



# CLEAN COOKING

## AN “EMERGENCY BRAKE” CLIMATE SOLUTION WITH UNPARALLELED CO-BENEFITS

By Donee Alexander, Jillene Connors Belopolsky, Daniel Jasper, Yusuf Jameel, Christopher O. Olopade, and Shonali Pachauri

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## RECOMMENDED ACTIONS

At COP27, the United Nations (UN) Climate Change High-Level Champions and the Clean Cooking Alliance (CCA) identified clean cooking<sup>i</sup> – cooking methods that reduce the use of polluting fuels – as a critical “breakthrough” to halve emissions by 2030. To date, progress on clean cooking has been unacceptably slow. While the global population lacking access to clean cooking fell from 2.9 billion in 2010 to 2.3 billion in 2021, the UN Sustainable Development Goal of universal access by 2030 remains elusive. If current trends continue, some 1.9 billion people could still be without access to clean cooking by the end of this decade.<sup>1</sup> Without dramatically

i The WHO defines “clean” fuels and technologies as those that attain the fine particulate matter (PM<sub>2.5</sub>) and carbon monoxide (CO) levels recommended in the [WHO global air quality guidelines \(2021\)](#). The WHO Guidelines for indoor air quality: household fuel combustion (2014) provide PM<sub>2.5</sub> and CO emission rate targets for devices, which are linked to the levels from the Air Quality Guidelines. Fuels and technologies known to be clean for health at point of use and are categorized as clean for PM and CO household emissions include: solar, electric, biogas, natural gas, liquefied petroleum gas (LPG), and alcohol fuels including ethanol.

### CLEAN COOKING ALLIANCE

Donee Alexander  
Jillene Connors Belopolsky

### PROJECT DRAWDOWN

Daniel Jasper  
Yusuf Jameel

### UNIVERSITY OF CHICAGO

Christopher O. Olopade

### INTERNATIONAL INSTITUTE FOR APPLIED SYSTEMS ANALYSIS

Shonali Pachauri

PROJECT  
DRAWDOWN.


 CLEAN  
COOKING  
ALLIANCE

scaling efforts today, polluting cooking stoves and fuels will continue to claim millions of lives each year while perpetuating gender inequity, forest degradation, and exacerbating climate damage. Therefore, we urge policymakers, donors, and investors to:

- **Pull the “emergency brake” by rapidly scaling up investments in clean cooking solutions to US\$10 billion a year.** This will reduce global cumulative emissions by 10% by 2040 and abate one gigaton of carbon dioxide equivalent (CO<sub>2</sub>-eq) each year.<sup>2,3</sup> Funding projects on a case-by-case basis may be slowing progress in this sector. Innovative funding mechanisms like the [Spark+ Africa investment fund](#) and the [Nordic Green Bank’s Modern Cooking Facility for Africa](#) offer viable pathways for multilateral development banks, bilateral development agencies, and foundations to deliver on capital requirements.

- **Reinforce gains in clean cooking access for 100 million people on the brink of losing access due to recent global shocks.** One hundred million people face higher energy prices due to the Russia-Ukraine conflict and several hundred million are at risk of energy poverty due to the fallout of the COVID-19 pandemic<sup>4,5</sup> Policymakers and funders must quickly deploy financing to fortify access to clean cooking in communities on the verge of returning to polluting fuels such as wood, charcoal, and kerosene. Funding mechanisms could include [leveraging carbon markets](#) and other outcome-based financing as well as those mentioned above.
- **Prioritize clean cooking at the national level and integrate planning and programs across ministries, agencies, and sectors.** Policymakers have a variety of instruments to help increase distribution and uptake including [targeted subsidies](#), [fuel price caps](#), and the [removal of taxes and levies](#) on certain types of fuel and cooking appliances. Dedicated teams or “[Delivery Units](#)” can accelerate progress and deliver national priorities.



Photo by Romana Manpreet / Clean Cooking Alliance

Despite marginal progress over the past decade, the world is woefully off track to achieve the United Nations Sustainable Development Goal of reaching universal access to clean cooking by 2030. Today, 2.3 billion people are still cooking with polluting fuels such as wood, charcoal, animal dung, crop residues, and coal, which harm human health, contribute to climate change, and compromise sustainable development. Efforts to accelerate access to clean cooking by the end of this decade are urgently needed to avoid destructive feedback loops between deteriorating public health, maladaptive development trends, and climate disaster. A wide range of clean cooking technologies exist today, each offering its own set of benefits and drawbacks. While using renewable energy to heat stoves has no direct emissions, it requires considerable equipment and infrastructure which is often lacking in these contexts.

Advanced stoves that burn processed biomass, pellets, or briquette fuels can reduce emissions but can be more expensive than traditional alternatives. Liquefied petroleum gas (LPG) has far lower emissions than traditional fuels, however, it is still a fossil fuel, requires an extensive supply chain, and increases global dependence on oil.

In practice, identifying and deploying the appropriate technology requires a coordinated effort in each community between stakeholders such as users, funders, businesses, and relevant government agencies. Given that cooking from renewable energy offers the most promising benefits, clean cooking can also be seen as another impetus to scale up funding for renewable electricity production projects in Africa and South Asia, the two areas most reliant on polluting cooking fuels. Africa, for example, is home to 20% of the world's population and one billion Africans rely on polluting fuels for cooking, yet the continent receives just 2% of global investments in renewable energy.<sup>6,7</sup>

Prioritizing clean cooking has a multifaceted impact on the climate and environment. For example, replacing polluting fuels and technologies with clean cooking methods has the potential to reduce cumulative greenhouse gas (GHG) emissions by 10–14% by 2040,<sup>8</sup> slow forest degradation and deforestation, and abate short-lived climate pollutants – powerful climate forcers that stay in the atmosphere for relatively short periods – such as black carbon, more commonly known as “soot”. Achieving universal access to clean cooking would save as many as 3.2 million lives and nearly US\$2.4 trillion every year in health-related costs and lost productivity.<sup>9,10</sup> Achieving these outcomes is possible

with an estimated US\$10 billion annual investment in the clean cooking sector, representing less than half of one percent of the annual costs associated with inaction.<sup>11</sup> Clean cooking, then, must become a priority for policymakers, investors, and donors as it is a critical climate and development solution that saves both lives and money.

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In March 2023, the Intergovernmental Panel on Climate Change (IPCC) released its AR6 synthesis report, distilling over a decade of climate science. The report makes clear that current national implementation strategies do not align with global targets and, if left unchanged, would *likely* result in global average temperature rise breaching 1.5°C. Confronted with these realities, countries must rapidly scale up climate actions, starting with “emergency brake” solutions that instantly reduce emissions and are near the point of exponential adoption such as clean cooking.

The UN Climate Change High-Level Champions and the Clean Cooking Alliance (CCA) identified that with the necessary capital, clean cooking could reach the

point of widespread adoption. To galvanize support and increase knowledge, the groups worked with government, donor, and private sector stakeholders to recognize clean cooking as a “2030 Breakthrough” at COP27. The “breakthrough” designation sets a shared objective to rapidly scale up investments to the US\$10 billion benchmark for annual innovative financing and serves as an impetus for policymakers to prioritize financial support for these breakthrough solutions.

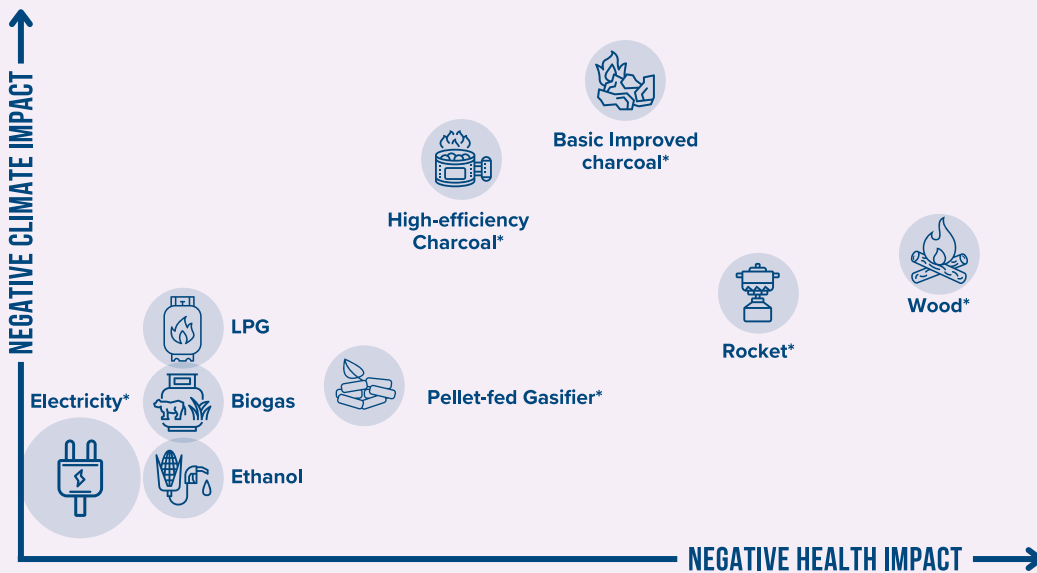
## Clean cooking is a climate “emergency brake”

Changing how families cook their food each day is a critical lever to slow climate change. Every day, over a quarter of the world’s population relies on polluting fuel sources such as wood and coal to cook in traditional stoves or open fires.<sup>12</sup> Reliance on these polluting fuels can have devastating impacts both locally and globally.

For example, deforestation is responsible for 11% of global greenhouse gas emissions.<sup>13</sup> Local stressors, such as woodfuel harvesting for cooking, can then have ramifications not just for local ecosystems but for the world’s climate. Approximately 30% of global GHG emissions related to forest degradation are derived from woodfuel harvesting.<sup>14</sup> In total, emissions from nonrenewable woodfuels for cooking amount to one gigaton of CO<sub>2</sub> equivalent (CO<sub>2</sub>-eq) per year – about 2% of global emissions – on par with emissions from the aviation industry.<sup>15</sup> These include both carbon dioxide (CO<sub>2</sub>) and short-lived climate pollutants (SLCPs) like black carbon, which has a warming impact up to 1,500 times stronger (on a unit basis) than CO<sub>2</sub>.<sup>16</sup> The incomplete combustion of solid fuels for household cooking and heating is responsible for more than half of all human-induced black carbon emissions from low- and middle-income countries.<sup>17</sup>

### WHAT IS CLEAN COOKING?

“Clean cooking solutions” refers to a suite of fuel-stove combinations with emissions performance that meets the World Health Organization’s guidelines for indoor air quality. This category includes high-efficiency charcoal and biomass pellet stoves, liquefied petroleum gas (LPG), biogas, ethanol, and electric stoves and pressure cookers. Solutions are context-specific and must meet consumer needs and willingness to pay.



\* Climate impact depends on many factors including level of displacement and renewability of fuel

Globally, up to 34% of woodfuel is harvested unsustainably with some 275 million people living in hotspots where that number climbs to more than 50 percent.<sup>18,19</sup> The share of GHG emissions from woodfuel for many of the countries with these hotspots can be sizable; in some cases, it is even the largest single source of emissions. In 12 nations – Belize, Burundi, Eritrea, Ethiopia, Guinea-Bissau, Haiti, Kenya, Lesotho, Liberia, Nepal, Rwanda, and Uganda – the burning of woodfuels is estimated to account for more than 50% of the country's total emissions.<sup>20</sup>

Further, burning solid fuels such as wood, charcoal, and coal releases black carbon into the atmosphere, allowing it to travel around the world. In addition to their immediate warming effect in the atmosphere, these particulates are then deposited in the Arctic where they absorb sunlight and increase the pace of melting. Moreover, the particulates cover the reflective surface of the ice which normally helps cool global temperatures by reflecting sunlight back into space, a phenomenon known as the albedo effect. Similarly, black carbon can also be deposited on glaciers, like those in the Himalayas, which increases the pace of melting causing dangerous flash floods and threatening water security.<sup>21</sup>

Clean cooking is an indispensable solution in the world's climate action toolbox. Today's highly efficient stoves can reduce fuel use by 30–60%, and the use of cleaner fuels, such as electricity, biogas, ethanol, and liquefied petroleum gas (LPG), results in fewer GHG and black carbon emissions. Transitioning to renewable electricity is the best long-term solution; however, we acknowledge that some low- and middle-income countries may have limited options and will utilize LPG in order to reduce emissions and exposure to household air pollution while renewable electricity access for all is developed. Countries must be supported to accelerate inclusive clean cooking transition pathways that best suit the needs of their citizens.

Given that there is currently a constant stream of greenhouse gases and black carbon being emitted into the atmosphere, the impact of this solution deployed at scale would be immediately noticeable in improved air quality.<sup>22</sup> Furthermore, a universal transition to cleaner cooking fuels – such as LPG, if necessary, in the short-to medium-term and electricity from renewable sources in the long-term – would result in a net cooling effect on the planet.<sup>23</sup>

## The unparalleled co-benefits of clean cooking

Expanding access to clean cooking is one of the most immediate and cost-effective tools available to achieve international climate and development goals, reducing emissions while simultaneously providing significant benefits to health, nature, biodiversity, food security, gender equality, and local economies. Any one of these benefits alone is justification for intervention, but when the benefits are taken together, clean cooking takes on a level of importance that is not yet reflected in current policy and financing frameworks.

### Improved health outcomes

Decades of research from countries around the world have shown that air pollution impacts birth outcomes and diseases of the heart, lungs, and brain. Each year, up to 3.2 million people die prematurely from illnesses attributable to household air pollution (HAP) exposure from the incomplete combustion of solid fuels and kerosene used for cooking.<sup>24,25</sup> Over 60% of these deaths occur among women and children.<sup>26</sup> In addition, lack of access to clean cooking is a major driver of outdoor pollution as residential burning of polluting fuels contributes over 16% of global ambient air pollution (measured as PM<sub>2.5</sub>).<sup>27</sup>

With a successful transition from open fires and inefficient stoves to clean cookstoves and fuels, randomized control trials have shown reductions in severe pneumonia in young children, reduced duration of respiratory infections in children, lower blood pressure in pregnant women, increased birth weights, and increased gestational age at delivery.<sup>28, 29, 30, 31, 32</sup> Expanding these positive health outcomes into policy and practice, however, requires reliable and sustained access to high-quality stoves and fuels.

### Protecting nature and biodiversity

Solid fuel use also negatively affects ecosystems and biodiversity, particularly through deforestation and the removal of organic matter (e.g. dead branches and sticks). As noted above, up to a third of global woodfuel harvesting is unsustainable. As these forests are degraded, species lose their natural habitats, disrupting entire ecosystems and increasing the vulnerability of the communities who depend on them.<sup>33</sup> Additionally, removing trees can exacerbate soil erosion, increase

water temperatures by up to 4°C, and lower oxygen levels in adjacent streams. This in turn depletes aquatic fauna, reduces water quality, increases sediment by up to 550 times, and enhances the risks of landslides and flooding.<sup>34</sup>

By switching to clean cooking stoves and fuels, communities can decrease deforestation which allows ecosystems to better recover from past forest degradation. This reduced pressure on local ecosystems also improves biodiversity. One study in Southern India, for example, found more diversity and abundance in sapling populations surrounding villages that used biogas compared to those that used traditional fuels.<sup>35</sup>

## Improving food security

As an integral part of the food system, cooking obviously plays a role in consumption and nutrition. But by contributing to climate change and air pollution, cooking with solid fuels and kerosene also impacts food production, negatively affecting agriculture, farm yields, food quality, and food security. As the current global food system is responsible for approximately one-third of anthropogenic greenhouse gas emissions, there is an increasing emphasis on cultivating a sustainable and ethical alternative that benefits both people and the planet – this new system must include clean cooking solutions.

By coating plants in particulate, black carbon inhibits photosynthesis and therefore limits the plant's ability to produce food. Furthermore, black carbon impacts temperature, precipitation, and radiation leading to a decrease in crop yields and agricultural productivity.<sup>36</sup> Research has shown that SLCPs directly reduce wheat and rice yields in India with roughly 90% of these losses attributable to the direct effects of black carbon and ozone.<sup>37</sup> Therefore, the adoption of clean cooking fuels to mitigate black carbon can help safeguard crop yields, which is crucial to ensuring food security.

Reliance on polluting fuels can also make families vulnerable to resource scarcity. Families may skip more meals and switch to foods with shorter cooking times that are less nutritious because they need more time to gather fuel and have less time to cook. Data from the UN Food and Agriculture Organization (FAO) collected across various counties in Kenya found that the frequency of meals prepared each day was reduced when people had to travel longer distances to gather

fuelwood.<sup>38</sup> In Marsabit, Kitui, and Meru counties, for instance, households reduced their cooking frequency from three meals per day to two.

Dietary habits and cooking patterns in low- and middle-income countries are also highly sensitive to energy and food price fluctuations. For example, due to higher food prices following the start of the Russian-Ukrainian war, half of households in an informal settlement in Nairobi, Kenya reported skipping more meals and 30% decreased their use of LPG.<sup>39</sup> As families were unable to maintain their rate of clean cooking fuel use – average pay-as-you-go LPG consumption decreased by two-thirds in 2022 – they consumed less diverse and nutritious meals with lower protein.

Clean cooking has further been shown to positively influence the diversity of food cooked by female heads of household. Women may be able to shift their diets to include more nutritious and/or diverse foods when switching from a polluting to a clean cooking fuel since it allows them more time to prepare multiple dishes and go grocery shopping.<sup>40</sup> Data collected from informal settlements in Nairobi demonstrated a 15% increase in dietary diversity and consumption of protein-rich foods (e.g. legumes, meat, and fish) among female household heads cooking with pay-as-you-go LPG.<sup>41</sup>

## Gender equality

Accelerating access to clean cooking is critical for advancing gender equality as the burden of cooking and collecting fuel most often falls on women and girls. The time women and girls must devote to cooking and gathering fuel can take away from educational and employment opportunities.<sup>42</sup> Rural households spend an average of approximately 1.3 hours per day (ranging from 30 minutes to 6 hours) collecting fuel, according to a World Bank study spanning more than 70 time-use surveys in various countries, at a cost of US\$800 billion per year in the form of lost productivity associated with time use.<sup>43, 44</sup>

Women's agency as household decision-makers and consumers can also increase the degree of benefits they achieve when transitioning to clean cooking fuels.<sup>45</sup> In informal settlements in Nairobi, Kenya, for example, the proportion of women in charge of household decisions who reported taking on new employment after adopting clean cooking fuels was 32% higher than that among women living in male-headed households.<sup>46</sup>

Access to clean cooking – along with access to energy and education – also enhances women’s ability to make reproductive choices. A recent analysis of Demographic Health Surveys from over fifty countries finds that access to electricity, education, and modern cooking fuels lowers birth rates after controlling for other determinants.<sup>47</sup>

Ultimately, women not only benefit from clean cooking but are also critical to its widespread adoption. Their roles as innovators, entrepreneurs, investors, and policymakers are essential to ensure the development and implementation of clean cooking solutions that women want, have access to, and can afford.

## Peace and security

Circumstances become more challenging and contentious when populations compete for fuel sources. As of 2023, there are an estimated 109 million people who have been displaced due to conflict, war, or disaster, 80% of which were forest-dependent for cooking, shelter, animal feed, nutrition, and sources of income, according to FAO.<sup>48</sup> In areas such as sub-Saharan Africa, where firewood is often the main source of fuel, competition for dwindling natural resources between displaced and local communities can contribute to social tensions.<sup>49</sup>

When collecting fuel, women and girls may face gender-based violence (GBV), which can be exacerbated as resources are depleted and they spend more time collecting fuel in increasingly remote locations. A study conducted by the UN High Commissioner for Refugees (UNHCR) in Chad found that 42% of households surveyed reported incidents of GBV during firewood collection over a six-month period.<sup>50</sup> Time saved from collecting fuel with clean cooking methods can then equate to less risk of GBV by precluding the need to gather biomass for household energy.<sup>51</sup> In humanitarian and conflict contexts, while water, food, and shelter are sometimes provided for displaced populations, access to firewood and energy resources is rarely or inadequately supplied. In many cases, women must travel outside of temporary shelters to collect firewood, exposing themselves to injury, rape, and assault.<sup>52</sup>

Many displaced people have also reported selling or exchanging a portion of their food rations to procure the firewood needed to cook their remaining food, which can have serious consequences including malnutrition.



Photo courtesy of Climate Impact Partners

Increasing the availability and affordability of clean cooking solutions can help alleviate the need for such trade-offs as well as the associated social tension over resources in some communities. In this regard, access to clean cooking is a crucial component to advancing peace and human security, particularly in settings of conflict and crisis.



Photo by Mauro Vombe / Clean Cooking Alliance



CASE STUDY

# CLEAN COOKING CO-BENEFITS FOR CLIMATE, HEALTH, & GENDER IN KENYA

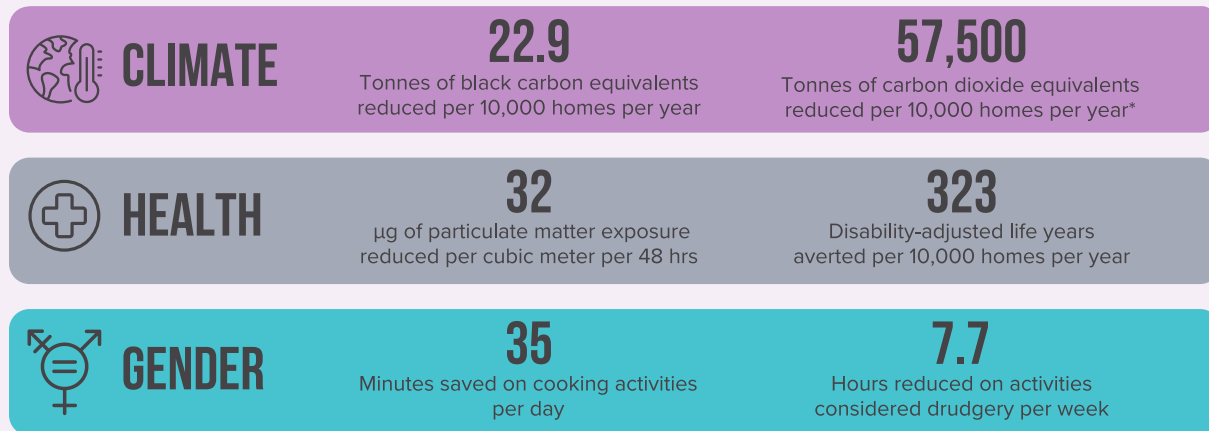
A recent field assessment in Kenya of clean cooking co-benefits found significant improvements in climate, health, and gender outcomes after household adoption of biodigester systems which utilize organic waste to produce biogas.<sup>53</sup> These benefits are in addition to the emission reductions, which have been demonstrated under the Gold Standard and Clean Development Mechanism (CDM) frameworks.

The use of Sistema.bio biodigester systems were found to emit considerably less black carbon compared to wood, resulting in substantial mitigation of short-lived climate pollutants (SLCPs). The study estimated a net reduction of approximately 963.4 metric tons in black carbon equivalents (BCe) across the five-year project for 84,000 biogas digesters.<sup>i,ii</sup> In addition, as measured by the Gold Standard certification framework, the project generates annual GHG emission reductions of 57,500 metric tons CO<sub>2</sub>-eq per 10,000 homes – the equivalent to 12,795 gasoline-powered passenger vehicles being driven for one year.<sup>54</sup>

In biogas-using households, personal exposure to dangerous particulates was reduced by approximately 32 micrograms per cubic meter of air. This decrease is associated with important health benefits for the population, equating to approximately 323 healthy life years each year for every 10,000 homes.<sup>iii</sup>

Biogas use was also associated with significant time savings and reductions in manual labor (or “drudgery”) for female primary cooks. Surveys indicated time savings of 35 minutes per day on cooking activities and a reduction of 7.7 hours per week on activities considered drudgery. Three-quarters of primary cooks – nearly all of them women – reported a substantial positive impact of biogas on their lives beyond health or climate benefits, suggesting there are empowerment pathways not captured by time use, such as improved agency, economic empowerment, and more. This study presents valuable evidence for the co-benefits that come from leveraging impact finance to accelerate clean cooking projects.

Figure 1 – The co-benefits of clean cooking solutions for climate, health, and gender.



Source: World Bank

\* Based on 2018-19 issuance of carbon credits to the developer

i One kilogram of BC is about 460 times more potent than an equivalent amount of CO<sub>2</sub> over a 100-year time horizon and 1,600 times more potent over a 20-year horizon based on unofficial estimates of the Intergovernmental Panel on Climate Change (IPCC). The IPCC estimates of global warming potential are conservative compared to others in the published literature.

ii BCe is analogous to CO<sub>2</sub>e, both of which normalize the warming impact of an emission species to the equivalent quantity of BC or CO<sub>2</sub>, respectively.

iii The number of healthy life years made possible by an intervention are measured in Averted Disability Adjusted Life Years (ADALYs) and are a commonly used metric for public health reporting.

## On the verge of a clean cooking tipping point

The cost of inaction on polluting stoves and fuel use is staggering for people, the planet, and the economy. The World Bank estimates that each year the adverse impacts from solid fuel use cost the world US\$1.4 trillion in health expenditures, US\$200 billion in climate-related expenses, and US\$800 billion from women's lost productivity. To achieve universal access to clean cooking and prevent these costs would require US\$10 billion per year – less than half a percent of what the world currently pays by sticking to the status quo. To put this into perspective, this is like a household losing US\$2,400 per year on a problem that could be fixed for an annual fee of US\$10.

Of the US\$10 billion per year required to achieve universal access, 60% is required from the public sector to fill the affordability gap; the remaining costs are borne by households.<sup>55</sup> Yet, clean cooking initiatives remain vastly underfunded, with current annual investments at around US\$200 million, far short of what is required for a full-scale transition.<sup>56</sup>

Counterproductively, funding from multilateral development banks and development finance institutions has decreased substantially, falling 84% from 2019 to 2020.<sup>57</sup> From 2014 to 2020, investments in clean cooking companies grew at a rate of 20% per year. At this pace, investments in clean cooking will reach just 1/10th of the required amount by 2036.<sup>58</sup>

In recent years, most investments in clean cooking companies have come from private capital, which in 2022 amounted to 88% of total investments.<sup>59</sup> However, in 2020, just seven companies raised over 90% of the total investments in clean cooking, down from 18 companies that received that same amount in 2014, demonstrating an increasing concentration of capital in a handful of companies.<sup>60</sup>

Despite these concerning investment trends, universal access to clean cooking remains within reach of public and private investors and donors. Innovative funding mechanisms like Spark+ Africa – supported by CCA – and the Nordic Green Bank's Modern Cooking Facility for Africa, as well as carbon markets and other forms of outcome-based financing, offer viable pathways for multilateral development banks, bilateral development agencies, and foundations to deliver on the urgently-needed financing.



Photo courtesy of Sistema.bio

In addition to traditional public and private finance, clean cooking initiatives have begun to attract capital from innovative finance sources such as carbon and results-based finance. The global carbon market, which places a monetary value on carbon emission offsets, is valued at US\$900 billion and has tremendous funding potential for initiatives with demonstrable environmental benefits.<sup>61</sup> Historically, carbon finance has contributed less than 10% of the overall funding for clean cooking projects. While this has grown rapidly in recent years, increasing 21-fold between 2017 and 2020, there is still considerable room for greater climate financing for clean cooking initiatives.<sup>62</sup>

Accessing significant and consistent streams of carbon finance is a great opportunity to bridge the private sector funding gap and catalyze a healthy, sustainable global market for clean cookstoves and fuels. The primary barriers to achieving funding targets include a lack of advocacy and awareness of clean cooking initiatives within the carbon market, as well as a deficit of cookstove-specific standards and methodologies to provide certainty and confidence to carbon investors and buyers.

Many of CCA's current programs, including the ambitious Responsible Carbon Finance for Clean Cooking Initiative, seek to overcome these funding barriers and create a sizeable and credible niche for clean cooking initiatives within the carbon market. By connecting multiple funding sources with clean cooking projects, CCA aims to strengthen the viability of clean cooking companies and drive down the consumer cost of cooking solutions, ultimately achieving universal access to clean cooking by 2030.

## CALL TO ACTION

Clean cooking is a scientifically proven, financially responsible, and eminently scalable climate and development solution that can improve numerous aspects of human and environmental well-being. Universal access is within reach, only if financial support is quickly and significantly increased from both the public and private sector. Public spending – particularly from multilateral development banks and development institutions – must immediately and drastically scale up clean cooking interventions to have any chance of meeting international climate and development goals.

The costs associated with inaction are too high to ignore. As many as 3.2 million lives and US\$2.4 trillion are lost every year due to solid fuel use, which also exacerbates climate change and biodiversity loss. Now is the time for a full-scale mobilization to achieve universal access.

Public spending must immediately and drastically scale up clean cooking interventions to have any chance of meeting international climate and development goals.

## REFERENCES

- 1 International Energy Association, International Renewable Energy Agency, United Nations Statistics Division, World Bank, World Health Organization. (2023). *Tracking SDG 7: The Energy Progress Report*.
- 2 Floess, Emily, Andrew Grieshop, Elisa Puzzolo, Dan Pope, Nicholas Leach, Christopher J Smith, Annelise Gill-Wiehl, Katherine Landesman, and Rob Bailis. (2023). *Scaling up Gas and Electric Cooking in Low- and Middle-Income Countries: Climate Threat or Mitigation Strategy with Co-Benefits? Environmental Research Letters* 18 (3): 034010. <https://doi.org/10.1088/1748-9326/acb501>.
- 3 Bailis, R., Drigo, R., Ghilardi, A. & Masera, O. (2015). *The Carbon Footprint of Traditional Woodfuels. Nature Climate Change* 5 (3). <https://doi.org/10.1038/nclimate2491>.
- 4 International Energy Association. (2022). *World Energy Outlook 2022*. [www.iea.org/reports/world-energy-outlook-2022](http://www.iea.org/reports/world-energy-outlook-2022).
- 5 Pachauri, S., Pobleto-Cazenave, M., Aktas, A. et al. Access to clean cooking services in energy and emission scenarios after COVID-19. *Nat Energy* 6, 1067–1076 (2021). <https://doi.org/10.1038/s41560-021-00911-9>.
- 6 International Energy Association. (2023). *A Vision for Clean Cooking Access for All*. <https://www.iea.org/reports/a-vision-for-clean-cooking-access-for-all/executive-summary>
- 7 International Energy Association. (2023). *Financing Clean Energy in Africa*. <https://www.iea.org/news/doubling-energy-investment-in-africa-requires-urgent-action-to-bring-down-financing-costs-and-boost-access-to-capital>
- 8 Floess, Emily, Andrew Grieshop, Elisa Puzzolo, Dan Pope, Nicholas Leach, Christopher J Smith, Annelise Gill-Wiehl, Katherine Landesman, and Rob Bailis. (2023). *Scaling up Gas and Electric Cooking in Low- and Middle-Income Countries: Climate Threat or Mitigation Strategy with Co-Benefits? Environmental Research Letters* 18 (3): 034010. <https://doi.org/10.1088/1748-9326/acb501>.
- 9 World Health Organization. (2022). *Household Air Pollution*. [www.who.int/news-room/fact-sheets/detail/household-air-pollution-and-health](http://www.who.int/news-room/fact-sheets/detail/household-air-pollution-and-health).
- 10 World Bank Group. (2020). *The State of Access to Modern Energy Cooking Services (English)*. <http://documents.worldbank.org/curated/en/937141600195758792/The-State-of-Access-to-Modern-Energy-Cooking-Services>
- 11 Ibid.
- 12 International Energy Association. (2023). *A Vision for Clean Cooking Access for All*. <https://www.iea.org/reports/a-vision-for-clean-cooking-access-for-all/executive-summary>
- 13 International Panel on Climate Change (2022). Summary for Policymakers In: *Climate Change 2022: Mitigation of Climate Change*. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK and New York, NY, USA. <https://doi.org/10.1017/9781009157926.001>.
- 14 Pearson, T.R.H., Brown, S., Murray, L. et al. (2017). *Greenhouse gas emissions from tropical forest degradation: an underestimated source. Carbon Balance Manage* 12, 3. <https://doi.org/10.1186/s13021-017-0072-2>
- 15 Bailis, R., Drigo, R., Ghilardi, A. & Masera, O. (2015). *The Carbon Footprint of Traditional Woodfuels. Nature Climate Change* 5 (3). <https://doi.org/10.1038/nclimate2491>.
- 16 Climate & Clean Air Coalition. *Black carbon – An air pollutant with damaging effects on human health, crops, ecosystems and climate*. <https://www.ccacoalition.org/en/slcp/bs/black-carbon>.
- 17 World Bank Group. (2020). *The State of Access to Modern Energy Cooking Services (English)*. <http://documents.worldbank.org/curated/en/937141600195758792/The-State-of-Access-to-Modern-Energy-Cooking-Services>.
- 18 Bailis, R., Drigo, R., Ghilardi, A. & Masera, O. (2015). *The Carbon Footprint of Traditional Woodfuels. Nature Climate Change* 5 (3). <https://doi.org/10.1038/nclimate2491>.
- 19 Pearson, T.R.H., Brown, S., Murray, L. et al. (2017). *Greenhouse gas emissions from tropical forest degradation: an underestimated source. Carbon Balance Manage* 12, 3. <https://doi.org/10.1186/s13021-017-0072-2>.
- 20 Bailis, R., Drigo, R., Ghilardi, A. & Masera, O. (2015). *The Carbon Footprint of Traditional Woodfuels. Nature Climate Change* 5 (3). <https://doi.org/10.1038/nclimate2491>.
- 21 World Bank Group. (2021). “To Slow Himalayan Glacier Melt, Curbing Air Pollution is Key.” World Bank press release. <https://www.worldbank.org/en/news/press-release/2021/06/01/to-slow-himalayan-glacier-melt-curbing-air-pollution-is-key>
- 22 Gupta, P., Jangid, A. & Kumar, R. (2023). *COVID-19-associated 2020 lockdown: a study on atmospheric black carbon fall impact on human health. Environ Geochem Health* 45, 3507–3520. <https://doi.org/10.1007/s10653-022-01430-6>.
- 23 Floess, Emily, Andrew Grieshop, Elisa Puzzolo, Dan Pope, Nicholas Leach, Christopher J Smith, Annelise Gill-Wiehl, Katherine Landesman, and Rob Bailis. (2023). *Scaling up Gas and Electric Cooking in Low- and Middle-Income Countries: Climate Threat or Mitigation Strategy with Co-Benefits? Environmental Research Letters* 18 (3): 034010. <https://doi.org/10.1088/1748-9326/acb501>.
- 24 World Health Organization (2022). *Household air pollution*. WHO Newsroom. <https://www.who.int/news-room/fact-sheets/detail/household-air-pollution-and-health>.
- 25 Souransu Chowdhury, Ajay Pillarisetti, Alicia Oberholzer, James Jetter, John Mitchell, Eva Cappuccilli, Borgar Aamaas, Kristin Aunan, Andrea Pozzer, Donee Alexander. (2023). *A Global Review of the State of the Evidence of Household Air Pollution’s Contribution to Ambient Fine Particulate Matter and Their Related Health Impacts. Environment International*, Volume 173, 107835, ISSN 0160-4120, <https://doi.org/10.1016/j.envint.2023.107835>.
- 26 The Institute for Health and Evaluation Metrics. (2019). *The Global Burden of Diseases, Injuries, and Risk Factors Study (GBD)*. <https://www.healthdata.org/research-analysis/gbd>. Data available at: <https://vizhub.healthdata.org/gbd-results>
- 27 McDuffie, E.E., Martin, R.V., Spadaro, J.V. et al. (2021). *Source sector and fuel contributions to ambient PM<sub>2.5</sub> and attributable mortality across multiple spatial scales. Nat Commun* 12, 3594. <https://doi.org/10.1038/s41467-021-23853-y>.

- 28 McCracken, J., Smith, K. R., Stone, P., Díaz, A., Arana, B., & Schwartz, J. (2011). *Intervention to lower household wood smoke exposure in Guatemala reduces ST-segment depression on electrocardiograms*. *Environmental Health Perspectives*, 119(11), 1562–1568. <https://doi.org/10.1289/ehp.1002834>.
- 29 Schraufnagel, D. E., Balmes, J. R., De Matteis, S., Hoffman, B., Kim, W. J., Perez-Padilla, R., Rice, M., Sood, A., Vanker, A., & Wuebbles, D. J. (2019). *Health benefits of air pollution reduction*. *Annals of the American Thoracic Society*, 16(12), 1478–1487. <https://doi.org/10.1513/AnnalsATS.201907-538CME>.
- 30 Thakur, M., Nuyts, P. A. W., Boudewijns, E. A., Kim, J. F., Faber, T., Babu, G. R., Onno, C. P van Schayck, & Been, J. V. (2018). *Impact of improved cookstoves on women's and child health in low and middle income countries: A systematic review and meta-analysis*. *Thorax*, 73(11), 1026–1040. <https://doi.org/10.1136/thoraxjnl-2017-210952>.
- 31 Onakomaiya, D., Gyamfi, J., Iwelunmor, J., Opeyemi, J., Oluwasanmi, M., Obiezu-Umeh, C., Dalton, M., Nwaozuru, U., Ojo, T., Vieira, D., Ogedegbe, G., & Olopade, C. (2019). *Implementation of clean cookstove interventions and its effects on blood pressure in low-income and middle income countries: Systematic review*. *BMJ Open*, 9(5), e026517. <https://doi.org/10.1136/bmjopen-2018-026517>.
- 32 Patel, V., Burns, J. K., Dhingra, M., Tarver, L., Kohrt, B. A., & Lund, C. (2018). *Income inequality and depression: A systematic review and meta-analysis of the association and a scoping review of mechanisms*. *World Psychiatry*, 17(1), 76–89. <https://doi.org/10.1002/wps.20492>.
- 33 Bailis, R., Drigo, R., Ghilardi, A. & Masera, O. (2015). *The Carbon Footprint of Traditional Woodfuels*. *Nature Climate Change* 5 (3). <https://doi.org/10.1038/nclimate2491>.
- 34 Brandon, Katrina. (2014). *Ecosystem Services from Tropical Forests: Review of Current Science*. Center for Global Development Working Paper No. 380, Available at SSRN: <https://ssrn.com/abstract=2622749> or <http://dx.doi.org/10.2139/ssrn.2622749>.
- 35 Agarwala, Meghna & Ghoshal, Shankharoop & Verchot, Louis & Martius, Christopher & Ahuja, Richie & Defries, Ruth. (2017). *Impact of biogas interventions on forest biomass and regeneration in southern India*. *Global Ecology and Conservation*. 11. 213. <https://doi.org/10.1016/j.gecco.2017.06.005>.
- 36 Burney, J., & Ramanathan, V. (2014). *Recent climate and air pollution impacts on Indian agriculture*. *Proceedings of the National Academy of Sciences*, 111(46), 16319–16324. <https://doi.org/10.1073/pnas.1317275111>.
- 37 Ibid.
- 38 Food and Agriculture Organization of the United Nations. (2015). *Assessment of Safe Access to Fuel and Energy in Marsabit, Meru and Kitui Counties, Kenya*. Briefing Note. <https://www.fao.org/3/I9967EN/i9967en.pdf>.
- 39 Shupler, M.; Mwitari, J.; O'Keefe, M.; Lorenzetti, F.; Nabukwangwa, W.; Gohole, A.; Perros, T. et al. (2023.) *Declining Use of Clean Cooking Fuels & Food Security in 2022: Downstream Impact of the Russian-Ukrainian War in a Kenyan Informal Urban Settlement*. *MedRxiv*, 23292423. <https://doi.org/10.1101/2023.07.09.23292423>.
- 40 Shupler, M.; Karl, J.; O'Keefe, M.; Osiolo, H. H.; Perros, T.; Simiyu, W. N.; Gohole, A.; Lorenzetti, F.; Puzzolo, E.; Mwitari, J.; Pope, D.; Nix, E. (2022). *Gendered Time, Financial & Nutritional Benefits from Access to Pay-as-You-Go LPG for Cooking in an Informal Settlement in Nairobi, Kenya*. p 2022.06.02.22275930. <https://doi.org/10.1101/2022.06.02.22275930>.
- 41 Ibid.
- 42 Rossanese, M., Charron, D., Delapena, S., Ipe, J., Jagoe, K., Livingston, K., Piedrahita, R., Rouse, J., Waweru, F., and Waruguru, M. (2020). *Sharing the burden: Shifts in family time use, agency and gender dynamics after introduction of new cookstoves in rural Kenya*. *Energy Research & Social Science*, 64, 101413. 15. <https://www.sciencedirect.com/science/article/pii/S2214629619306668>.
- 43 Energy Sector Management Assistance Program and the World Bank (2022). *Opening Opportunities, Closing Gaps: Advancing Gender-Equal Benefits in Clean Cooking Operations*. <https://documents1.worldbank.org/curated/en/099215003152218466/pdf/P1742320beb6090670933705085ff1c047b.pdf>.
- 44 Energy Sector Management Assistance Program, Modern Energy Cooking Services, and the World Bank. (2020). *The State of Access to Modern Energy Cooking Services*. <https://documents1.worldbank.org/curated/en/937141600195758792/pdf/The-State-of-Access-to-Modern-Energy-Cooking-Services.pdf>.
- 45 Shupler, M.; Karl, J.; O'Keefe, M.; Osiolo, H. H.; Perros, T.; Simiyu, W. N.; Gohole, A.; Lorenzetti, F.; Puzzolo, E.; Mwitari, J.; Pope, D.; Nix, E. (2022). *Gendered Time, Financial & Nutritional Benefits from Access to Pay-as-You-Go LPG for Cooking in an Informal Settlement in Nairobi, Kenya*. p 2022.06.02.22275930. <https://doi.org/10.1101/2022.06.02.22275930>.
- 46 Ibid.
- 47 Belmin, C., Hoffmann, R., Pichler, P.-P., & Weisz, H. (2021). *Fertility transition powered by women's access to electricity and modern cooking fuels*. *Nature Sustainability*. <https://doi.org/10.1038/s41893-021-00830-3>.
- 48 Food and Agriculture Organization of the United Nations and the United Nations High Commissioner for Refugees. (2018). *Managing forests in displacement settings: Guidance on the use of planted and natural forests to supply forest products and build resilience in displaced and host communities*. <https://www.fao.org/3/i8309en/i8309en.pdf>.
- 49 Ibid.
- 50 United Nations High Commissioner for Refugees. (2014.) *Light Years Ahead Project: Monitoring & Evaluation System and Baseline Survey Report*.
- 51 Jagoe, K., Rossanese, M., Charron, D., Rouse, J., Waweru, F., Waruguru, M., ... & Ipe, J. (2020). *Sharing the burden: Shifts in family time use, agency and gender dynamics after introduction of new cookstoves in rural Kenya*. *Energy Research & Social Science*, 64, 101413. 15. <https://www.sciencedirect.com/science/article/pii/S2214629619306668>.
- 52 Women's Refugee Commission (2014). *Influx of Refugees and Limited Firewood Leads to Spike in Gender-based Violence*. <http://www.womensrefugeecommission.org/blog/influx-of-refugees-and-limited-firewood-leads-to-spike-in-gender-based-violence/>.
- 53 Energy Sector Management Assistance Program. (2023.) *Building Evidence to Unlock Impact Finance: A Field Assessment of Clean Cooking Co-Benefits for Climate, Health, and Gender*. World Bank.
- 54 U.S. Environmental Protection Agency. (2023.) *Greenhouse Gas Equivalencies Calculator*. <https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator>.
- 55 World Bank Group. (2020). *The State of Access to Modern Energy Cooking Services (English)*. <http://documents.worldbank.org/curated/en/937141600195758792/The-State-of-Access-to-Modern-Energy-Cooking-Services>.

- 56 Clean Cooking Alliance. (2022.) *"Clean Cooking Industry Snapshot Third Edition."* 2022. Clean Cooking Alliance. <https://cleancooking.org/wp-content/uploads/2022/05/CCA-2022-Clean-Cooking-Industry-Snapshot.pdf>.
- 57 Ibid.
- 58 Ibid.
- 59 Ibid.
- 60 Ibid.
- 61 Azoth Analytics. (2023.) *Global Carbon Credit Market (Value, Volume) – Analysis By Market Type (Voluntary, Compliance), End User, By Region, By Country: Market Size, Insights, Competition, Covid-19 Impact and Forecast (2023-2028)*.
- 62 Clean Cooking Alliance. (2022.) *"Clean Cooking Industry Snapshot Third Edition."* 2022. Clean Cooking Alliance. <https://cleancooking.org/wp-content/uploads/2022/05/CCA-2022-Clean-Cooking-Industry-Snapshot.pdf>.

## ABOUT PROJECT DRAWDOWN

Project Drawdown is the world's leading resource for climate solutions. By advancing science-based climate solutions, fostering bold climate leadership, and promoting new narratives and voices, we are helping the world stop climate change as quickly, safely, and equitably as possible. A 501(c)(3) nonprofit organization, Project Drawdown is funded by individual and institutional donations.

## ABOUT CLEAN COOKING ALLIANCE

The Clean Cooking Alliance (CCA) works with a global network of partners to build an inclusive industry that makes clean cooking accessible to the three billion people who live each day without it. Established in 2010, CCA is driving consumer demand, mobilizing investment to build a pipeline of scalable businesses, and fostering an enabling environment that allows the sector to thrive. Clean cooking transforms lives by improving health, protecting the climate and the environment, empowering women, and helping consumers save time and money.

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