoor $PM_{2.5}$

Daily cooking duration

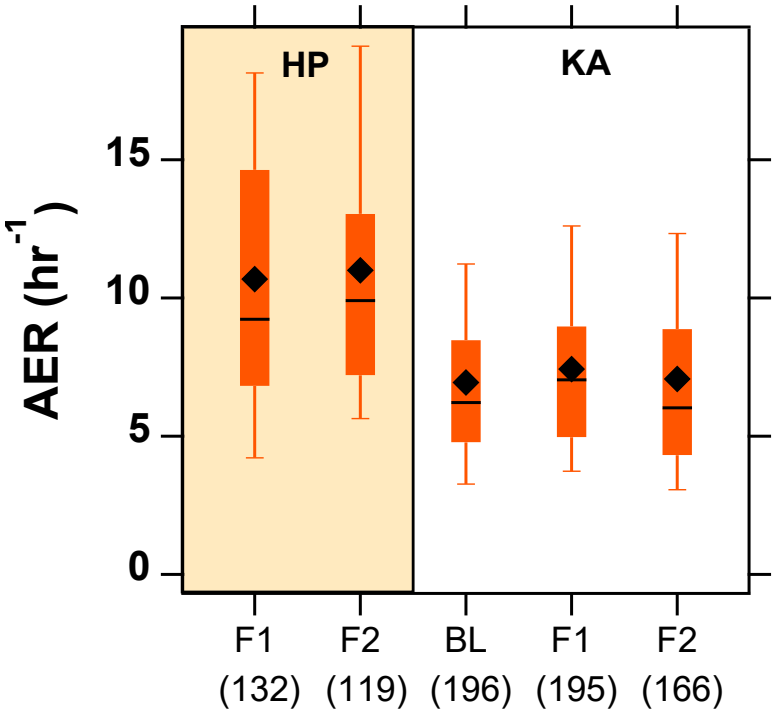


% wall opening*



*ratio of total opening area to the total surface area in the kitchen/cooking room

Air exchange rate



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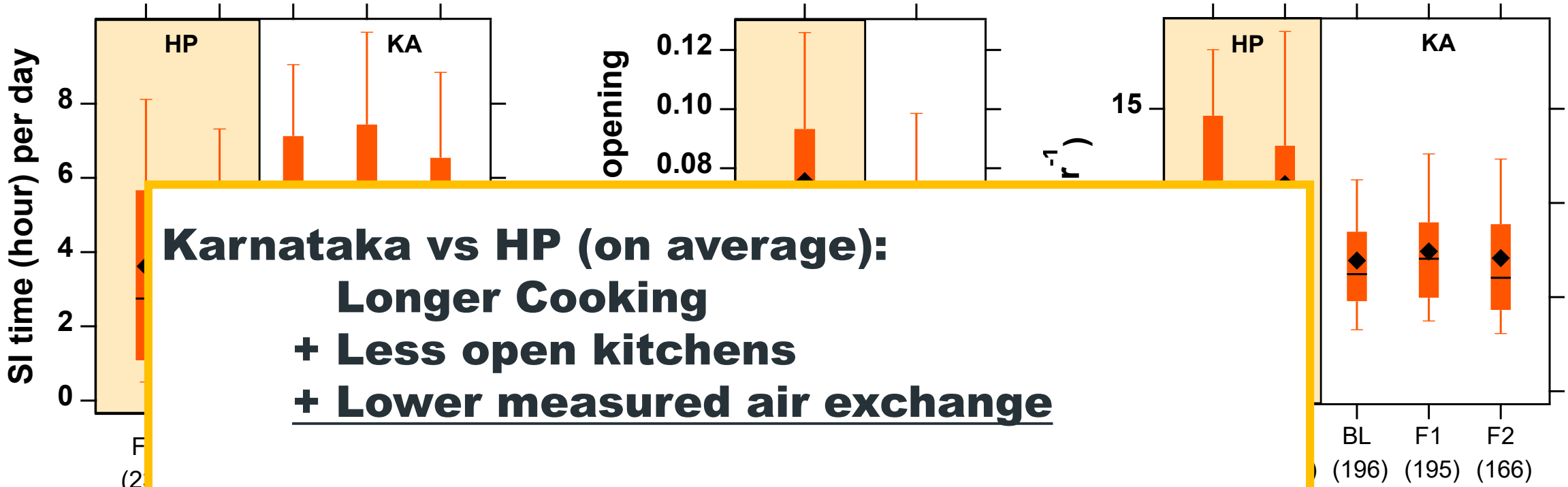


Karnataka vs HP (on average):

Longer Cooking

+ Less open kitchens

+ Lower measured air exchange

= Worse IAQ for similar emissions…

the total surface area in the kitchen/cooking room

Combining emission and IAQ data – what can it tell us about the box model approach being used*?

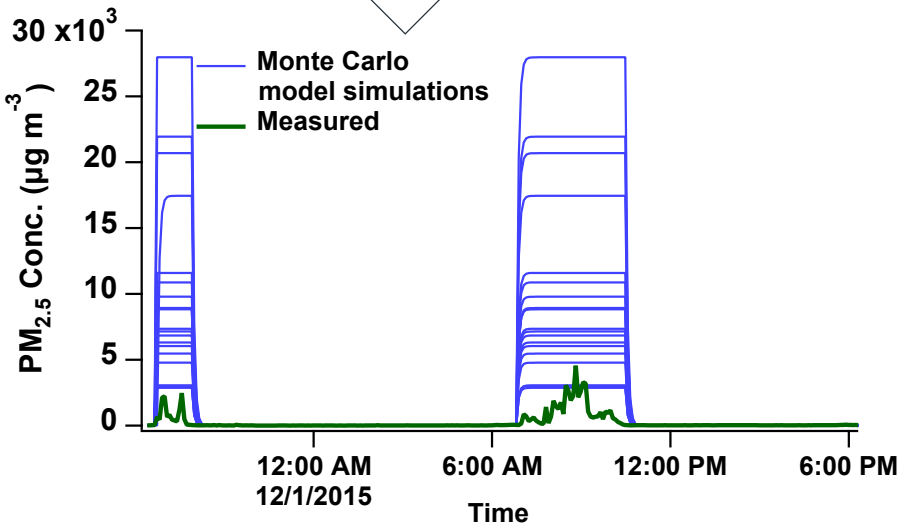
Emission rate, cooking duration,
Kitchen volume, AER and background PM conc.

Inputs

$$\frac{dC}{dt} = \text{Emission} + \text{Advection}_{in} + \sout{\text{Production}} - (\sout{\text{Deposition} + \text{Loss}} + \text{Advection}_{out})$$

Monte Carlo

Johnson et al., 2011
WHO, 2014



***e.g. for setting ISO Tiers and for exposure estimates**

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$$\frac{dC}{dt} = \text{Emission} + \text{Advection}_{in} \pm \cancel{\text{Production}} - (\cancel{\text{Deposition}} + \cancel{\text{Loss}} + \text{Advection}_{out})$$

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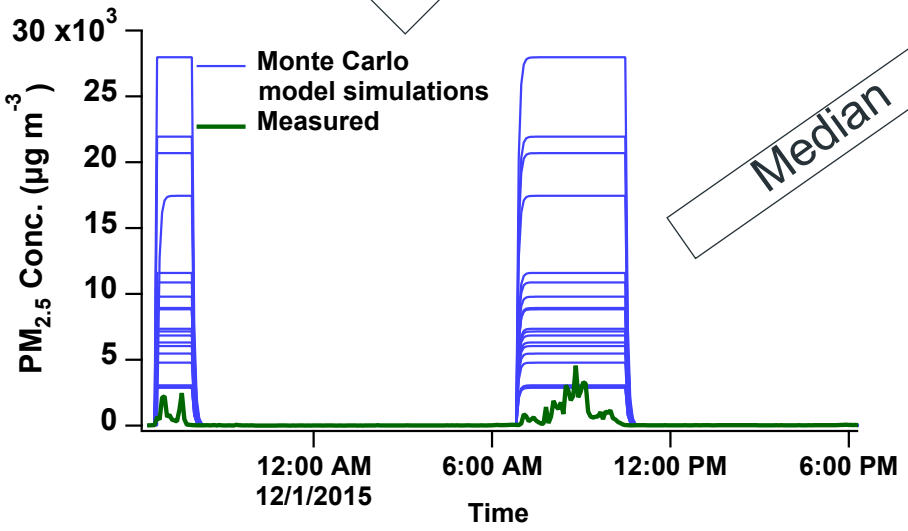
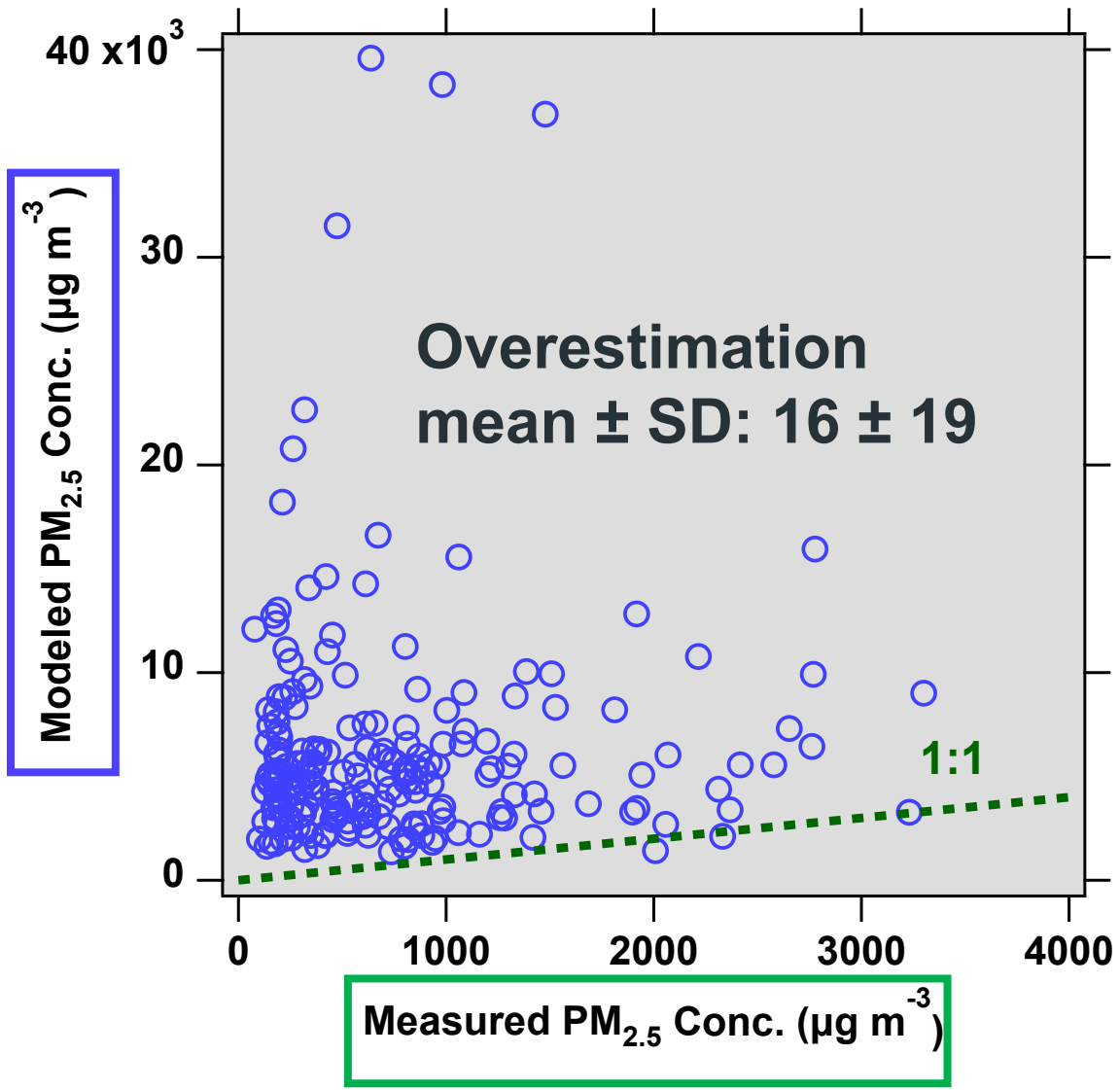
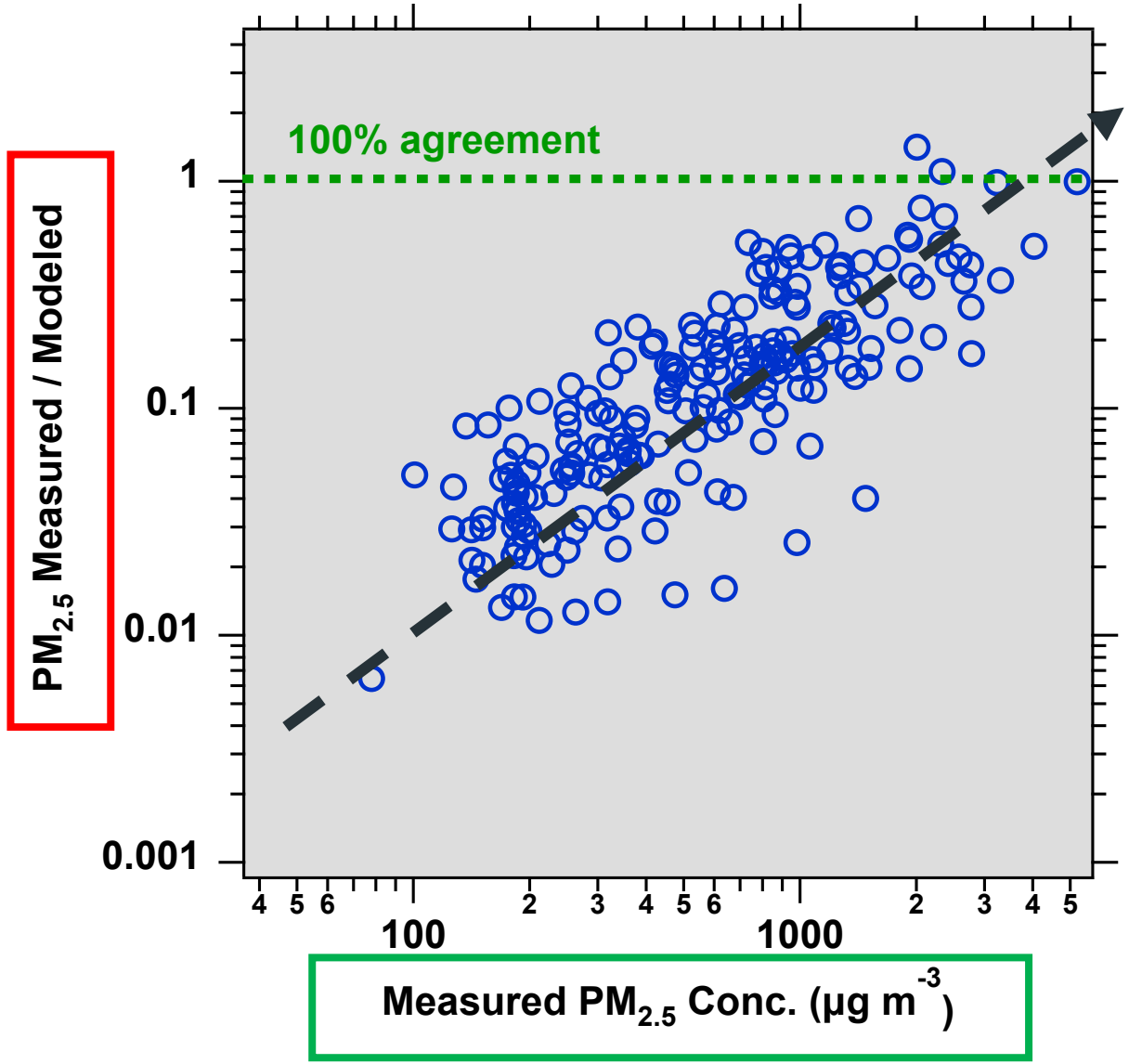


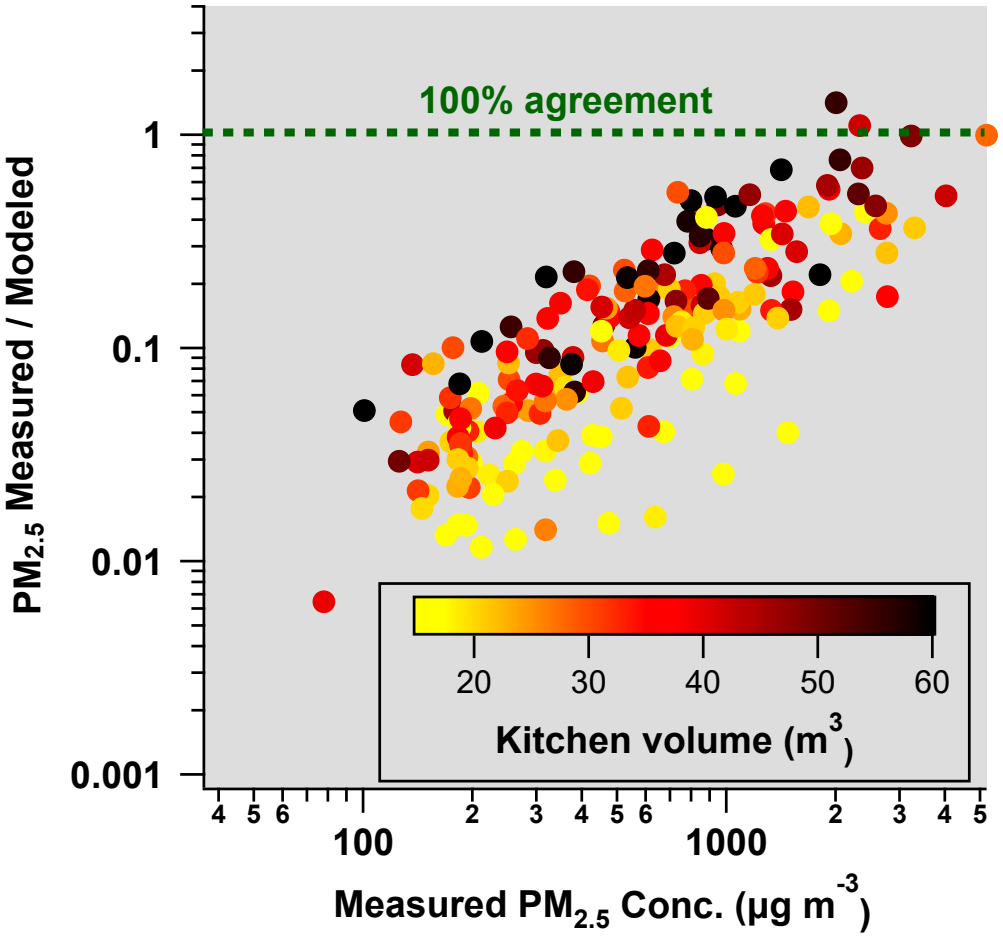
Median



Measurement/model ratio – less bias at high $PM_{2.5}$



Model performs better for kitchens with larger volume and higher air exchange rate



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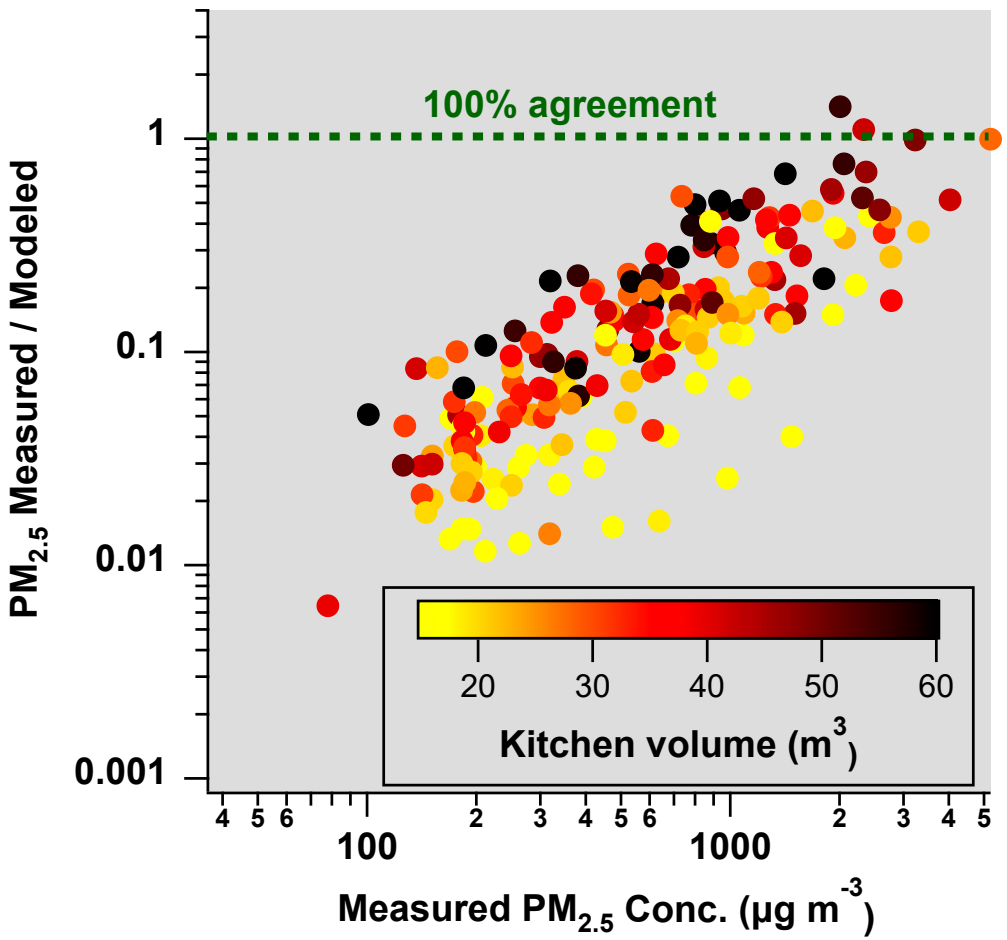
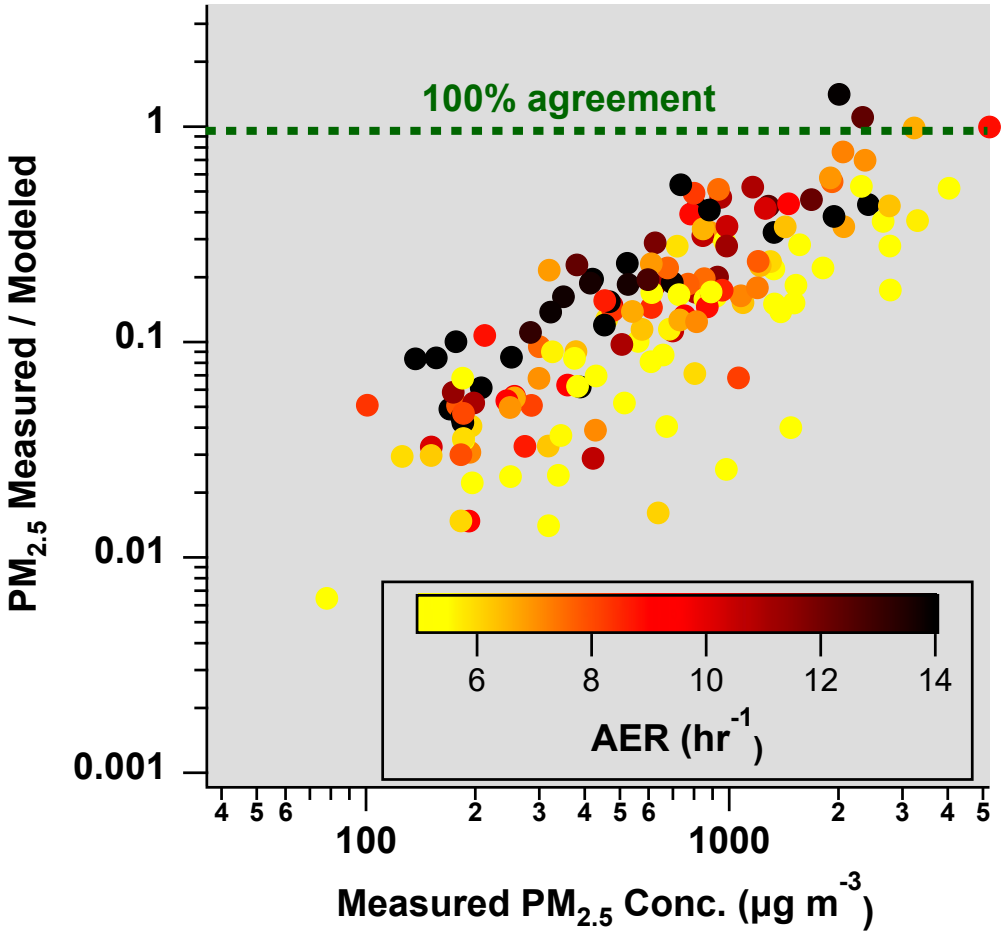
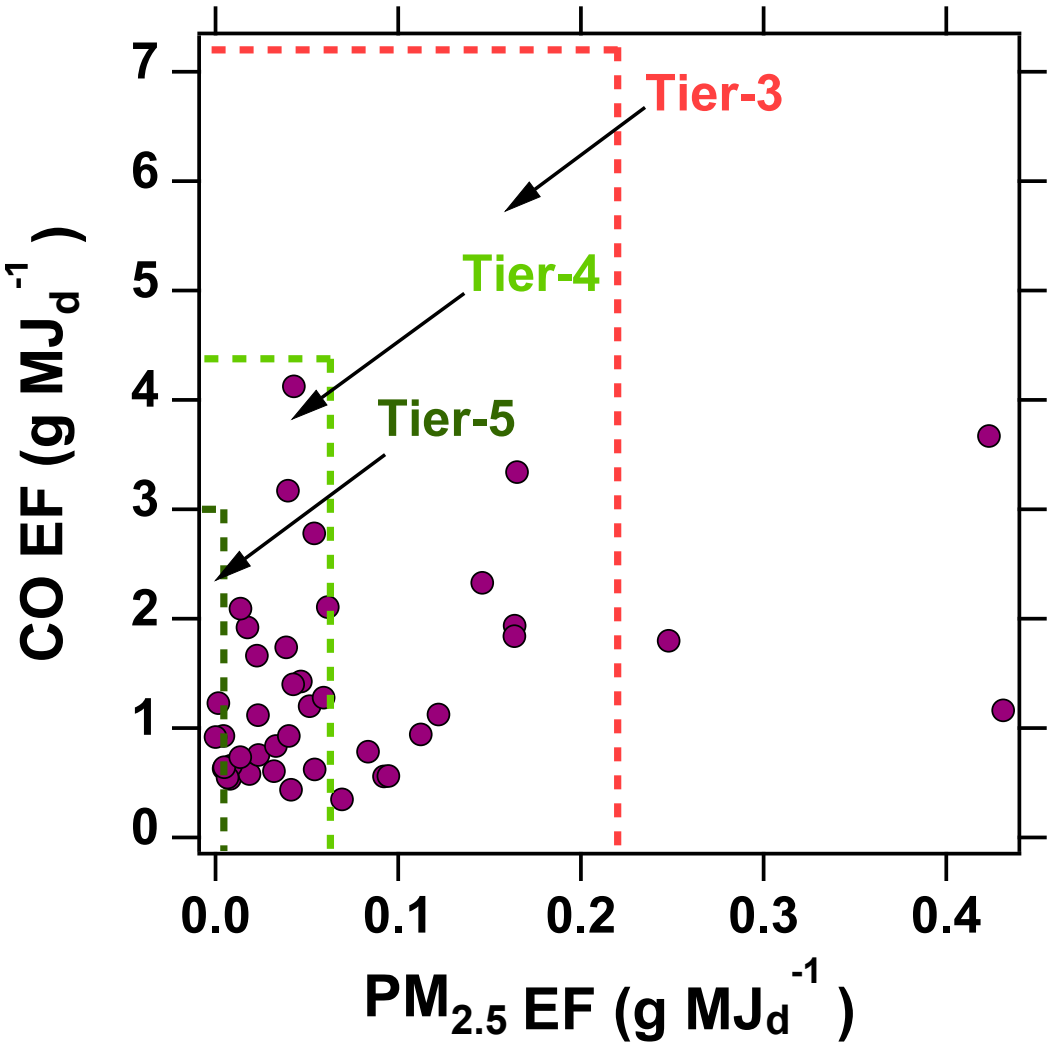




Multilinear regression: Kitchen area, aspect ratio (length : width) and temperature

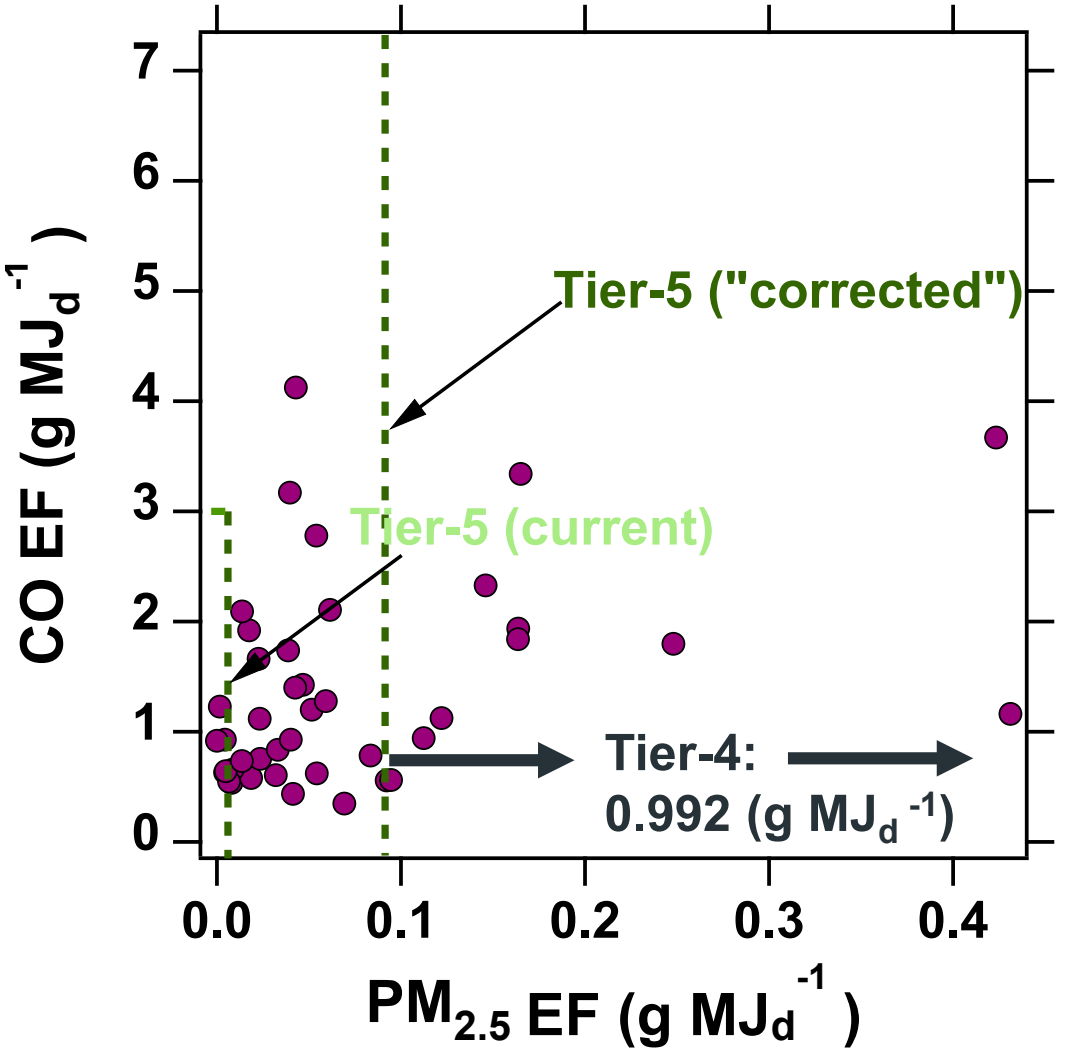
Implication of model overestimation for ISO emission rate targets

Recall, many of our in-home LPG tests fell outside of desired emission Tiers…



Model overestimation may mean ISO emission rate targets are highly conservative

If we 'correct' Tier boundaries using mean 'bias' from model-measurement comparison, things look better…



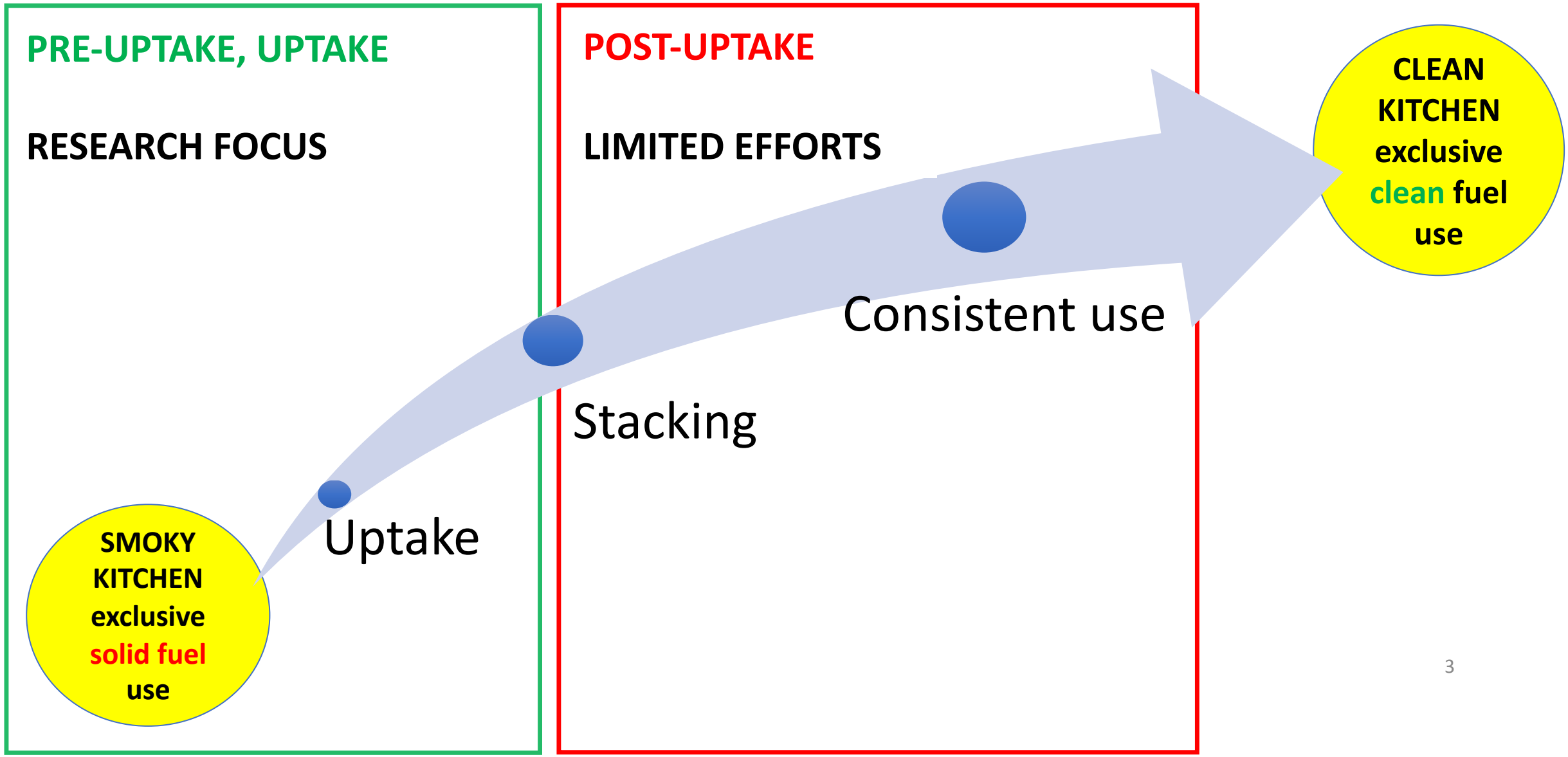
Other study take-aways

- Traditional stove emissions – depend on fuel moisture and humidity
- Traditional Tandoor and Himanshu Tandoor EFs were similar, but IAQ impacts very different.
- Other biomass stoves – little use, no great performers…
- Stove brown carbon emissions – substantial, distinct from ‘open burning’ and controlled lab test stove brown carbon absorption
  - Higher OC emissions, but OC is less absorbing than lab tests.

Stacking in Koppal: Analysis using LPG Sales Data

Stacking: Have access to LPG but still use firewood

Post-uptake knowledge gaps



Post-uptake knowledge gaps

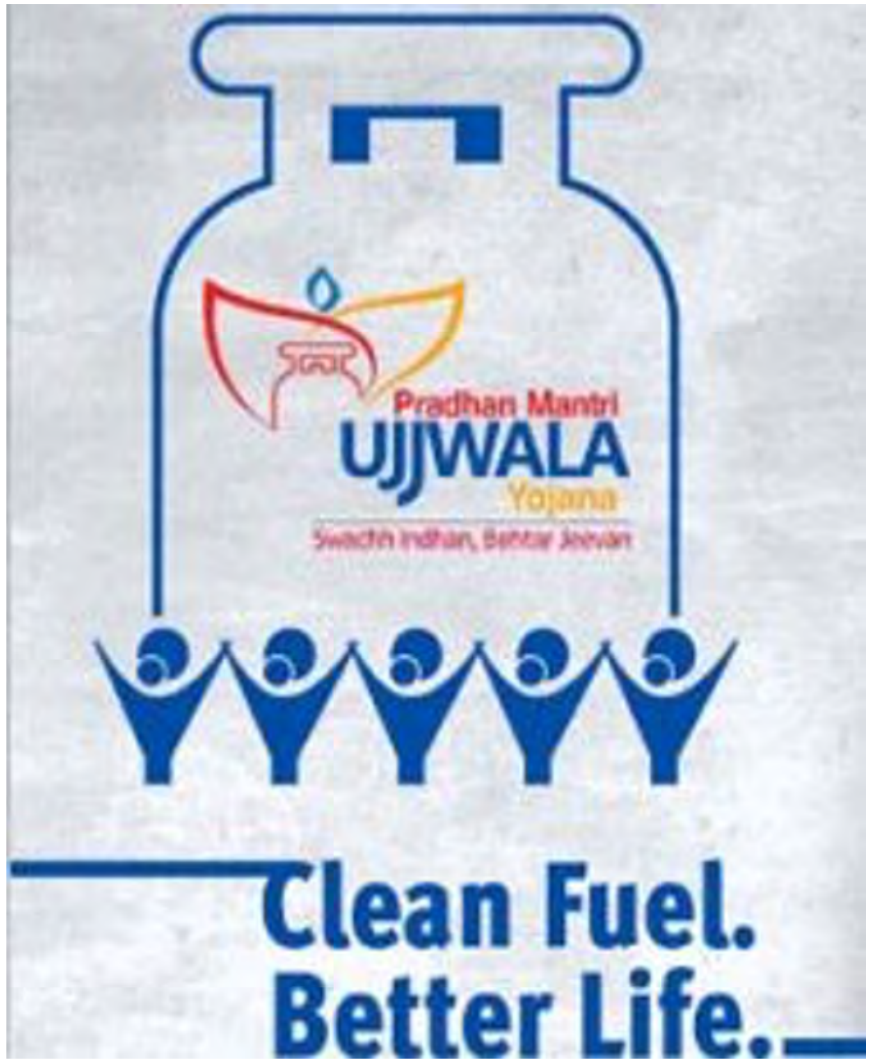
Stacking treated in "*very general terms*":

- "*Dynamic use patterns*" over time not studied (Ruiz Mercado et al., 2015)
- "*move beyond the acknowledgement of fuel stacking realities to push the understanding of its motivations*" (Gould et al., 2018)
- "*empirical understanding of the drivers of transition very limited*"(Pachauri et al., 2013)

POST-UPTAKE USE PATTERNS & ITS DETERMINANTS UNKNOWN

Policy context: Ujjwala roll-out in India

- *Ujjwala*: Subsidy + Micro-finance for ‘poor’ women
- Zero upfront cost option -> **UPTAKE**
- Massive campaign -> **AWARENESS**
- Supply Chain Upgrade -> **AVAILABILITY**
- 80 million HH in 40 months -> **99% coverage**



Immediate Motivation

- Anecdotal evidence indicated mismatch between reported LPG use during survey & field workers of partner NGO

- Visit to local LPG supplier (distributor): Record availability
  - Who
  - When
  - How much: standard (14.2 kg)/ small (5 kg)
  - At what price

Distributor Code

Consumer Code

Date of enrollment

5 kg or 14.2 kg

Upfront price paid to Distributor

distcode	lpgid	Installation_Date	SBC_DBC	Eq_Code	order_Date	delivery_date	RSPamount
122562	10000000075173878	2016-07-19 21:01:00	SBC	14.2kg	2016-07-19 20:15:00	2016-07-19 21:01:00	0.0
122562	10000000075173878	2016-07-19 21:01:00	SBC	14.2kg	2017-01-13 11:55:00	2017-01-16 19:21:00	623.5
122562	10000000075173878	2016-07-19 21:01:00	SBC	14.2kg	2017-07-14 11:27:00	2017-07-17 19:35:00	595.0
122562	10000000075173878	2016-07-19 21:01:00	SBC	14.2kg	2018-01-19 18:20:00	2018-01-19 18:22:00	773.0
122562	10000000075173878	2016-07-19 21:01:00	SBC	14.2kg	2018-03-26 19:35:00	2018-03-26 19:38:00	723.5
122562	10000000075173878	2016-07-19 21:01:00	SBC	14.2kg	2018-05-04 14:09:00	2018-05-04 20:24:00	686.0
122562	10000000075173878	2016-07-19 21:01:00	SBC	14.2kg	2018-07-11 15:39:00	2018-07-18 19:30:00	794.0
122562	10000000075173878	2016-07-19 21:01:00	SBC	14.2kg	2018-12-22 07:50:00	2018-12-22 18:33:00	849.5
122562	10000000075173878	2016-07-19 21:01:00	SBC	14.2kg	2019-02-26 20:00:00	2019-03-01 21:10:00	740.0
122562	10000000075173878	2016-07-19 21:01:00	SBC	14.2kg	2019-07-01 17:23:00	2019-07-02 19:58:00	674.5
122562	10000000075173878	2016-07-19 21:01:00	SBC	14.2kg	2019-09-10 12:31:00	2019-09-12 19:23:00	629.0
122562	10000000075173878	2016-07-19 21:01:00	SBC	14.2kg	2019-10-24 08:37:00	2019-10-25 18:17:00	642.5
122562	10000000075173878	2016-07-19 21:01:00	SBC	14.2kg	2019-12-25 15:04:00	2019-12-26 20:06:00	738.0
122562	10000000075173878	2016-07-19 21:01:00	SBC	14.2kg	2020-03-27 11:17:00	2020-03-28 19:10:00	852.0

Access to Dataset

- EPA project distributor affiliated to Indian Oil Corp.

Ministry of Petroleum and Natural Gas
Government of India

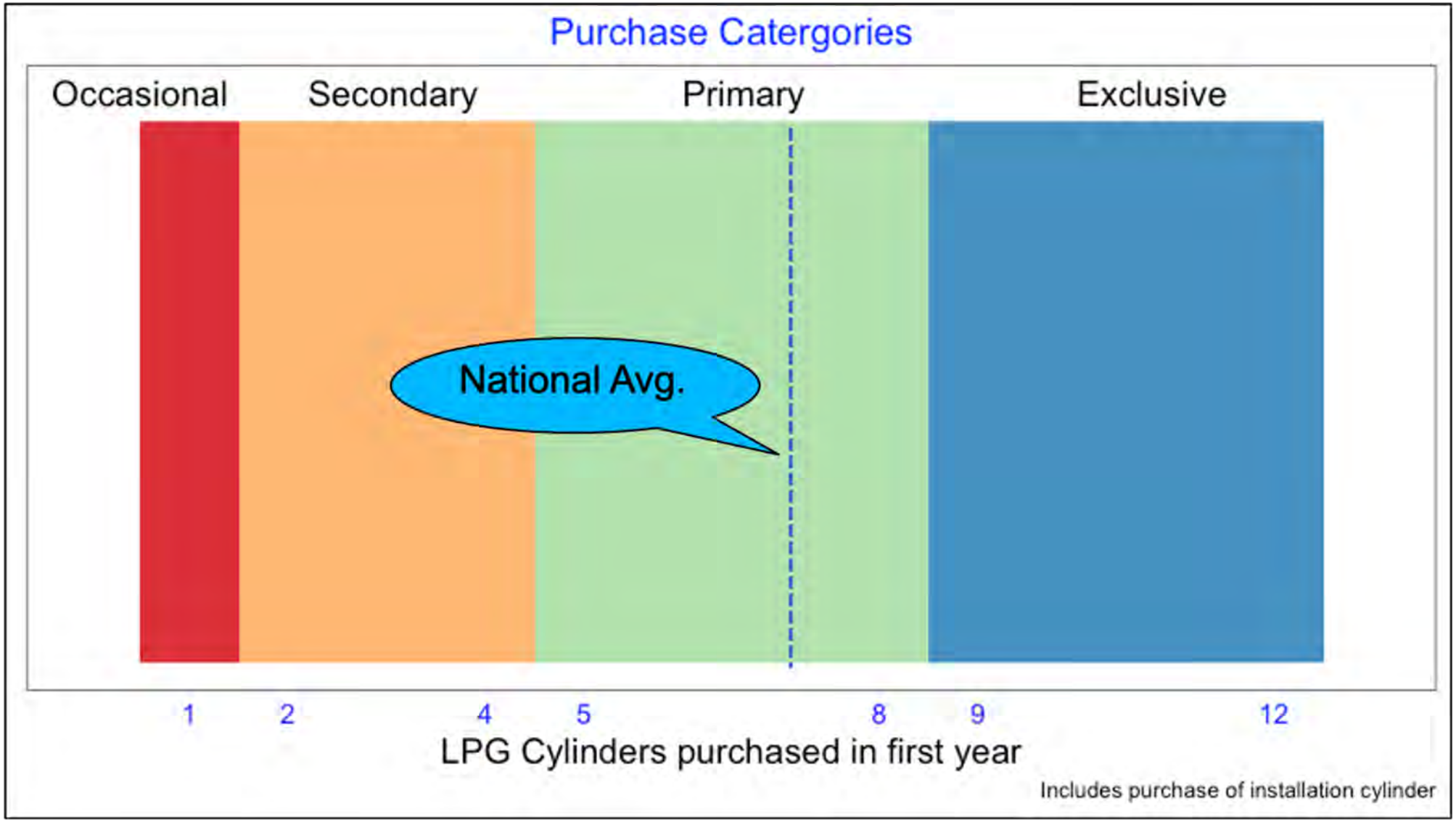
- 3 distributors of Indian Oil
  - Exclusively cater to rural consumers
- 25,000 consumers in the district
- Data going back up to 2016
- Purchase = Usage*

Exploratory Research

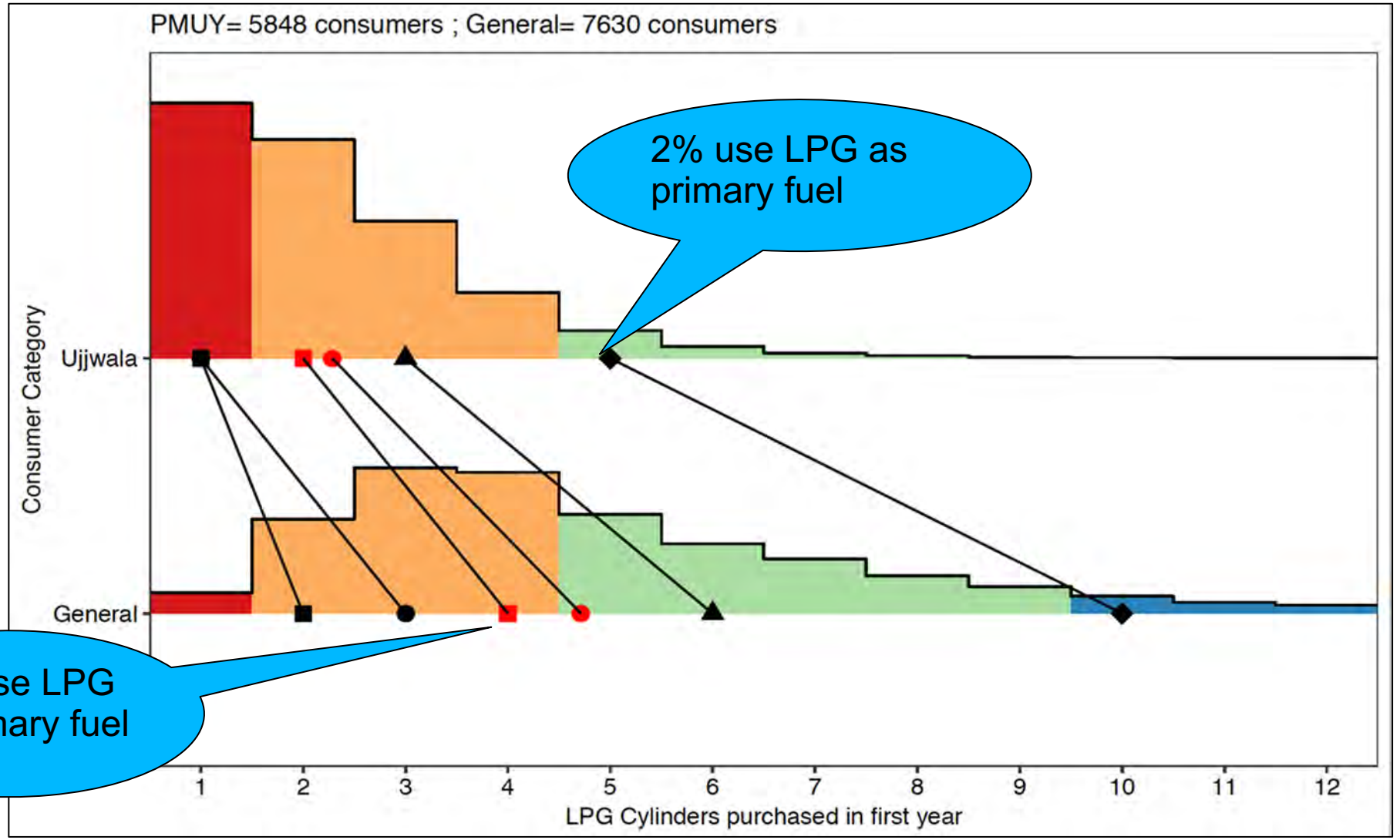
- How different are LPG use patterns between beneficiaries (Ujjwala-PMUY) & general consumers?
- Does more experience lead to more LPG use?
- Do the response in EPA survey on LPG consumption match their LPG purchase records?

Refill pattern & its significance

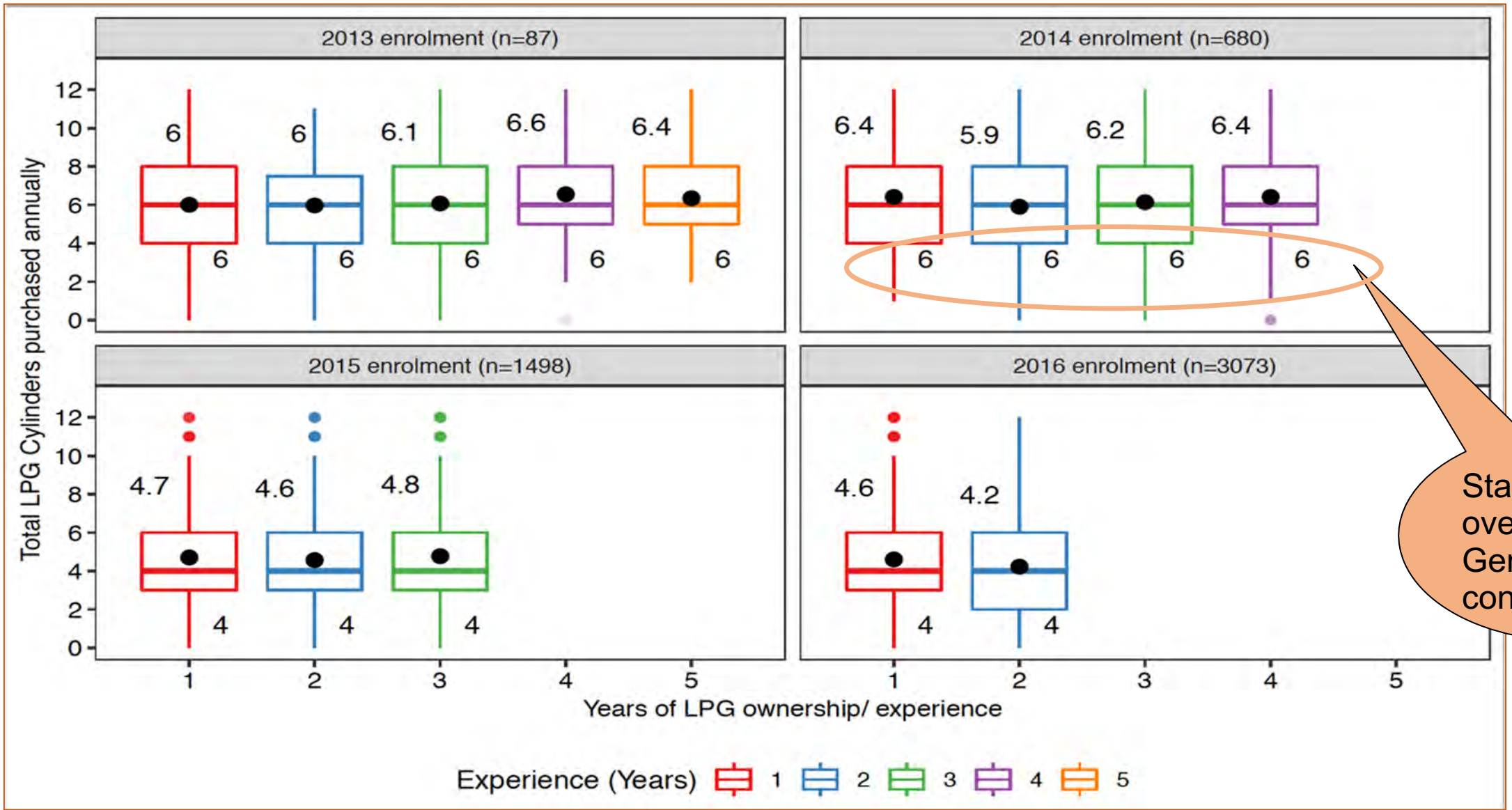
- Typical rural family of 5
- Exclusive LPG use: 9 [Standard] Cylinders
- 95% HH use 10 or less



Ujjwala vs. General Consumers



More Experience ≠ Increase in Use



nature energy

ANALYSIS

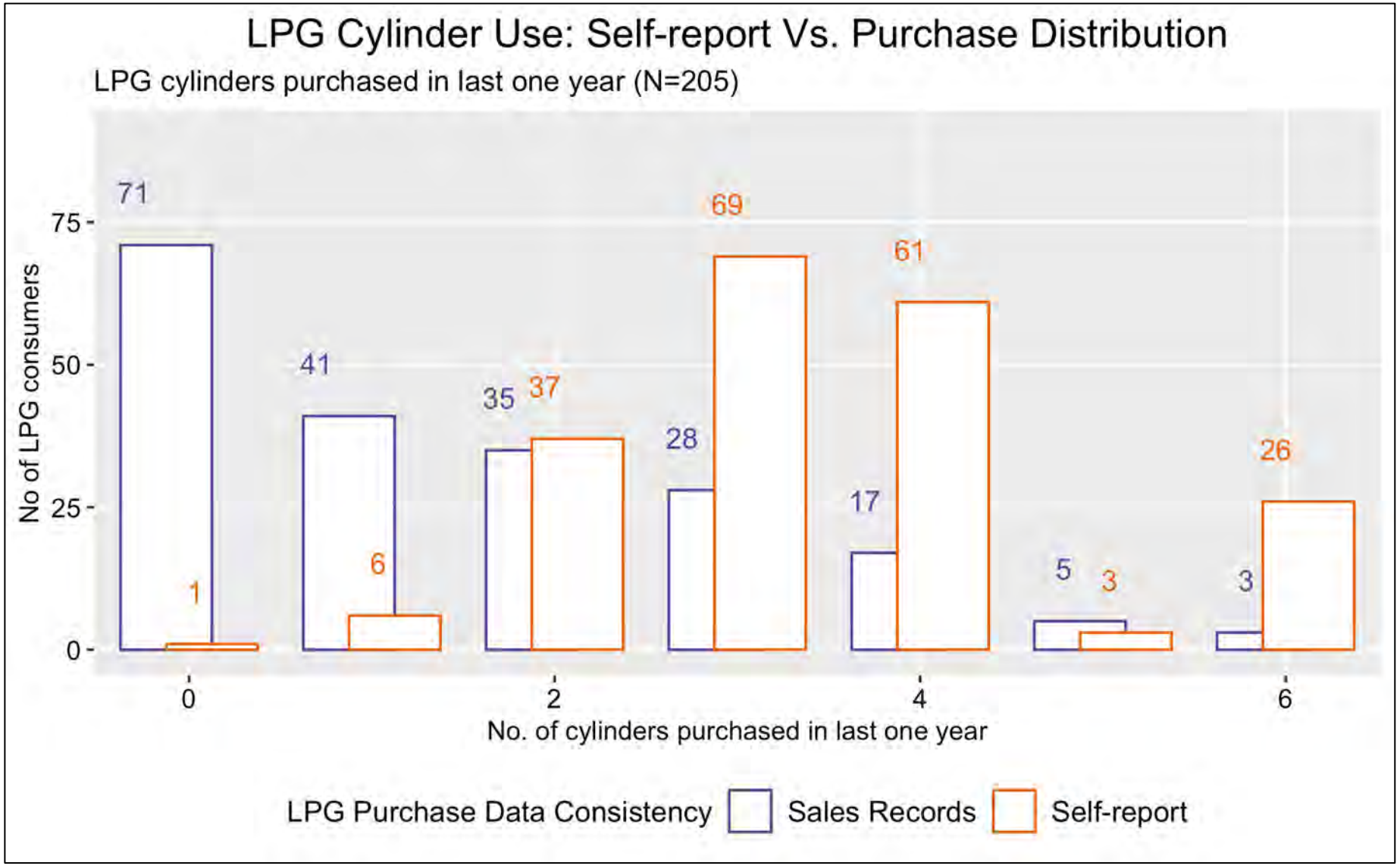
https://doi.org/10.1038/s41560-019-0429-8

Using sales data to assess cooking gas adoption and the impact of India's *Ujjwala* programme in rural Karnataka

Abhishek Kar[1*], Shonali Pachauri[2], Rob Bailis[3] and Hisham Zerriffi[4]

More than 70 million poor women in India have received liquefied petroleum gas (LPG) stoves within the first 35 months under a government programme, Pradhan Mantri Ujjwala Yojana (PMUY). Here, we analyse multi-year LPG sales data from a district in Karnataka to assess enrolment and consumption trends for both PMUY beneficiaries and general (non-PMUY) rural consumers. We find rapid growth in enrolments of LPG consumers, but this is not matched by an increase in LPG sales, suggesting that LPG access has not induced a full transition away from the use of polluting solid fuels. The number of LPG refills among PMUY beneficiaries is less than half that of rural general consumers. We also find no observable increase in LPG consumption among general rural consumers with years of experience. These results suggest that mid-course policy revisions to encourage regular LPG use are needed for both PMUY and general rural consumers.

Significant over-reporting of LPG consumption



World Development Perspectives 18 (2020) 100199

Contents lists available at ScienceDirect

World Development Perspectives

journal homepage: www.elsevier.com/locate/wdp

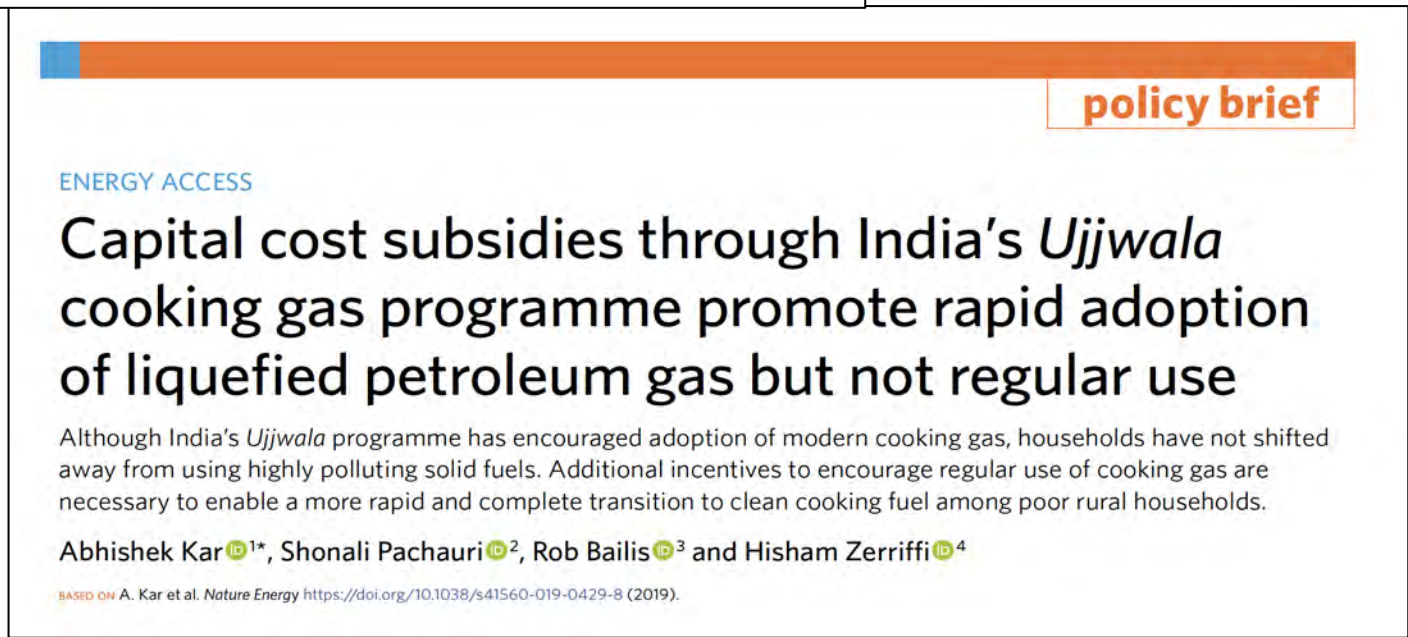
Case report

The risk of survey bias in self-reports vs. actual consumption of clean cooking fuels

Abhishek Kar[a,*], Michael Brauer[b], Rob Bailis[c], Hisham Zerriffi[d]

[a] *Columbia World Projects, Columbia University, NY, USA*
[b] *School of Population and Public Health, The University of British Columbia, Vancouver, Canada*
[c] *Stockholm Environment Institute, United States Centre, Somerville, MA, United States*
[d] *Forest Resources Management, Faculty of Forestry, The University of British Columbia, Vancouver, Canada*

Policy Briefs



Policymakers

PMO India
@PMOIndia

Pradhan Mantri Ujjawla Yojana: Smokeless kitchens are becoming a reality.
financialexpress.com/opinion/pradha...

via NaMo App

THE FINANCIAL EXPRESS

Pradhan Mantri Ujjawla Yojana: Smokeless kitchens are becoming a reality

August 7, 2018

Smokeless kitchens are becoming a reality under Narendra Modi Government's ambitious Pradhan Mantri Ujjawla Yojana (PMUY). Before PMUY was launched, 62% Indian households had LPG connections, now LPG coverage has extended to 85% households.

Journalists

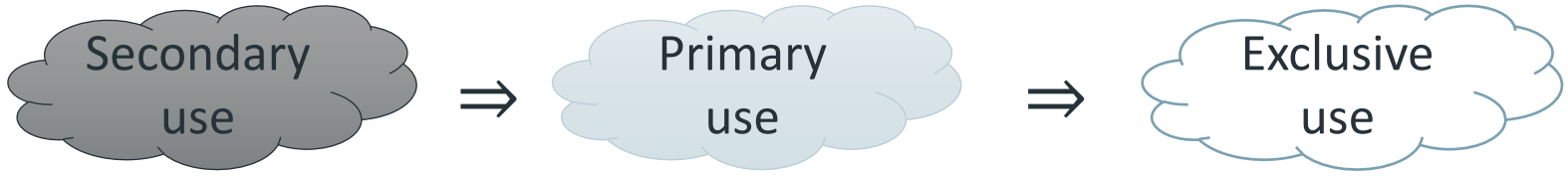
Closing thoughts - 1

Lessons from the intervention

- People preferred LPG stoves (induction a distant 2nd) over every biomass stove we could find
- Offering additional opportunities to select/purchase a stove resulted in higher uptake of clean options
- Simply acquiring clean options doesn't result in exclusive use (true for our intervention & PMUY)
- Survey responses about LPG consumption were clearly biased
  - Approach survey data with caution and supplement with independent sources when possible

We observed hundreds of HHs stacking LPG and biomass -- many HHs also had chimneys

- HHs using LPG showed a clear progression towards better IAQ:



Closing thoughts - 2

- HHs with chimneys also had significantly better IAQ than those without

BUT – two important caveats!

- Only exclusive use of LPG approaches WHO IT-1
- Exclusively "clean" cooking can still be associated with substantial emissions

PMUY

- A **huge success** providing LPG access to poor families
  - And in collecting data to enable objective impact assessment!
- But **LPG consumption is modest** and doesn't appear to increase over time
  - Health and other benefits are unlikely without additional intervention

Publications

1. Singh, D., S. Pachauri and H. Zerriffi (2017). "Environmental payoffs of LPG cooking in India." Environmental Research Letters **12**(11): 115003 https://iopscience.iop.org/article/10.1088/1748-9326/aa909d/meta
2. Singh, D., T. Aung and H. Zerriffi (2018). "Resource Collection Polygons: A spatial analysis of woodfuel collection patterns." Energy for Sustainable Development **45**: 150-158 https://www.sciencedirect.com/science/article/pii/S0973082617313960
3. Huang, Y., N. Unger, T. Storelvmo, K. Harper, Y. Zheng and C. Heyes (2018). "Global radiative effects of solid fuel cookstove aerosol emissions." Atmospheric Chemistry and Physics **18**(8): 5219-5233 https://acp.copernicus.org/articles/18/5219/2018/
4. Jagadish, A. and P. Dwivedi (2018). "In the hearth, on the mind: Cultural consensus on fuelwood and cookstoves in the middle Himalayas of India." Energy Research & Social Science **37**(Supplement C): 44-51 https://www.sciencedirect.com/science/article/abs/pii/S2214629617302980
5. Jagadish, A. and P. Dwivedi (2019). "Deconstructing networks, unearthing consensus: Diffusion of “cleaner” cookstoves in rural Himalayas of India." Energy, Sustainability and Society **9**(1): 5 https://link.springer.com/article/10.1186/s13705-019-0188-1
6. Jagadish, A., P. Dwivedi, K. D. McEntire and M. Chandar (2019). "Agent-based modeling of “cleaner” cookstove adoption and woodfuel use: An integrative empirical approach." Forest Policy and Economics **106**: 101972 https://www.sciencedirect.com/science/article/abs/pii/S1389934118304192
7. Kar, A., S. Pachauri, R. Bailis and H. Zerriffi (2019). "Using sales data to assess cooking gas adoption and the impact of India’s Ujjwala programme in rural Karnataka." Nature Energy **4**(9): 806-814 https://www.nature.com/articles/s41560-019-0429-8
8. Menghwani, V., H. Zerriffi, P. Dwivedi, J. D. Marshall, A. Grieshop and R. Bailis (2019). "Determinants of Cookstoves and Fuel Choice Among Rural Households in India." EcoHealth **16**(1): 21-60 https://link.springer.com/article/10.1007/s10393-018-1389-3
9. Kar, A., Singh, D., Pachauri, S. , Bailis, R., & Zerriffi, H. (2019), Ujjwala at 6 crores: Impact on Cooking Energy Transition and Climate Change. In: The Ujjwala Saga - Unending Happiness & Health. pp. 16-21 Ministry of Petroleum and Natural Gas, Government of India, http://pure.iiasa.ac.at/id/eprint/15741/
10. Kar, A., Pachauri, S., Bailis, R. et al. (2020) Capital cost subsidies through India’s Ujjwala cooking gas programme promote rapid adoption of liquefied petroleum gas but not regular use. Nat Energy 5, 125–126. https://doi.org/10.1038/s41560-019-0536-6
11. Islam, M. R. Wathore, et al, (2021). “In-use emissions from biomass and LPG stoves measured during a large, multi-year cookstove intervention study in rural India” Science of The Total Environment 758, 143698 https://doi.org/10.1016/j.scitotenv.2020.143698
12. Singh, D., H. Zerriffi, R. Bailis and V. LeMay (2021). "Forest, Farms and Fuelwood: Measuring changes in fuelwood collection and consumption behavior from a clean cooking intervention." Energy for Sustainable Development (in Press)
13. Islam M., R. Wathore, et al, (2021). “Assessing the effects on indoor air quality of a large, multi-year cookstove randomized control trial in rural India” (submitted to ES&T)

Thank you!

Question & Answer

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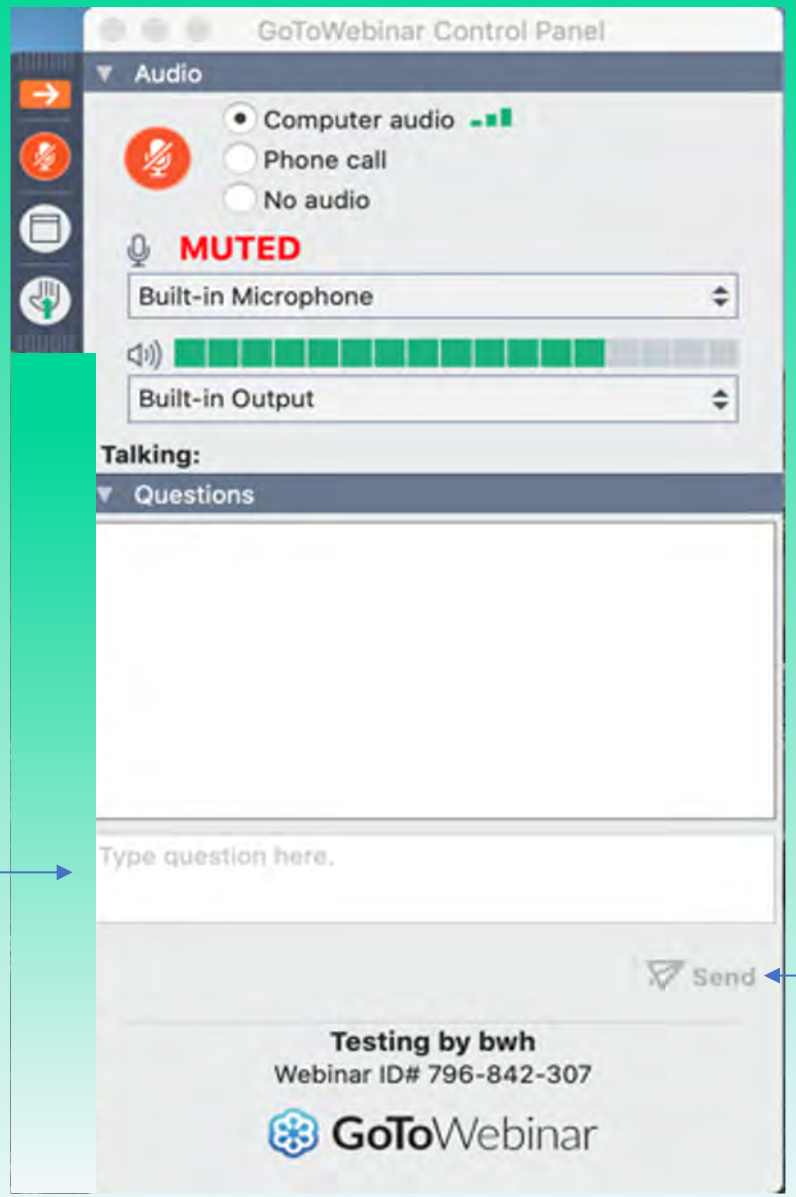

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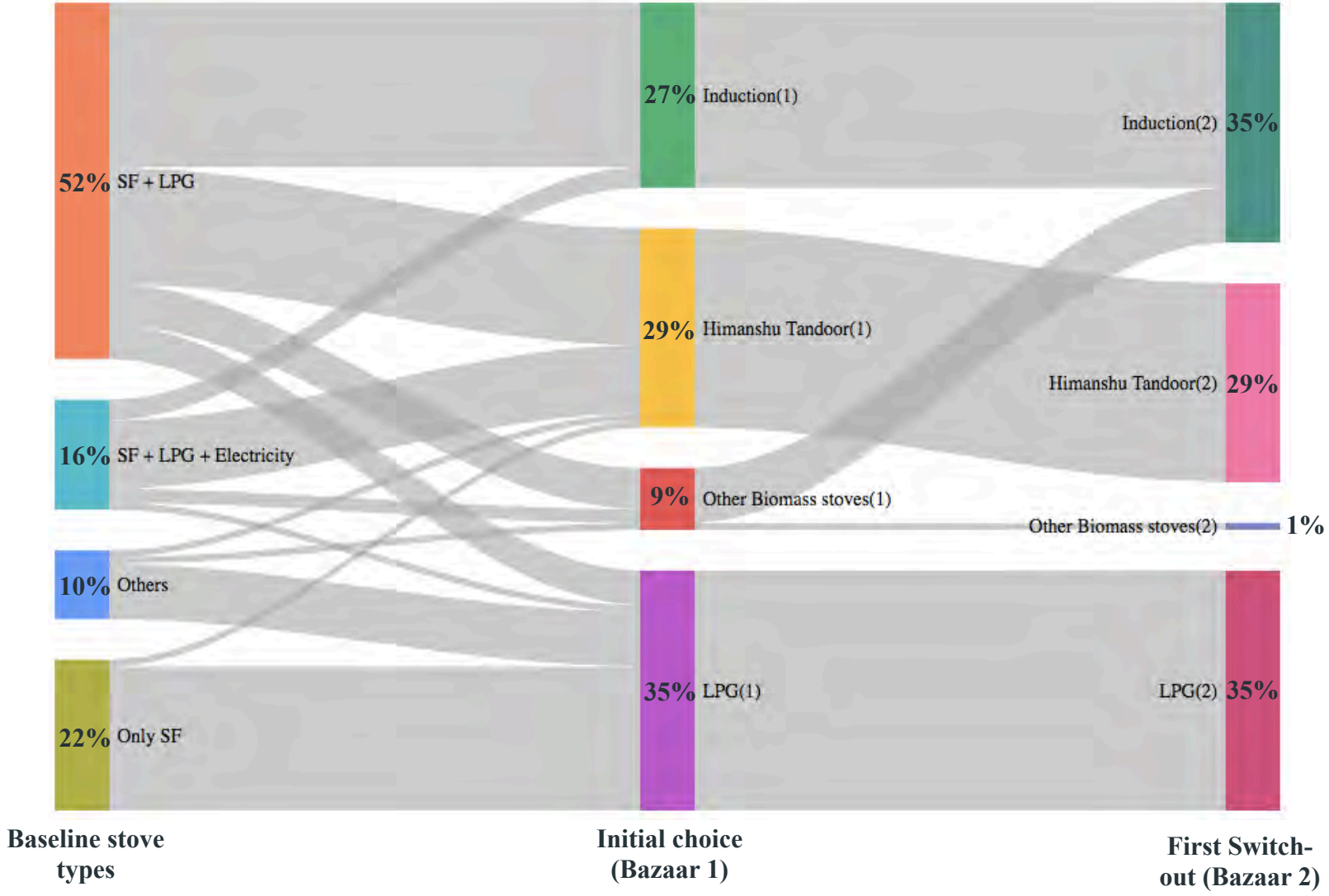

Survey Biases

- ***Social desirability bias:***
  - Tendency to give socially desirable responses in order to be viewed favourably by others
  - *Respondents best guess on what will make him/ her look good in front of (outsider) surveyor & (community) bystanders*

Ref: https://twitter.com/BPCUran/status/985089582629728256/photo/2

Survey Biases

- ***Demand Charecteristics:***
  - Tendency of Survey participants to become *"good subjects"*
  - *Respondents best guess on what researcher/ surveyors would be happy to hear*

Ref: https://twitter.com/BPCUran/status/985089582629728256/photo/2

mint

LPG connections have increased, but Pradhan Mantri Ujjwala Yojna (PMUY) beneficiaries do not seem to be using their LPG cylinders. Photo: Mint

India's poor are not using LPG cylinders they got under Ujjwala scheme

2 min read . Updated: 28 Jun 2017, 03:34 AM IST

Policy interest

- To what extent is Ujjwala consumption pattern different from other consumers in rural areas?