



**FUEL-EFFICIENT COOKING STOVES:
A TRIPLE WIN FOR CHILD HEALTH, DEVELOPMENT
AND THE ENVIRONMENT**



In short...

- 2.5 billion people worldwide are fully dependent on burning biomass fuels for cooking.¹
- 1.6 million deaths each year – mostly women and children – can be attributed to diseases resulting from smoke inhalation from open cooking fires.²
- Children are especially vulnerable to exposure from pollutants, which can impede the development of their organs and immune systems.³
- Exposure to biomass smoke is a significant risk factor for acute lower respiratory infections in children, including pneumonia, which remains one of the most common causes of death in children under five globally.⁴
- In developing countries, 730 million tonnes of biomass are burned each year, amounting to more than 1 billion tonnes of CO₂ in the atmosphere.⁵
- More efficient cooking stoves can reduce smoke inhalation with significant health benefits, as well as reducing greenhouse gas emissions, slowing deforestation and providing a host of social benefits.



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“Previously, I had to travel to the forest every two days to gather enough fuel for my family of eight. The fuel-saving stove consumes little... now I visit the forest every four days. The traditional open fire has a lot of smoke. It enters my nose and mouth, causing severe pain in my lungs. It was also irritating my eyes. I had to itch my eyes with my hands. This stove has little or no smoke. [It] also has a flame guard that protects us from burning our hands and clothes. I used to have to make a lot of back and forth visits to check on my food when I was doing something else around the homestead. The improved stove is moveable; I can take it anywhere I have other chores, and do both at the same time.”

– Lelo, an Ethiopian woman, reports on her experience with the Tikikil stove.

The big picture: history and context

The relationship between public health – particularly the health of women and children – secure access to cleaner energy for the poor, and climate change mitigation is complex. This report focuses on one aspect of this relationship – the more efficient use of biomass energy through the use of fuel-efficient stoves.

Globally, two key challenges faced by the energy sector are ensuring the security of energy supplies, and curbing energy's contribution to climate change.⁶ Yet for the world's poor, whose per capita contributions to climate change are infinitesimal and who largely rely on biomass fuels⁷ to meet their daily energy needs, the challenges surrounding energy access and usage are of a different nature. For women and children who spend hours each day foraging for wood, energy supplies are threatened by the unsustainable harvesting of rapidly depleting forests. Cooking fires in poor rural homes produce smoke that contains many of the toxins found in tobacco smoke. Fuel smoke has been associated with health impacts such as acute lower respiratory infections and chronic obstructive pulmonary disease – which kill 900,000 children under five each year.⁸

Initially, interest in the provision of more efficient stoves for cooking in the developing world stemmed from an appreciation of the environmental benefits of reduced deforestation. In recent years, as evidence on the harmful health impacts of indoor air pollution has mounted and climate change has become more prominent on the global agenda, there has been a resurgence of interest in cleaner stoves as a way of simultaneously improving health, reducing greenhouse gas emissions, generating environmental benefits, and contributing to social and economic development.

Despite this interest, there has been little high-level prioritisation of financial and technological resources to support access to household energy in ways that promote health and sustainable development. There is no Millennium Development Goal specifically related to energy, although the ambitious goals around poverty eradication will not be realised without confronting the challenge of energy provision for the poor.⁹ Few developing countries have set targets for reducing the share of population reliant on biomass fuels. The United Nations General Assembly has declared 2012 the *UN Year of Sustainable Energy for All*. In order to realise this aim, robust action needs to be taken at global, regional and national levels so energy technologies that protect the health of poor women and children, and contribute to sustainable development, can be widely promoted.



As a major international development NGO, World Vision understands the need of poor communities for cleaner and more reliable sources of energy. Using experience gained from over 50 years in the field, World Vision has been investigating and trialling a variety of fuel-efficient stoves as part of a holistic approach to sustainable development. By engaging poor communities and working alongside local people, World Vision is helping to find solutions to the complex issues of energy, health and the changing climate.

The scope, scale and dimensions of the problem

Dependence on solid fuels is invariably associated with poverty. In sub-Saharan Africa, for example, 77 percent of people use solid fuels, compared with 74 percent in South East Asia and less than 5 percent in the majority of industrialised countries.¹⁰ The type of fuel used correlates with income – solid fuel use is more prevalent in poorer communities and then in poorer households in those communities.¹¹ With high proportions of developing country populations dependent on biomass fuels now, and significant obstacles to transitioning to other, cleaner fuels, the option of “skipping” efficient biomass technologies and transitioning directly to gas or electricity is not realistic for poor countries in the foreseeable future.¹²

The widespread dependence on biomass energy in poor communities, and the lack of access to more efficient energy technologies, gives rise to a host of other health and development concerns that, in turn, hinder communities’ efforts to work their way out of poverty:

- Meeting the energy needs of growing populations in developing countries is contributing to rampant deforestation, which reduces carbon sinks, contributes to erosion, and results in the overall degeneration of natural systems on which rural communities depend. In Ethiopia, for example, forests that originally covered 90 percent of the highlands shrank to 16 percent in the 1950s and now cover less than 3 percent of land.¹³
- Women and children can spend hours each day searching for, collecting and transporting solid fuel – hours which might be spent more productively if the need for fuel was reduced and the supply was more abundant.
- Particulate matter (PM) in biomass smoke has significant amounts of respirable size particles, some of which can penetrate deeply into the lung.¹⁴ Exposure to indoor air pollution from open fires results in exposure to PM concentrations up to 20 times higher than the World Health Organization deems safe.¹⁵ There are strong links between exposure to indoor air pollution and both acute lower respiratory infections in children under five and chronic obstructive pulmonary disease in women.¹⁶
- There are also links – albeit less well-established due to a lack of quantitative exposure assessment studies – between indoor air pollution and eye disease, asthma, tuberculosis and nasopharyngeal cancer.¹⁷
- Carbon monoxide (CO), a typical pollutant of open fires, is associated with low birth weight, peri-natal deaths and poor foetal growth.¹⁸
- Children are uniquely vulnerable to pollutant exposure. They inhale more air per kilogram of bodyweight than adults, so they absorb proportionally greater doses of contamination from pollutants.¹⁹ Their growing and developing organs, along with their immune systems, can suffer permanent impairment.

This host of health and development concerns not only contributes to large numbers of preventable deaths among women and children each year, but also significantly reduces poor people’s abilities to work and perform daily tasks. In terms of sick days, the annual health burden for India alone is estimated to be 1.6-2 billion work days lost.²⁰ The World Health Organization estimates that globally, 38.5 million Disability Adjusted Life Years (DALYs) can be attributed to indoor air pollution, making its consequences comparable with those of tobacco use, and exceeded only by malnutrition, unsafe water and sanitation, and unsafe sex.²¹

The solution: benefits of introducing improved stoves

The benefits of introducing more fuel-efficient stoves are numerous, and cut across many development sectors. However, it is often hard to quantify or assign monetary value to these benefits, because many of them are indirect and fluctuate depending on a wide range of different factors. The emissions reductions resulting from the installation of an improved stove, for example, depend on whether the fuel is sourced from renewable sources,²² the size of the pieces of fuel burnt and whether combustion of each piece is complete,²³ the moisture and energy content of the fuel, and the skill of the cook using the stove.

Even more difficult to quantify are the health benefits of introducing improved stoves – it is clear that exposure to indoor air pollution has severe health consequences for women and young children, but research has yet to quantify hazard along a continuum of exposures.²⁴

The benefits of introducing improved stoves appear to be large and include:

- **Health benefits, particularly for women and children:** A field trial of fuel-efficient stoves in Mexico has shown that stoves can reduce indoor air pollution by 70 percent, reducing the risk of a range of health impacts.²⁵ This would also have secondary effects, such as reducing household expenditure on healthcare.
- **Environmental benefits:** Field trials indicate that the installation and correct use of improved stoves can produce a 74 percent reduction in greenhouse gases, contributing to global efforts to reduce emissions.²⁶ Beyond the mitigation agenda, the flow-on environmental benefits include reduced erosion, improved fertility and water-holding capacity of soils, and the conservation of forests as protection from extreme weather events and storehouses of biodiversity.



- **Economic benefits:** While in-depth cost-benefit analyses based on detailed and consistent field datasets are rare, one such analysis indicated that for every dollar invested in a particular intervention, a return of \$8.70-\$11.10 was yielded.²⁷ Global estimates indicate that the net intervention cost of halving the population who lack access to an improved stove is *minus* \$34 billion annually.²⁸
- **Social benefits:** Whilst difficult to calculate, the social benefits of improved stoves are likely to be considerable. Women who can spend less time collecting fuel have more opportunity to undertake income-generating activities and take care of their children. Smoke-free kitchens without open fires are safer places for children to live. Research also shows that households who are early adopters of fuel-efficient stoves are more likely to make other positive changes such as painting or cleaning kitchen walls and upgrading floors.²⁹

Challenges in the introduction of improved stoves

- **Alternative purposes of an open fire:** Indoor fires that cook food often also serve other purposes, such as heating indoor areas, preserving food through smoking, keeping thatched roofs dry and rot-free, repelling mosquitoes, and lighting. Improved stoves do not address all of these needs, and hence need to be part of broader sustainable development efforts.
- **Compatibility with local fuels and foods:** Open fires can support any size or style of pot, and can be managed to provide different levels of heat over a period of time. Some improved stoves will only accept cooking pots made to certain specifications, and some of them have proven not to distribute heat evenly. One example of a response to this is the development of the Mirt stove, which is a specific model designed for the cooking of Ethiopian *injera*, large, flat pancake-like bread that requires low, even heat over a large surface to prepare.
- **Community acceptance:** In order for improved stoves to deliver sustainable development benefits, the people who use them must ultimately conclude that they are superior to alternative means of cooking. Different communities and individuals may have different criteria by which they evaluate a stove's merits – and often those criteria differ from the ones dictating a stove's design. A stove may be designed to maximise energy efficiency and reduce smoke, for example, but stove users may also judge the model based on factors like safety, convenience, price and perceived durability, and the aesthetics of the stove.³⁰ There is now an increasing realisation that the success of stove programs must be measured not by the number of stoves distributed in the initial phase, but by the number of stoves which remain in use over time.³¹



World Vision's approach to fuel-efficient stoves: a case study from the Oromiaya region of Ethiopia

World Vision's response to climate change is grounded in our vision of a sustainable world, where climate change is minimised, poverty is eradicated, and children and communities are able to thrive.

World Vision's holistic approach to climate change and development builds interventions around the three pillars of social, environmental and economic sustainability. We consequently look for benefits beyond adaptation to changing climatic circumstances, seeking to also contribute towards mitigation or more traditional development goals such as health and food security.

In Ethiopia, wood is the most important energy source for cooking in households.³² Consumption is particularly high in rural areas, where alternative sources of fuel are either unavailable or unaffordable for the majority of consumers. Inefficient open fires used to cook household meals waste wood and exacerbate health problems associated with indoor air pollution. World Vision's pilot stove project has disseminated 2,500 stoves in its initial phase. Features of the project include:

- Kitchen Performance Tests of multiple stove varieties (locally-made and imported) have been conducted by community members, enabling end-users to discuss the relative advantages and disadvantages of different models available. Kitchen Performance Tests also often give a more realistic estimate of the fuel savings and smoke reduction achievable than more controlled lab-based tests.³³
- Although several challenges related to quality control and production capacity had to be overcome, manufacturing of the locally-designed Tikikil stove now provides employment in the project area.
- Women's cooperatives have been established as training and distribution points for stoves within communities, where members can purchase units over a period of time making monthly payments. This helps overcome the barrier of a high initial capital outlay for poor households, but still assigns a value to stoves which stimulates a sense of ownership in the user. Imported stoves are priced to ensure the local market remains competitive.
- The project is seeking accreditation under the Clean Development Mechanism³⁴ and Gold Standard Foundation, and will generate Certified Emissions Reductions and hence revenue to cover the cost of project implementation over seven years. However, significant upfront funding was required

to establish the project and purchase stoves before carbon revenue became a possibility.

- The project has sought involvement from government agencies at local and regional levels, which help undertake training and monitoring aspects of the project. Establishing links with local authorities helps ensure the sustainability of the project over the long term.

World Vision, having gained valuable experience through trialling stoves in the communities they were destined for, is aiming to scale this project up in the coming years.





The state of play – what needs to happen?

As a child-focused humanitarian and development organisation, World Vision is committed to development approaches that ensure environmental, social and economic sustainability while improving health and ensuring children are protected. Reducing the number of women and children exposed to indoor air pollution is one way to contribute to this broader goal, but even to achieve this aim action is required from many quarters.

Different institutions have different – and complementary – roles to play. Research centres around the globe continue to work on improving the design of stoves, so that they can meet better fuel efficiency and particulate emission standards. From this body of work, benchmarks for improved stove performance have been suggested, which may lead to international performance standards for cooking stoves.³⁵ It has been suggested that ‘tiers of certification’ could allow for both locally-produced and international stove designs to be assessed against standards, thus allowing for a marketplace whereby multiple models in different price ranges might be available.³⁶

National governments have an important role to play in agenda-setting and program coordination. Setting explicit goals around the percentage of the population fully dependent on biomass for cooking as part of national development and poverty reduction strategies may produce more action. Currently, the fact that stove projects cut across multiple sectors makes it difficult to interest policy makers in government departments with specific and limited mandates. Better coordination across ministries of health, environment, agriculture and industry would reduce inefficiencies.

Non-government organisations will continue to play an important role in working with local authorities and vulnerable communities to facilitate greater uptake and ensure the proper use of stoves. Improving the monitoring and evaluation of stove projects, particularly with respect to health benefits and usage patterns over time, needs to be more rigorous. For example, there is a need to quantify health hazards along a continuum of exposures. Particular questions of importance include the effects of exposure to indoor air pollution during pregnancy, at a young age and as adults on the risk of various disease outcomes, and whether this risk can be reversed by reducing exposure.³⁷ NGOs may not have the specialist knowledge required to manage the monitoring and evaluation required to answer such research questions, and partnerships with specialist agencies may be required.

An important development in recent years has been the founding of the Global Alliance for Clean Cookstoves, which seeks to coordinate activity and raise the profile of this issue.³⁸ Financing for stove projects in recent decades has been low due to perceptions about past failures, the lack of prioritisation accorded to energy provision and health investment for the poor, and the complexity of existing climate finance options. Less than 1 percent of World Bank funding, for example, was directed towards clean cooking between 2000 and 2008.³⁹ Increased funding for stove work, including through simplified methodologies for the Clean Development Mechanism⁴⁰, may help overcome the barriers of high entry cost and could increase the number of stove projects able to sustain themselves through carbon markets.

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- ¹¹ See Omear Masera, Rodolfo Diaz & Victor Berrueta, 2005. 'From cookstoves to cooking systems: the integrated program on sustainable household energy use in Mexico' in *Energy for Sustainable Development*, vol. 9 no. 1, pp 25-36. Omear et al note that intensive fuelwood use in Mexico occurs in areas determined by social, environmental and cultural conditions. They also argue that the 'fuel ladder' or 'fuel switching' approach is overly simplistic, noting that many households use multiple fuels for different purposes, allowing them to maximise the advantages of certain fuels and to be more resilient to uncertain or changing economic circumstances.
- ¹² Obstacles to transitioning to cleaner fuels such as liquid petroleum gas include: high capital costs for infrastructure needed to generate, process and deliver clean energy; and the volatility of petroleum-based fuel prices and supplies. Majid Ezzati estimates that it will be 2-3 decades before developing countries can contemplate transition. See Majid Ezzati, 2005. 'Indoor air pollution and health in developing countries,' comment in *The Lancet*, vol. 366, July 9 2005.
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