Empowering Households for Cleaner Air: Integrating Technology Adoption and Information Access to Improve Health and Climate Outcomes

POLICY NOTE

Air pollution is one of the greatest health and climate challenges of our time, responsible for an estimated 7–9 million premature deaths annually (WHO, 2021). The burden is particularly severe in low- and middle-income countries, where household cooking practices and rapid urbanisation contribute to high levels of both indoor and outdoor pollution.

Cleaner air and healthier lives require an integrated strategy, combining affordable and accessible clean household energy transitions with widespread, reliable, and trusted air quality information systems

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Two new studies provide fresh insights into how households can be better supported in managing this dual challenge:

- In Kenya, evidence from a randomised controlled trial (Berkouwer & Dean, 2025) shows that improved cookstoves reduce fuel costs, lower pollution spikes during cooking, and reduce respiratory symptoms. However, ambient air pollution continues to limit overall health improvements.
- In Pakistan, evidence from another randomised trial (Imtiaz et al., 2023) shows that households place high value on receiving air quality forecasts and adjust behaviour in response. However, trust in data sources and the persistence of high background pollution limit the potential of information alone.

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Based on presentations by Susan Berkouwer and Shotaro at the IGC Climate Conference in Uganda

Introduction

Air pollution is a major public health concern in South Asia and sub-Saharan Africa, contributing to millions of deaths annually. In 2021, for example, South Asia and East, West and Southern Africa experienced household air pollution age-standardised death rates that were double the global average. South Asia is among the regions that bear the world's highest burden (85.1/100,000) of disease linked to ambient PM2.5 particulate matter, almost double the global average (HEI, 2024).

Millions of households in sub-Saharan Africa and South Asia continue to rely on charcoal, firewood and other solid fuels for cooking (HEI, 2024). These fuels generate high levels of indoor air pollution, exposing women and children in particular to harmful particulate matter.

In cities, household emissions add to already high levels of ambient air pollution from transport, industry and other urban activities. This implies that even when households adopt cleaner cooking technologies, they continue to be exposed to dangerously high ambient air pollution levels.

Morbidity and mortality related to air pollution result in significant economic losses, including lost productivity due to morbidity, and increased healthcare expenditure. The World Bank estimates that 1.2 billion working days are lost globally every year due to air pollution. Furthermore, the health damage caused by air pollution costs $6 trillion a year, approximately a 5% reduction in global GDP (Awe et al, 2023). Air pollution therefore results in a triple burden: on health, the economy and the environment.

Evidently, reducing air pollution and a population's exposure to it holds massive benefits. In this policy brief, informed by evidence from Kenya and Pakistan on clean cooking transition and access to air quality information, we discuss two such policy pathways aimed at reducing exposure to indoor pollution and ambient air pollution, evidence of the results of these pathways, and the resulting policy implications.

Clean cooking transition: evidence from Kenya

Berkouwer and Dean (2025) provide causal evidence from Kenya on the health impacts of repeated spikes in air pollution. They offered 1,000 charcoal cookstove users in Nairobi, who on average spend two hours a day cooking, randomised subsidies and access to credit for an improved cookstove, the Jikokoa, that uses 39% less charcoal. Each respondent was randomly assigned a subsidy between $10-39, stratified on baseline charcoal usage. The subsidy

treatment was cross-randomised with random credit treatment, allowing recipients to pay for the stove in instalments over a three-month period, as well as an attention treatment. Respondents carried a backpack containing high-frequency pollution monitoring devices for 48 hours, allowing for measurement of pollution levels. The random assignment of the stove price and credit treatment status, which are used as proxies for stove adoption, enabled the researchers to identify the casual effect of stove adoption on the outcomes of interest.

The researchers found that, three-and-a-half years after subsidies were offered, 83% of respondents who adopted an improved stove at baseline still owned one at endline, and 90% of those who did not adopt one still did not own one. On outcomes of the use of the cookstoves, the study found that:

1. Improved cookstoves reduced peak PM2.5 concentrations during cooking hours by 41%.
2. Improved cookstove adoption caused a statistically significant reduction in self-reported respiratory symptoms. However, there was no measurable improvement in clinical health outcomes, such as oxygen saturation or blood pressure
3. Households that adopted the improved stoves spent 39% less on charcoal. The reduced charcoal consumption translates into lower carbon emissions. The authors estimate this to be about 1.81 tCO_2e/year per stove; cost ≈ $8 per tCO_2e.

These results show that reducing liquidity and credit constraints for households can facilitate their uptake of cleaner cooking technologies. However, even though improved cookstoves help reduce household-level emissions and cooking costs, because urban households continue to be exposed to high background pollution from ambient pollution, health improvements are limited.

Evidence from air quality interventions in Pakistan

One solution to reducing the effects of ambient air pollution is through reduced exposure to polluted air. Provision of information to citizens can influence and improve their forecasting abilities and avoidance behaviour (Ahmad et al, 2022). However, capacity and resource constraints mean that governments in developing countries often struggle to provide consistent and reliable air quality readings. Non-governmental air quality information services can help fill this gap and improve citizen's access to air quality information. However, the effectiveness of these sources depends on citizens' preference for, and beliefs about, the accuracy of the information source and their willingness to pay for

the information, taking into account different attributed sources of the information.

Imtiaz et al (2023) studied how information sources shape demand for air quality information in a working-class neighbourhood in Lahore, Pakistan, where there is severe air pollution. They implemented a randomised controlled trial in which they provided identical air pollution forecasts for the day ahead via SMS. They randomly varied the attributed source of the information between the government and a private alternative. This design allowed them to measure whether and how citizens value air quality information and how they value and trust the sources from which the information comes. In particular, the researchers wanted to know:

- whether consumers were willing to pay for air quality information, regardless of its attributed source, and
- whether consumers have differential demand for air quality information by the source, even when service quality is the same across sources.

The researchers looked at what mechanisms drive the differential willingness to pay – that is, how information affects relative preferences for sources and underlying beliefs about service quality.

Imtiaz et al (2023) found that:

- There is high demand for air quality information among residents of the working-class neighbourhoods in Lahore. However, this demand is not differentiated by source.
- Even though there is willingness to pay for two additional months of service after experiencing the free service, there are no significant differences in the respondents' willingness to pay for the two information sources, or their forecast ability between them, suggesting that the recipients are satisfied with the services they received, regardless of the information source.
- The study does, however, find that the recipients' preferences between sources, on an individual basis, shift significantly positively as a result of exposure to the randomly assigned source.
- Respondents in the government arm expect a 12% higher error in the SMS forecast than those in the private arm. This indicates that those who received information from the government source believe the information to be less accurate than those in the private arm, even though they are equally willing to pay for the information service.

Taken together, these results show that expanding access to air quality information can improve social welfare. In addition, the results have implications for how access to air quality information can be expanded. Firstly, the high willingness to pay shows that scaling the service could lead to large public

benefits. Secondly, the high average willingness to pay for SMS-based forecasts, regardless of source, highlights that service quality, rather than information source, might be the dominant factor. However, the finding that the information sources do not lead to differential changes in beliefs about the air quality levels show that individual consumers develop differential preferences for, and beliefs about, the quality of sources as they gain continued exposure through the SMS. This suggests that respondents favourably adjust their beliefs about the service quality of the information source to which they are exposed. This point shows that people's preferences can change easily in a market where information is constantly shifting and hard to access.

Conclusions and implications

The two studies show that closing gaps in air pollution requires a combination of technology, finance, and information interventions. Berkouwer & Dean (2025) show that credit and liquidity constraints limit the adoption of cleaner cooking technologies. Therefore, lifting these constraints can facilitate adoption. Credit and payment plans, such as ‘pay-as-you’ schemes, can overcome liquidity constraints at the household level. Furthermore, public finance subsidies linked to measurable carbon outcomes for firms can serve the dual purpose of increasing affordability for households while mitigating the environmental impacts of cooking technologies. In all cases, targeting is key, especially of poor urban communities where charcoal reliance and exposure are the greatest.

Given the positive impact on avoidance behaviour from air quality information provision and the results demonstrated by Imtiaz et al (2023), investing in low-cost sensor networks can expand monitoring and data collection. The negligible difference in willingness to pay across information sources indicates a negligible difference in the returns on investment between more expensive, high-quality infrastructure, such as monitors, and low-cost alternatives. This also entails consumers trusting information from non-government actors and therefore a reliable supplier, with quality assurance backed by regulation, makes sense.

Taken separately, each of the interventions has limitations. To begin with, household technology adoption alone cannot address city-wide pollution. Similarly, information services cannot substitute for clean technology. Taken together, these approaches can reinforce each other – for example, public subsidies for cleaner cooking could be paired with nationwide air quality campaigns. Similarly, governments can simultaneously promote adoption of household-level technology and invest in trusted real-time monitoring networks. The two studies illustrate the need for a complementary integrated approach. While clean energy transitions address emissions at the source, reducing peak exposures within households, air quality information enables households to

adapt to ambient risks by making more informed behavioural choices. This calls for a multifaceted approach in dealing with air pollution.

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