

Stoking up a cookstove revolution

The secret weapon against poverty and climate change

Introduction

Fighting climate change and improving the health of the world's poorest people are often seen as competing priorities. Yet some technologies address both tasks at the same time. And one technology is among the cheapest methods of achieving either: improved cooking stoves.

Almost half the world's households, some three billion, eat food cooked on fires and stoves burning wood, dung, coal, straw, husks and charcoal. Traditional stoves make kitchens death traps for the world's most vulnerable people. Pollution levels from smoke and gases such as carbon monoxide are typically hundreds of times those that would be tolerated in the streets or a factory. An estimated 1.6 million people die annually as a result, including around a million children under five, mostly victims of childhood pneumonia.

But our calculations suggest that a global programme to manufacture the half-billion improved stoves needed to convert the world's poor to safer cooking could save hundreds of thousands of young lives a year - and at the same time cut global greenhouse gas emissions by the equivalent of up to one billion tonnes of CO₂ a year.

Such investments ought to attract large sums through the carbon market. We calculate that improved cooking stoves can keep a tonne of CO₂ out of the atmosphere for as little as \$1-3 - an exceedingly good deal in a market where offsets can be sold for \$20-30 a tonne.

The Ashden Awards for Sustainable Energy have recognised and supported advancing designs for different cultures and cooking needs. Since 2001, 18 stove projects in Africa, Asia and Latin America have won awards, most of which have gone on to expand and develop.

"We believe the humble stove is a powerful solution to the twin challenges of poverty and climate change. So for ten years, we have rewarded and championed some of the world's leading stove programmes. After they win an award, we boost their work through business support and introductions to finance, so they can roll out improved stoves to millions more people," says Sarah Butler-Sloss, Founder Director of the Ashden Awards for Sustainable Energy.



Efficient stoves reduce the use of wood by around 50 per cent.

"From when they were born the children suffered, because we cook while pregnant and we inhale the smoke. It was as if the baby had smoked, so the baby was born with respiratory problems.... Now we don't use so much fuelwood, there is no smoke in the house, we are healthier, we are not exposed to asthma and lung disease."

Dona Justa Nunez, owner of a Justa rocket stove in Tegucigalpa, Honduras

The Problem

Every day around the world, half a billion people, mostly women, spend between three and five hours a day cooking food for their families on open fires or stoves, usually indoors. Around these women, young children gather. This is daily domestic life for more than 80 per cent of the population in sub-Saharan Africa, India and much of Southeast Asia, and more than a quarter even in more advanced countries such as Mexico.

At first sight the symptoms of distress from the smoke and fumes given off by most traditional stoves are no more than wheezing, itchy eyes and the risk of burns. But the constant assault on young lungs creates a silent epidemic of disease. Household smoke, mostly from cooking stoves, is a major cause of childhood pneumonia, the biggest cause of death among children worldwide, and the largest cause of lost 'life years' for our species. Stove smoke and fumes are also strongly linked to chronic lung disease among women, TB and low birth weight. Thus cooking smoke ranks with unsafe water, malaria and malnutrition as one of the great scourges of the poor world.

Meanwhile cooking fires and stoves are significant contributors to climate change, through their emissions of carbon dioxide, other gases and particulates. Soot is now thought to be responsible for up to a fifth of the warming effect of man-made pollution. (See box, right)

More efficient – and therefore healthier and more climate friendly – cooking stoves are available. The cost of improved stoves can be as little as \$3 for a simply improved bucket stove, but not enough people buy them, even when they are available in local markets. Studies show that often the barriers to adoption are complex and sometimes cultural.



Traditional stoves, such as this one in Mexico, emit dangerous levels of smoke.

Warming emissions

A number of gases and particles in smoke produced by stoves and cooking fires contribute to global warming. The main one is carbon dioxide, the product of burning in air any carbon-based fuel, whether coal, wood, charcoal, dung or straw. If the fuel is ultimately replaced by nature, then there is no overall warming effect from CO₂, since the same amount of CO₂ is subsequently absorbed by new trees or crops. But if the fuel comes, for instance, from deforestation, then there is a permanent addition of CO₂ to the air.

Other greenhouse gases such as methane may be produced. And nitrogen oxides and some volatile organic compounds given off can combine to form ozone – another greenhouse gas.

The smoke will often contain soot, or black carbon. This has a strong warming effect because it traps heat and warms the air around. It may also fall onto snow, making the resulting surface darker and more heat-absorbent. Recent studies suggest black carbon, though it only lasts in the atmosphere for a few days, may rival methane as the second most important component of global warming after CO₂.

Some climate scientists argue that reducing black carbon emissions would be the fastest method of slowing climate change in the short term.

But fine particles in the smoke from stoves and cooking fires also shade the Earth, thus causing cooling. So the combined effects of all the constituents of smoke need to be studied further and can be highly variable, depending on when and where they occur. Nonetheless, several studies of the combined emissions from stoves suggest that household stoves typically may emit gases and particles that together have a net warming effect equivalent to between one and three tonnes of CO₂ annually.

The Solution

The basic components of stoves are a combustion chamber, usually over a grate through which air enters from below; a heat transfer area, where the hot gases given off by the fire heat the cooking pots or a hotplate; and sometimes a chimney to remove gases and smoke. But most stoves burn fuel inefficiently, much of the heat is lost because of poor insulation, and they allow smoke and unburnt gas to escape.

Different designs of stoves and construction materials are popular in different parts of the world. Each can be improved. The main methods of improvement are:

- Improved burning so less fuel is needed, less smoke forms and more of the hot gases from the fire are burned. The best way to improve burning is to make sure enough air reaches the burning areas.
- Removal of smoke and gas from the kitchen area to reduce negative health effects. A simple chimney can both remove smoke and gas from the home and draw air through the stove, improving burning.
- Better insulation and direction of hot gases so as not to waste heat.

Advanced stoves, called semi-gasifiers, separate the combustion of solid fuel and gases, each with its own air supply. The latest designs control air flow with a small fan, which can cut smoke further.

"Designing stoves is far more complicated than many people think. You need good technical design to achieve high efficiency and low emissions, and it must be cheap to produce. But above all the cook has to like it – a stove won't help the cook or the environment if it's left to gather dust in a corner," says Dr Anne Wheldon, Technical Director of the Ashden Awards.

Multiple benefits

Improving stoves can have multiple benefits. Laboratory studies confirm that many types of improved stove more than halve emissions of smoke, noxious gases and carbon dioxide, and field studies show their impacts in improved health. A long-term study in Guatemala suggests semi-gasifiers can reduce smoke and other emissions by up to 95 per cent in day-to-day use. Many improved stoves more than halve the use of wood.

The benefits extend to the wider environment, with reduced emissions of pollutants that cause both local pollution and global climate change, and locally dramatic reductions in deforestation, especially on the fringes of urban areas.



Shengzhou Stove Manufacturer's high quality manufacturing in China has been essential to the expansion of rocket stoves.



About 95 per cent of Cambodians cook with biomass fuels which is accelerating deforestation.

Stoves can be designed to burn agricultural waste as well as wood. When agricultural residues are used as a fuel source this reduces deforestation even further and deals with waste disposal.

Important development and economic benefits derive from the relative low cost of stoves and money saved from replacing charcoal.

Wider social benefits include the reduced time women and children spend cooking and collecting wood. This also makes them less vulnerable to harassment and attacks.

Different stoves for different folks

People in different parts of the world have widely different traditional cooking practices that use existing – usually inefficient – stoves and open fires. Improved versions that have been introduced are therefore also diverse, to adapt to local diets, cultures, and environment.

The world's biggest effort to improve stoves has been in China, where an estimated 180 million improved stoves were introduced from 1983 to 1995, and cook for most of the population. China has recently renewed efforts to provide a new generation of yet more efficient stoves.

Elsewhere progress has been much slower. But the pace is picking up.

In Latin America, many people cook standing up, using 'block stoves' made of mud, brick, fired clay or concrete, with a hotplate for cooking tortillas. An improved version is based on the 'rocket' design developed by an American NGO, the Aprovecho Research Centre in Oregon.

The rocket has better insulation, and a short internal chimney that directs air through the burning fuel to the combustible gases above. It also concentrates the heat to the plates through a narrow gap. One version of this is the Justa stove, developed by Trees, Water & People and Honduran NGO, AHDESA, which has a raised platform popular in Honduras and elsewhere in Latin America. In 2008, more than 35,000 of these were being used in the region. Another version, the Ecobarril, puts a rocket design into an oil drum, providing a large circular hotplate for cooking at outdoor foodstalls.

In Mexico, where 95 per cent of rural households still cook in traditional ways, the NGO GIRA, an Ashden Award winner, has developed the Patsari design with a large plate for making tortillas. It reduces indoor pollution by 70 per cent.



Patsari stoves in Mexico reduce indoor pollution by 70 per cent.

“Having this stove is so good. It has made cooking pleasurable again. I don't cough or cry while cooking any more; our clothes don't smell like smoke any more.”

Concepcion de Hernandez, owner of Justa stove, Honduras



Cleaner stoves can reduce the health impact on women and children in refugee camps.

In South Asia, women usually squat to cook on traditional low-level stoves called 'chulas' and rarely have a hot plate or chimney. They are also of a block design and are usually made of mud. The Bangladeshi NGO Grameen Shakti, another Ashden Award winner, has begun installing improved chulas that halve fuel use and remove smoke from the kitchen. Poor households can access micro-credit and earn back the \$10 cost of the stove within six months from savings in fuel costs alone.

In Africa and parts of Asia, millions of women cook on open fires and portable stoves – called bucket stoves in Asia and jikos in Africa. Bucket stoves, which usually burn charcoal, have a grate underneath and some insulation, but do not have a chimney. Many are used outdoors, where they fill villages with smoke. But indoors they are even more deadly, unless placed under a hood.

Ashden Award-winning GERES in Cambodia, developed an improved bucket stove called a New Lao, which had a ceramic grate with many more holes than normal, allowing better air circulation and combustion. It also has better insulation. At \$3-4 each, the New Lao stoves recoup their cost within months thanks to savings in expenditure on charcoal. The stoves are designed to last about three years and are being used by more than 180,000 families.

As well as saving lives, the stoves are cutting Cambodia's contribution to climate change. Each stove cuts demand for wood to make charcoal by about one tonne a year, with a similar saving in CO₂ emissions. Stove promotion is being subsidised by ClimateCare, the carbon offset company.

ClimateCare founder Mike Mason says: *"With efficient cooking stoves, people often comment that the technologies we are supporting have revolutionised their lives."* The most recent certification concluded that the New Lao stoves had cut emissions by the equivalent of 182,000 tonnes of CO₂ between 2003 and 2007.

Ashden Award winners, the Energy Research and Training Centre in Eritrea, have rolled out 90,000 stoves with a chimney and a conical combustion chamber to deliver heat to a ceramic plate for making injera, a traditional local pancake-like bread made from local teff flour that is eaten by 50 million people every day in Eritrea, Ethiopia and Sudan.

Scaling up

Many new stoves are designed by social entrepreneurs for manufacture by local artisans, often traditional stove makers. Non-Governmental Organisations usually provide training to ensure that they are made to the more exacting standards needed for optimum combustion.



"Paraffin used to take most of our family income. At first I did not trust the new stove but after lighting it I felt so happy. The children are no longer coughing. I use it all day without any problems."

Esther Kueme, user of Aprovecho stove, South Africa



SSM in China is producing over 12,000 rocket stoves a month.



Local stove artisan makes a New Lao stove in Cambodia.

Grameen Shaki in Bangladesh trains local technicians who have already built thousands of stoves in people's homes, and aim to provide 10 million stoves in this way by 2015.

But local manufacture has rarely scaled up in the manner needed to reach the hundreds of millions of households without improved stoves. So there is increasing interest in mass production and international distribution.

Ashden Award winner Aprovecho, is collaborating with China's largest manufacturer of domestic stoves, Shengzhou Stove Manufacturer (SSM), to mass produce lightweight portable ceramic stoves, based on the rocket design. The company has already sold more than 110,000 stoves mainly through distributors in countries like India, South Africa and Chile.

The stoves last around three years and cost as little as \$8 each. They cut fuel use by 40 per cent or more and reduce smoke and carbon monoxide emissions by more than 50 per cent. The stoves will typically cut greenhouse gas emissions by more than one tonne a year, or as much as two tonnes if the fuel comes from deforestation. This will result in reductions in emissions at a cost of only around \$2 per tonne of CO₂.

"Efficient stoves are the most direct and affordable way to address climate change, but we need millions and millions of them," says Dean Still, director of Aprovecho. *"To bring them to scale the quality has to be exceptional. Working with Shengzhou Stove Manufacturer in China, we have created a manufacturing base and supply chain to get stoves to people that need them at an unprecedented scale."*

There is a growing interest in using carbon offset funding to support these kinds of technologies.

David Mukisa, project manager Ugastove Ltd, Kampala, Uganda, says that unlike most overseas development aid, carbon finance funding *"goes directly to the people that need it. The close monitoring required by the carbon offset standards ensures that people genuinely benefit from the investment. ... I am really excited about the potential of carbon finance in Africa, and I can see many channels where it can be used."*

Cleaner stoves for a billion people

The Indian government is planning a major initiative to introduce improved cooking stoves across the country. A study of the potential benefits to India of a possible ten-year programme to introduce 150 million efficient gasifier cooking stoves suggests that the gains in human health and reduced emissions of global-warming gases would be huge.

At a cost of \$20-50 per unit, the stoves could reduce particulate emissions fifteen-fold. The study estimated that, provided the stoves met the needs of cooks and were widely adopted, the total annual death toll in India from acute lower respiratory infections among children under five would be cut by 30 per cent, or 140,000 a year by 2020. Among those children, 240,000 fewer would die over the first decade. There would be knock on effects later on lung and heart disease among adults.

The climate benefit of reduced emissions of black soot and other warming agents besides CO₂ would be the equivalent of 150 million tonnes a year. The inclusion of CO₂ (justified only if the biomass was not re-grown) would raise the amount of warming averted each year to the equivalent of 375 million tonnes of CO₂ a year.

The stoves in total would cost between \$3 billion and \$7.5 billion. If they lasted a decade on average, they would be able to cut emissions by the equivalent of one tonne of CO₂ for between \$1 and \$5.

"I gave my stove to my daughter when she got married, so she wouldn't have to face the dangers of going out to gather firewood."

Refugee Women's Committee member,
Ethiopia

Barriers to adoption

Despite their growing popularity, the acceptance of improved stoves can be a problem. One study in Mexico of early Patsari stoves found that 50% of women abandoned them in favour of their old, more dangerous stoves. GIRA worked closely with users to improve the design, and 70% of families now use their Patsari stove on a regular basis. This highlights the importance of looking at both the technology and building a relationship with the users.

Although many women dislike the smoke, for some it has a value. For instance, keeping away malaria-carrying mosquitoes and killing bugs that lurk in their thatched roofs.

A study, in Bangladesh, found that women said they knew about the health benefits of new stoves, but were cautious about adopting them ahead of family, friends or community leaders. Many said they feared the new stoves might change their husbands' views about their cooking.

"People tend to reject a technology that an opinion leader has rejected," says Grant Miller of Stanford Medical School, who organised the study. In future, far greater effort needs to go into both cook-friendly design of stoves and in 'social marketing' to educate women about the benefits of new stoves, he says.

Conclusion

Getting the technology and design of stoves right is essential to ensure their widespread adoption. They need to be culturally appropriate. But equally governments, businesses and development organisations need to promote and replicate the most effective stoves or the necessary scale of uptake will never be achieved. Carbon finance may be significant in achieving this.

Working closely with communities to overcome the barriers to adoption is essential to squaring this circle. The good news is that the costs are not great, the mechanics of scaling up production are not complex – and the benefits are multiple, including better health, improved rates of child survival, better lives for women, improved local environments and cost-effective measures to tackle climate change.

"There is now a compelling case for getting improved stoves to millions more people," says Sarah Butler Sloss, Founder Director of the Ashden Awards for Sustainable Energy. *"Better stoves improve health, save lives, help mitigate the effects of climate change while also saving money."*



Grameen Shakti in Bangladesh works closely with local communities to roll out improved stoves.

"I no longer have to carry heavy loads of wood from the forest, and I can cook good food for my children before they go to school."

Miriam Myeni, user of Aprovecho stove, South Africa



Users of the Patsari stove user in Mexico enjoy a cleaner, smoke-free kitchen.

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The Ashden Awards for Sustainable Energy champion and reward life-changing ideas, from solar lighting in rural Bangladesh, to smokeless stoves in Eritrea, to low-carbon buildings in the UK. We believe passionately in supporting people who are changing the face of energy to cut CO₂, protect the environment and improve people's lives.

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Our online Knowledge Centre contains detailed case studies on over 100 winners from the UK and the developing world, plus photographs and information on the technologies they use.

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