Plan for Session #15: Developing and testing the Primary Air Care (PAC) package in low and middle-income countries

<table>
<thead>
<tr>
<th>Title</th>
<th>Primary Air Care: Setting the agenda</th>
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<tbody>
<tr>
<td>Sub-Title</td>
<td>Global action to build sustainable energy systems and reduce emissions of greenhouse gases and hazardous air pollutants</td>
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<tr>
<td>Date</td>
<td>Friday, April 19, 2019</td>
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<tr>
<td>Venue</td>
<td>305 Olin Hall, 3300 San Martin Drive, Homewood campus of Johns Hopkins University</td>
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Introduction to this document

We have as a goal to come out of this one-day symposium with a vision or roadmap for future JHU engagement in research and practice to reduce emissions in low and middle-income countries. This document will serve as the basis for discussions in breakout groups from 2:30 to 4:00 pm during the symposium. Annex 1 explains what we mean when we say “intervention.” Most of the evidence from our on-going review of air pollution interventions, and a second review on heat interventions, has been generated in high-income countries. Annex 2 is an overview of the evidence base for different categories of interventions to reduce emissions.

We will discuss and debate how JHU can most productively engage in identifying and testing ways to establish governance and exercise stewardship over our shared atmosphere, reduce emissions, and reduce impacts on vulnerable groups, through small group discussions of the four options for JHU engagement outlined below.

Options for JHU engagement in research and practice

1. **Energy transitions for household air pollution (HAP)**

   **Background:** Household air pollution is estimated to cause 3-4 million deaths per year. Current thinking is that there is no design for a biomass-burning cookstove that lowers fine particulate matter (PM$_{2.5}$) low enough to substantially reduce the relative risk for adverse health outcomes, given the shape of the dose-response curve. JHU, through the Global Center for Non-Communicable Disease Research and Training, is involved in two major randomized trials comparing liquefied petroleum gas (LPG) versus conventional biomass-burning cookstoves: CHAP (1) and HAPIN (2). If these trials show a significant impact on the health outcomes of interest, there will be increased demand for evidence on how to best promote transition from biomass-burning cookstoves to clean fuel technologies, including LPG stoves (which still produce small quantities of greenhouse gases) or zero emissions options such as electric coil or induction cooktops powered by renewable solar or wind energy sources that contribute to meeting the Sustainable Development Goals (3). Quinn et al. recently published an analysis with case studies of current efforts to promote transition to different types of clean cookstoves (4). The analysis includes a logic model for clean cookstove scale up including enabling environment, industry structure and services, energy pricing and costing, consumer demand, and user and community needs and perceptions (4). Stove stacking (the concurrent use of both biomass and clean fuels) will continue to be a major barrier for achieving improvements in health outcomes as these programs are scaled up. The Initiative for Sustainable Energy Policy, at the School of Advanced International Studies has worked on LPG adoption and use in rural India (5, 6), reaching the following tentative conclusions: 1) use of both LPG and traditional biomass, or "fuel stacking", is increasingly the norm in rural India; 2) LPG is a popular and desired fuel in India, but lack of affordability impedes a complete transition away from traditional biomass.
Options for JHU engagement:

- Development and testing of new zero-emission cooking technologies, in order to characterize their cost, acceptance, emissions, and market potential.
- Socio-economic analysis of different options for HAP energy transitions, including acceptance, marketing, and supply chain analysis.
- Policy analysis and dialogue with national and global stakeholders on options for HAP energy transitions.
- Design and evaluation of large-scale programs to promote HAP energy transitions. Measures to address stove stacking and effective monitoring and evaluation systems should be included in the design of these programs.

2. Comprehensive package of interventions to reduce emissions in LMIC cities

**Background:** The world’s highest levels of air pollution are found in large LMIC cities. While the situation in cities in India, China and other Asian countries has been the subject of much recent coverage in the news media, levels of emissions in African cities are rapidly catching up (7). Cities offer the opportunity to develop and implement the entire package of Primary Air Care (PAC) consisting of governance of air quality, reduction in sources of outdoor and indoor emissions, and preparedness and response for poor air quality and extreme temperature events. Engagement with larger geographic scales is likely to be necessary, given, for example, the importance of agricultural and biomass burning and interregional pollutant transport, and controversy over the relative contribution of urban (local) industry, transport and residential versus rural (regional) biomass sources. Nevertheless, most current efforts to control sources or respond to air quality events focus on one source of pollution at a time, are episodic, and are not well evaluated.

Options for JHU engagement:

- Establish partnerships in selected LMIC cities to develop, implement and evaluate components of the PAC package, or the entire PAC package.
- Exchange of experiences and lessons learned between US and LMIC cities.
- Development, testing and introduction of new technologies to reduce important sources of emissions.
- Build a global network of cities working on reduction of emissions.

3. Community mobilization / participation to address local sources of emissions

**Background:** Community mobilization / participation is a necessary complement to other interventions implemented at regional or national levels related to policies, regulations and pricing. It can involve engaging with local residents to measure fine particulate matter (PM2.5) and other pollutants and interpret the results, take action against sources of emissions within the community (household and community trash burning, informal/ unregulated lead acid battery recycling, cottage industries, burning of crop stubble after the harvest), and pressure local and national governments to regulate larger sources of emissions that affect air quality in cities (incinerators, brick kilns, cement factories, transport terminals, ports, land clearing, etc.) . Barriers include perceptions of air pollution as necessarily being visible and having a bad odor, and lack of appreciation of the broad range of health effects of air pollution . This work is highly relevant in Baltimore, with on-going work in Curtis Bay, and urban and rural areas of low and middle-income countries. Nevertheless, the evidence base for how to best engage communities, and the effectiveness of community interventions, is extremely limited.
**Options for JHU engagement:**

- Development and evaluation of community-level interventions, through a community-based participatory research model (8)
- Build a global network on community-level interventions to share lessons learned and build evidence for effective intervention models

**4. Emissions from production, refining and distribution of fossil fuels**

As economies develop, and efforts to control indoor and local air pollution emphasize switching from combustion at the end use (e.g., biomass-fueled stoves and gasoline-based transport) to electric appliances and vehicles, attention will need to be paid to emissions from power generation facilities upstream. Natural gas and especially coal combustion in generation are important sources of regional NOx and (in the case of coal) PM and SOx emissions, and these emissions contribute to high background ambient concentrations that are an important contributor local air quality risk. Thus, development of electricity-based substitutes for end use combustion must recognize the potential for exacerbating problems from upstream sources.

The full effects of energy decisions include the fuel supply chain. Life Cycle Assessment (LCA) is a cradle-to-grave (or even cradle-to-cradle) approach to quantifying environmental burdens of products and processes from materials extraction to waste disposal. For the energy sector, LCA maps environmental impacts from energy extraction (e.g. mining and well production), through midstream infrastructure that includes transportation (e.g. via pipeline, tanker, or truck) and processing (e.g. natural gas processing, petroleum refining) through distribution to end use (e.g. use in a car or via power lines for electricity in a home). While LCA is a well-established, internationally-standardized tool, robust global datasets have yet to be developed that comprehensively track energy production, trade, and use across the world (9, 10). Further, air pollution and greenhouse gas emissions from energy and other related anthropogenic activities are poorly known, particularly across the developing world. In addition, globally aggregated and standardized life cycle impact characterization methods are limited in capturing many of the subtle but important differences in end use (11) (e.g. capturing the spatially-differentiated health effects of PM$_{2.5}$ emissions, such inside a home compared to release at a power plant stack and including existing concentrations) (12). As a result, many impact categories should be further improved to better capture the health and environmental outcomes of energy decisions.

A comprehensive PAC approach must account for all sources of air quality risks, and options throughout the electricity supply chain to limit the amount and impacts of fossil fuel consumption. The proposed research stemming from this theme would involve interdisciplinary scholars collaborating on improving the characterization of environmental and health impacts across the life cycle stages of selected energy technologies. Research projects could be focused on specific regions, countries, or macro-scale global assessments.

Critical to facilitating the use of renewable sources is the development of technologies to manage renewable variability, including grid controls, responsive demand, and storage. Analyses of alternative systems to supply new electric end uses should consider the potential roles, economics, and effectiveness of emerging technologies throughout the electric supply chain.
**Options for JHU engagement:**

- Systems analyses of the efficiencies and life cycle effects of power production including fuel production, transport, combustion, electricity transmission, and local distribution, accounting for locations and timing of emissions relative to vulnerable populations. These could then compare the effects of policies aimed at end uses as well as further up the supply chain.

- Source-attribution studies using widespread deployment of stationary and personal monitors together with emissions inventories in order to identify sources of air quality risks to health and their spatial and temporal variations.

**Sources cited**

Annexes: Evidence for interventions to reduce emissions

Annex 1: The scope of “interventions”

In this document, “intervention” is a broad category, including ALL the following:

- National policies, guidelines, regulations and laws concerning greenhouse gas emissions, criteria air pollutants and other hazardous emissions;
- Taxes levied on the carbon content of fuels, other incentives to reduce consumption or reduce emissions, and other interventions to influence choices;
- Creation or improvement of governance structures similar to California’s Air Quality Management Districts to monitor air quality in an airshed, and take action to reduce local sources of emissions;
- Development and introduction / promotion of technologies to reduce or eliminate outdoor / ambient and indoor / household emissions, including alternatives to fossil fuels, clean cookstoves;
- Work with community groups, especially racial and ethnic minorities and other vulnerable groups, to analyze local sources of emissions in their communities, and take action either locally (reducing burning of trash, reducing burning of crop stubble) or with local, state and national governments (mobilizing against location of polluting industries and incinerators in low-income neighborhoods, alternatives to incineration, reduction of emissions from idling trucks and ports);
- Warning systems for major “air pollution events” and other days when Air Quality Index anticipated to be elevated, and extreme heat events, with accompanying actions such as 1) advice to vulnerable groups to limit outside activity, 2) voluntary actions to reduce emissions, 3) wearing masks, 4) reducing heat / limiting emissions inside homes, 5) seeking care in case of illness related to air quality or heat.
**Annex 2: Overview of evidence for interventions**

We currently have underway two large scoping reviews. The first is a search for outdoor air pollution interventions that started with 21,000+ articles that have been screened and brought down to roughly 3,900 articles, which have been sorted into categories based on pollution source and intervention type. Further analysis of some of these groups are underway by students. The second search is for heat wave/extreme heat interventions that started with almost 8,200 articles and has been screened and brought down to roughly 1,300 articles, which have been sorted into response, preparedness and greening interventions and are being further analyzed as MPH capstone projects.

The following table summarizes the amount of evidence currently existing in the peer-review literature for a few selected categories of interventions to reduce emissions and associated health impacts:

<table>
<thead>
<tr>
<th>Category</th>
<th>Level of evidence for high-income countries (HICs)</th>
<th>Level of evidence for low and middle-income countries (LMICs)</th>
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<tbody>
<tr>
<td>National policies, guidelines, regulations, laws: Power plants</td>
<td>Large evidence base, successful regulations widely implemented</td>
<td>Evidence can be extrapolated from HICs, growing evidence in China, particularly</td>
</tr>
<tr>
<td>National policies, guidelines, regulations, laws: Vehicles</td>
<td>Large evidence base</td>
<td>Evidence can be extrapolated from HICs; car free Sundays popular in some LMICs</td>
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<tr>
<td>National policies, guidelines, regulations, laws: Industries</td>
<td>Large evidence base</td>
<td>Evidence can be extrapolated from HICs, not well implemented in LMICs</td>
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<tr>
<td>Carbon taxes, other incentives to reduce emissions or consumption</td>
<td>Large evidence base for carbon and emissions taxes; less on other incentives</td>
<td>Less evidence for LMICs though some articles are about global programs</td>
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<tr>
<td>Clean cookstoves, alternatives to burning of biomass</td>
<td>Not applicable, very little burning of biomass for cooking</td>
<td>Several large-scale trials underway globally (ex: CHAP &amp; HAPIN)</td>
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<tr>
<td>Reduction of trash burning, alternative trash management</td>
<td>Little burning of trash, limited evidence base for landfill/incinerator controls</td>
<td>Work being done in this area but not being published (ex: Ghana with EPA)</td>
</tr>
<tr>
<td>Reduction of agricultural burning, reduction of agricultural emissions</td>
<td>Medium evidence base for various agricultural management interventions</td>
<td>Little evidence for agricultural burning or other ag. management interventions</td>
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<tr>
<td>Community mobilization to reduce local sources of emissions</td>
<td>Few publications, though much work is being done through small, local groups</td>
<td>Limited</td>
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<tr>
<td>Warning systems and preparedness for poor air quality</td>
<td>Successful systems in place in many HICs with good evidence</td>
<td>Some evidence for systems in countries such as China</td>
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<tr>
<td>Warning systems and preparedness for extreme temperatures</td>
<td>Many publications, stand-alone warning systems or part of larger program</td>
<td>Less evidence, good example in India</td>
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<tr>
<td>Care for people affected by poor air quality or extreme heat</td>
<td>Growing evidence base, particularly around emergency care</td>
<td>Less evidence</td>
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