

# Indoor Air Pollution

## The Problem

Nearly 2.6 million people died globally in 2016 from harmful exposure to PM<sub>2.5</sub> emissions from household use of solid fuels such as wood, coal, charcoal, and agricultural residues for cooking according to estimates by the Global Burden of Disease 2016 (GBD 2016) Project. This makes household air pollution (HAP) one of the leading health risk factors in developing countries.

About 27,000 people died from HAP in Andhra Pradesh in 2016 according to GBD 2016. About 38% of the population in Andhra Pradesh relied on solid fuels for cooking in 2015-16, while 62% used modern fuels (mainly LPG) according to the National Family Health Survey IV (IIPS, 2017). While 10% of urban households used solid fuels, as many as 50% of rural households did so.

Very few of the households using solid fuels in Andhra Pradesh use improved biomass cookstoves with more efficient, cleaner burning and less pollution. Judging from exposure studies in India and around the world, household members' average exposures to PM<sub>2.5</sub> may be on the order of 100-200 µg/m<sup>3</sup> among households cooking with solid biomass fuels, depending on cooking location in the household environment (Larsen, 2017). These exposure levels are 5-20 times the WHO's outdoor annual air quality guideline (AQG) of 10 µg/m<sup>3</sup>, and cause serious health effects including heart disease, stroke, lung cancer and respiratory diseases.

This study evaluates the benefits and costs of three interventions affecting household air pollution caused by the use of solid fuels for cooking. The interventions studied are Promotion of improved biomass cookstoves, Free provision of LPG connection to poor households and A 50% reduction of subsidies to LPG fuel. Benefits and costs are presented as a ratio of annualized benefits and annualized costs (benefit-cost ratios) over the expected useful life of each intervention.

## Solutions

Interventions	BCR	Annualized Benefit (INR crore)	Annualized Cost (INR crore)
Promotion of improved biomass cookstoves	5.6	871.4	155
Free provision of LPG connection to poor households	2.8	1995.4	724.9
50% reduction of subsidies to LPG fuel	0.65	1,820.4	2,800.2

Total costs and benefits are discounted at 5%

The full paper by **Bjorn Larsen** Environmental Economist is available on [www.APpriorities.com/IAP](http://www.APpriorities.com/IAP).

## Promotion of improved biomass cookstoves

### The Problem

About 38% of the population in Andhra Pradesh relied on solid fuels for cooking in 2015-16, while 62% of households used modern fuels (mainly LPG) according

to the National Family Health Survey IV (IIPS, 2017). While 10% of urban households used solid fuels, as many as 50% of rural households did so. About 59% of households in Andhra Pradesh (and Telangana) cooked in their dwelling, 4% cooked in a separate building, and 37% cooked outdoors according to the NFHS III 2005-06 (IIPS, 2008).

Very few of the households using solid fuels in Andhra Pradesh use improved biomass cookstoves with more efficient, cleaner burning and less pollution.

Air concentrations of PM2.5 from the use of solid biomass cooking fuels often reach several hundred micrograms per cubic meter ( $\mu\text{g}/\text{m}^3$ ) in the kitchen, and well over one hundred micrograms in the living and sleeping environments.

**The Solution**

A program promoting the adoption and sustained use of an improved biomass cookstove (ICS), such as a Rocket stove that burns biomass more efficiently and emits less harmful smoke, and that has two burners.

Improved biomass cookstoves are designed to be more energy efficient and to generate less smoke than traditional cookstoves or cooking over open fire. Such stoves therefore have the potential to reduce harmful PM2.5 emissions over the life to the stove.

Costs and benefits are estimated based on an assumed household intervention adoption rate of 30% and a sustained user rate of 65%.

**Costs**

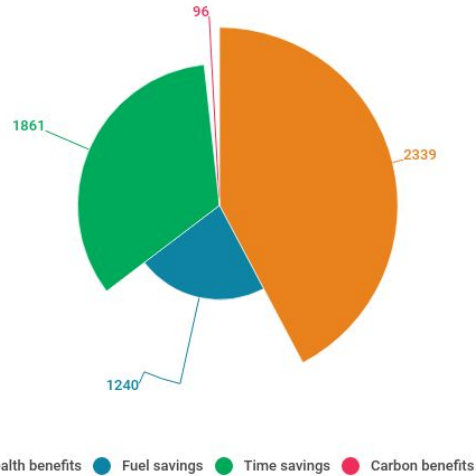
Costs include initial cost of stove, cost of stove maintenance over its useful life, and program promotion cost. Annualized cost per household is estimated at Rs. 985 and total annualized cost is estimated at Rs. 155 crores based on total intervention beneficiaries of 1.57 million households, i.e., households purchasing an ICS.

**Benefits**

The quantified benefits of the intervention are the value of health improvements, time savings from reduced biomass fuel collection and preparation (or biomass fuel purchases) resulting from the higher energy efficiency of the stoves, reduced cooking time resulting from the improved cookstove, and reduced CO2 emissions. At a 65% long-term use rate the intervention is expected to avert 786 deaths and 1,752 YLDs per year.

Annualized benefits per household, adjusted by the user rate, are Rs. 5,536 when averted deaths are valued using YLLs valued at 3 times GDP per capita. Total benefits of the intervention is estimated at Rs. 871.4 crores.

**Improved biomass cookstoves benefits**



Benefits in rupees per year per household, 5% discount rate. Source: Authors calculations.

**Free provision of LPG connection to poor households**

**The Problem**

While 90% of urban households use clean fuels (mainly LPG) for cooking, 50% do so in rural areas according to the NFHS IV 2015-16 (IIPS, 2017). The rates of clean cooking fuel utilization are lower among the poorer segments of the population.

One impediment to adoption of LPG for cooking is the initial cost of LPG cylinders and auxiliary equipment. A government program therefore provides LPG connection equipment to households below the poverty line (BPL) free of charge in order to encourage households to switch from solid fuels to LPG.

**The Solution**

The Government of India has therefore implemented a program (Pradhan Mantri Ujjwala Yojana (PMUY) launched in 2016) that provides free LPG connections (LPG cylinder and auxiliary equipment) free of charge to households below the poverty line (BPL) to encourage these households to switch from solid fuels to LPG. The budgeted cost to the government is Rs.

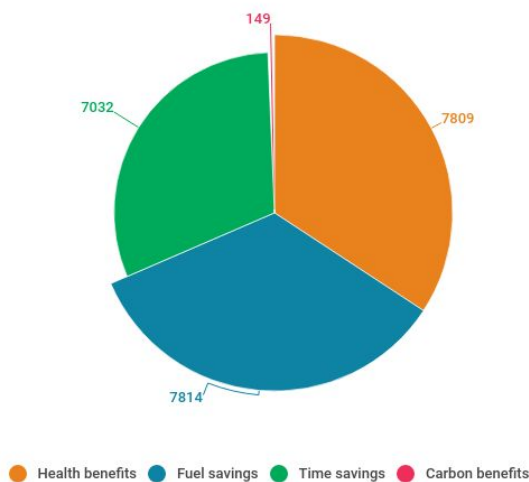
1,600 per connection. The intervention assessed is free provision of LPG connection to poor households.

Cost and benefits are estimated based on the assumption that 35% of households receiving the intervention will adopt LPG as primary cooking fuel.

**Costs**

The main household cost of using LPG for cooking is the cost of LPG fuel. This is followed by the LPG stove and connection equipment (latter provided for free by the government program). Stove maintenance cost is a minor outlay compared to the other costs. Annualized cost per household is estimated at Rs. 8,285. Total annualized Costs of the intervention is estimated at Rs. 724.9 crores.

**Benefits of LPG connection**



Benefits in rupees per year per household, 5% discount rate. Source: Authors calculations.

**Benefits**

The quantified benefits of the intervention are the value of health improvements, time savings from reduced biomass fuel collection and preparation (or biomass fuel purchases), reduced cooking time resulting from the LPG cookstove, and reduced net CO2 emissions. The estimated reduction in health effects from the intervention amounts to 1,187 deaths averted and 2,646 YLDs per year.

Annualized benefits per household that adopts LPG as primary cooking fuel are Rs. 22,804 when averted

deaths are valued using Years of Life Lost (YLLs) valued at 3 times GDP per capita. Total annualized benefits of the intervention is estimated at Rs. 1,995.4 crore.

**50 percent reduction of subsidies to LPG fuel**

**The Problem**

LPG fuel retail prices in India are substantially below the market price, as determined by world prices and transportation and distribution cost. LPG retail prices have been increased in the past year, but so has world prices of LPG. The subsidy therefore amounted to about 25% of market price or non-subsidized price as of April 2018.

Increasing the subsidized price of LPG to reduce or eliminate the LPG fuel subsidy is likely to make some households cut LPG consumption and increase the use of solid fuels for cooking. This entails negative health effects.

**The Solution**

Subsidy reduction will reduce the resource allocation inefficiency that subsidies create, simplest measured by the so-called deadweight loss. Subsidies also create budgetary burdens for the government and/or state enterprises.

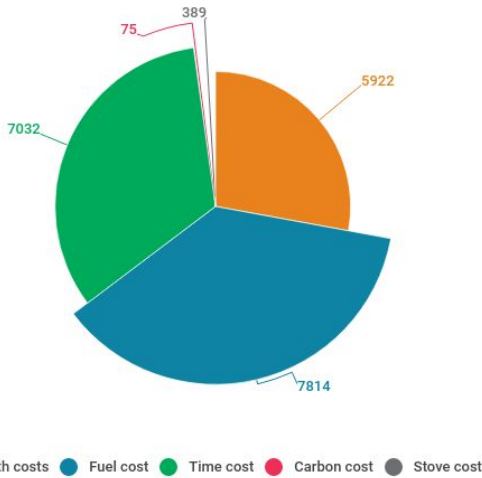
The intervention assessed is a 50% reduction of the LPG fuel subsidy. A 50% reduction in LPG subsidies, with subsidies measured by the difference in non-subsidized and subsidized LPG price as of April 1st 2018, is estimated to reduce total household demand for LPG by 15%. This is equivalent to 15% of the approximately 38% of households in Andhra Pradesh that used LPG as primary fuel for cooking in 2015-16, i.e., around 1.3 million households.

**Costs**

Costs of LPG subsidy reduction are many. Some households will switch back to cooking with solid fuels and thus face the health effects of these fuels as well as sustain increased use of time from biomass fuel collection and cooking. Net CO2 emissions will also increase. These households will also need to purchase a biomass stove. The cost of increased health effects reflects an estimated increase in mortality of 1,357 deaths and 3,025 YLDs per year.

The total annualized costs of the intervention are estimated at Rs. 2,800 crores.

### Social costs of reducing LPG subsidy



Costs in rupees per year per household, 5% discount rate. Source: Authors calculations.

### Benefits

The main benefit of a subsidy reduction is LPG fuel cost savings among households that no longer will

cook with LPG. A second benefit is the welfare gain (or reduced “deadweight loss”) from a supply and demand for LPG fuel at retail prices closer to market prices. A 50% reduction of subsidies to LPG fuel has a BCR of less than one.

Total annual benefits of the intervention are estimated at Rs. 1,820.4 crores.