

AIR POLLUTION BEGINS AT HOME

A REPORT ON COOKING PRACTICES IN PATNA

ACKNOWLEDGEMENTS

Centre for Environment and Energy Development (CEED) would like to acknowledge the contribution of several people involved in making of report “Air pollution begins at home;A report on cooking practices in Patna”.

Authors

Ms. Ankita Jyoti

Ms. Nimisha Deshwal

Surveyors

Md. Imran

Prem Kumar

Rounit Kumar Sinha

Concept & Copyright

Centre for Environment and Energy Development (CEED)

Photographs

Centre for Environment and Energy Development (CEED)

Design

Namrata Kumar

For further enquiries

Ankita Jyoti,

Program Manger

Ankita@ceedindia.org

Copyright to CEED

Analysis and errors are sole responsibility of authors

TABLE OF CONTENTS

Chapter- I

Introduction	8
--------------	---

Chapter 2.

Study area and Methodology	12
-----------------------------------	----

2.1 Objectives and Study Area	13
-------------------------------	----

2.2 Household Energy Survey	14
-----------------------------	----

2.3 Data collection and analysis	14
----------------------------------	----

Chapter-3

Findings and Interpretation	16
------------------------------------	----

3.1 Consumption factor of solid fuel (2016)	16
---	----

3.2 Future projections	16
------------------------	----

Chapter-4

Conclusions and Recommendations	20
--	----

4.1 Cross-sector Co-ordination	21
--------------------------------	----

4.2 Solid fuel to clean cooking fuel Conversion	21
---	----

4.3 Improved cook stoves Program	21
----------------------------------	----

4.4 Awareness generation and education	21
--	----

4.5 Renewable energy for cooking	22
----------------------------------	----

Annexure- I	23
--------------------	----

Sample area	23
-------------	----

Annexure 2	24
-------------------	----

Survey questionnaire	24
----------------------	----

LIST OF FIGURES

Figure 1	Composition of smoke emitted from solid fuel burning	08
Figure 2	Percentage of Biomass and charcoal dependent consumers as primary fuel source (Excluding Lakshadweep) in India	09
Figure 3	Share of primary fuel use for cooking among Households	10
Figure 4	Energy ladder (Author)	10
Figure 5	District Map of Bihar showing intensity of biomass and charcoal consumption	12
Figure 6	Share of Household Fuel consumption in Patna (Census, 2011)	12
Figure 7	Household energy Survey areas	13
Figure 8	Population Projection of Households in Patna Urban Area using solid fuel for cooking and heating purposes (household using solid fuel)	16
Figure 9	Projected trends of PM 2.5 produced by Households in Patna Urban Area using solid fuel for cooking and heating purposes	17
Figure 10	Projected trends of Black Carbon produced by Households in Patna Urban Area using solid fuel for cooking and heating purposes	18
Figure 11	Percentage distributions by gender of population suffering from illness in surveyed areas	18
Figure 12	Physical discomfort and ailments in surveyed areas (total population)	19
Figure 13	Income Distribution among households of surveyed areas	19

LIST OF TABLES

Table 1	Emission factors for various solid fuel types	14
Table 2	Consumption Factor for various solid fuel types	16

ACRONYMS AND ABBREVIATIONS

PUAA	Patna Urban Agglomeration Area
PM	Particulate Matter
WHO	World Health Organization
ARI	Acute Respiratory Infection
PAHs	Polycyclic Aromatic Hydrocarbons
BaP	Benzo[a]Pyrene
LPG	Liquefied Petroleum Gas
CO₂	Carbon Dioxide
BC	Black Carbon
PMC	Patna Municipal Corporation
MNRE	Ministry of New and Renewable Energy
BREDA	Bihar Renewable Energy Development Agency

EXECUTIVE SUMMARY



Around 90% of Bihar's population uses home-made traditional stoves or fire wood for cooking purposes. These stoves are burned with biomass fuels such as wood, agricultural residue, dung, coal and charcoal. Availability of bio-fuel in abundance and its affordability makes it a primary source of fuel for households. These sources of fuel are highly inefficient and emit copious quantities of particulate matter (PM2.5) and black carbon. The emissions from burning these particles have serious health complications, air pollution and environmental consequences. In addition, it has serious implications on gender equity and livelihood.

This report presents the study conducted to evaluate the solid fuel consumption factor of 'Patna Urban Agglomeration Area' (PUAA) and the same was modeled to project the emission of pollutant PM2.5 and black carbon till year 2051. The current and future trends to explain the widespread use of solid fuels are also estimated in the report. In the present study, the emissions of PM2.5 and BC from open fire was calculated based on emission factors.

Both qualitative and quantitative household energy surveys were conducted in PUAA in the month of January and February 2016 to estimate the consumption. The household

survey collected information about the consumption pattern of traditional solid fuel, income level, number of dependents, household behaviors, health effects and other sociological factors.

Data analysis revealed that crop waste is the most widely used fuel followed by dung cake, fuel wood and charcoal in PUAA. **It is estimated that, around 1,38,346 households in 2016 of PUAA are still using solid fuel as main source for cooking and it is expected to reach 8.6 lakhs households in 2051**, if trends are not reversed in favor of clean cooking. Taking the consumption factor, census data of 1991, 2001, 2011 and emission factor into consideration, it is estimated that solid fuel burning is projected to emit 831.54 tons of particulate matter (PM2.5) and 232 tons of black carbon in year 2016. Similarly, if immediate measures are not taken, particulate matter (PM2.5) will increase to about 13,214 tons and the level of black carbon will go up to 3,395 tons in year 2051.

From this study we also planned to discover significant effects of burning solid fuel on ambient air, climate and overall health. The local/regional level of ambient air quality in PUAA is frequently affected by the contribution of solid fuel burning with increasing concentrations of PM2.5 in the city. The computed result also raises serious concerns on black carbon concentration; one of the principal agents of global warming. The significant implications of household energy for climate change is a relatively new issue, but it requires greater attention to maintain a sustainable environment. Further, it is noted that the solid fuel emissions' impacts on health in PUAA is highly variable, where women are the worst affected. **The survey revealed that 72% of the total health complaints in households were of women and children and male health implications was found at 28%.** Mostly, the health complaints were pertaining to eye irritation, visual impairment, watery eyes, muscle fatigue and respiratory problems.

Attempts to convert households from dirty to clean fuel or from traditional stoves to more efficient stoves in PUAA are dismal. Some of the reforms and suggestions that can be implemented by the government are also described in this report. The suggestions are framed around five broad areas;

cross-sector co-ordination, solid fuel to clean cooking fuel conversion, improved cook stove programs, education and awareness generation and finally renewable energy for cooking.

All these suggestions would be the beginning of a transition towards cleaner fuel in Patna Urban Agglomeration Area (PUAA). The implementation of these suggested policies move away from the trend of using traditional solid fuel in its first

phase. Imminent efforts are also needed to accelerate the progress towards cleaner fuels.

Ramapati Kumar

**Chief Executive Officer (CEO)
Centre for Environment and Energy Development
(CEED)**



An indoor cooking chullah

CHAPTER - 1

INTRODUCTION

Energy insufficiency is the prevailing feature of deprived rural and urban households in developing countries and one of the many manifestations of poverty. Particularly, lack of access to modern cooking fuels and electricity represents a major bottleneck, holding back progress in improving health, gender equality, livelihood and it also disturbs the environment sustainability.

India with the second largest population in the world has 64%¹ of its total inhabitants dependent on solid fuels for household usage. **Majority of the Indian population relies on solid fuels for domestic cooking and lighting purposes due to their inability to access cleaner and more efficient source of energy.** The dependence is common for the rural face of India; approximately 94% of the primary energy usage is dependent on biomass (fuel wood - 56%, dung - 22%, crop residues - 16%), **and nearly 2 billion kilograms of biomass/charcoal is burnt every day in our country to fulfill the daily needs of households.**

Further, the Census of India, 2011 in its 'Household and Amenities Survey' has presented a morbid scene for the states in the Eastern Plains of the Gangetic region where **Bihar ranks first among the highest consumers of biomass and charcoal.**

These traditional, unprocessed energy sources have significant impact on the health, livelihoods and environment. A number of studies have been done raising concerns on the usage of traditional solid fuels and their inefficient burning. **The combustion of traditional solid fuel produces large amount of smoke that affects the health and livelihood of millions, the general ambient air quality, indoor air and earth's radiation budget causing global warming.**

The thermal inefficiency of solid fuel, design of traditional cook stoves and poor ventilation are major reasons for health repercussions and several environmental pressures.

The burning of solid fuel emits substantial amount of smoke that contains cocktails of chemicals with different kind of toxic properties. It mainly encapsulates pollutants like particulate matter, methane, carbon dioxide, black carbon and nitrous oxide. In addition, a large number of other toxic and carcinogenic compounds, such as polycyclic aromatic hydrocarbons (PAHs) (e.g. benzo[a]pyrene (BaP)), aldehydes and free radicals have also been validated in smoke². These are in common with the tobacco smoke³.

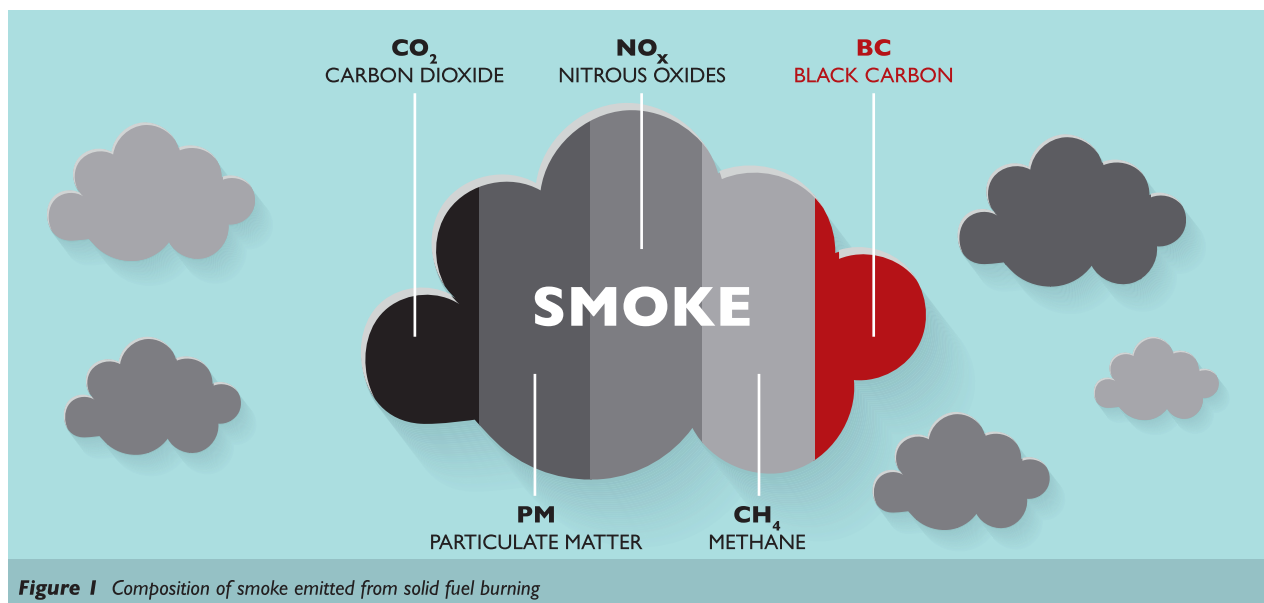


Figure 1 Composition of smoke emitted from solid fuel burning

¹WHO, 2016 (http://gamapserver.who.int/gho/interactive_charts/phe/iap_exposure/atlas.html)

²Naehler LP, Brauer M, Lipsett M, et al. 2007, Woodsmoke health effects: a review, *Inhal Toxicol*, Vol. 19, pp. 67–106

³C.Venkataraman et. al. The Indian National Initiative for Advanced Biomass Cookstoves: The benefits of clean combustion

Moreover, the main components of smoke, which is a serious matter of concern in terms of health and environment, are particulate matter, black carbon (a major fraction of PM) and carbon dioxide.

The inefficient cooking releases an enormous amount of particulate matter (PM2.5); an important reason for the alarming presence of indoor air pollution and its high concentration also affects the regional/local ambient air quality. High concentration of PM2.5 in ambient air causes many adverse impacts ranging from health outcome to material hardship where Indoor air pollution (especially PM) is believed to be the reason behind 0.6 million premature deaths every year in India (WHO, 2011) with women and children especially at risk. **Essentially, the amount of smoke coming from burning of solid fuel is equivalent of consuming two packs of cigarettes a day as estimated by The World Energy Assessment.**

A number of health impacts are associated with this traditional solid fuel cooking, the most serious of which is chronic and

acute respiratory illnesses, such as bronchitis and pneumonia. The causal linkages between solid fuel combustion's emissions and acute respiratory infection (ARI) among children are also concluded in many reports.

The impact of solid fuel in domestic cooking is not only reserved to health impacts, air quality deterioration but it also disrupts the radiation balance of earth, causing global warming and climate change. It contributes to climate change at regional and global levels. Black carbon-a major fraction of PM2.5 in solid fuel fumes can absorb a million times more energy than carbon dioxide (CO2). **The high absorption of energy by black carbon contributes to an increase in average temperature of earth (Global Warming).** This influenced increment in average temperature also changes the pattern and intensity of precipitation⁴.

Bihar has the largest number of the energy poor households to meet their basic needs followed closely by Chhattisgarh (88%), Jharkhand (87%), Odisha (86%) and Meghalaya (82%) as apparent in Fig. 2.

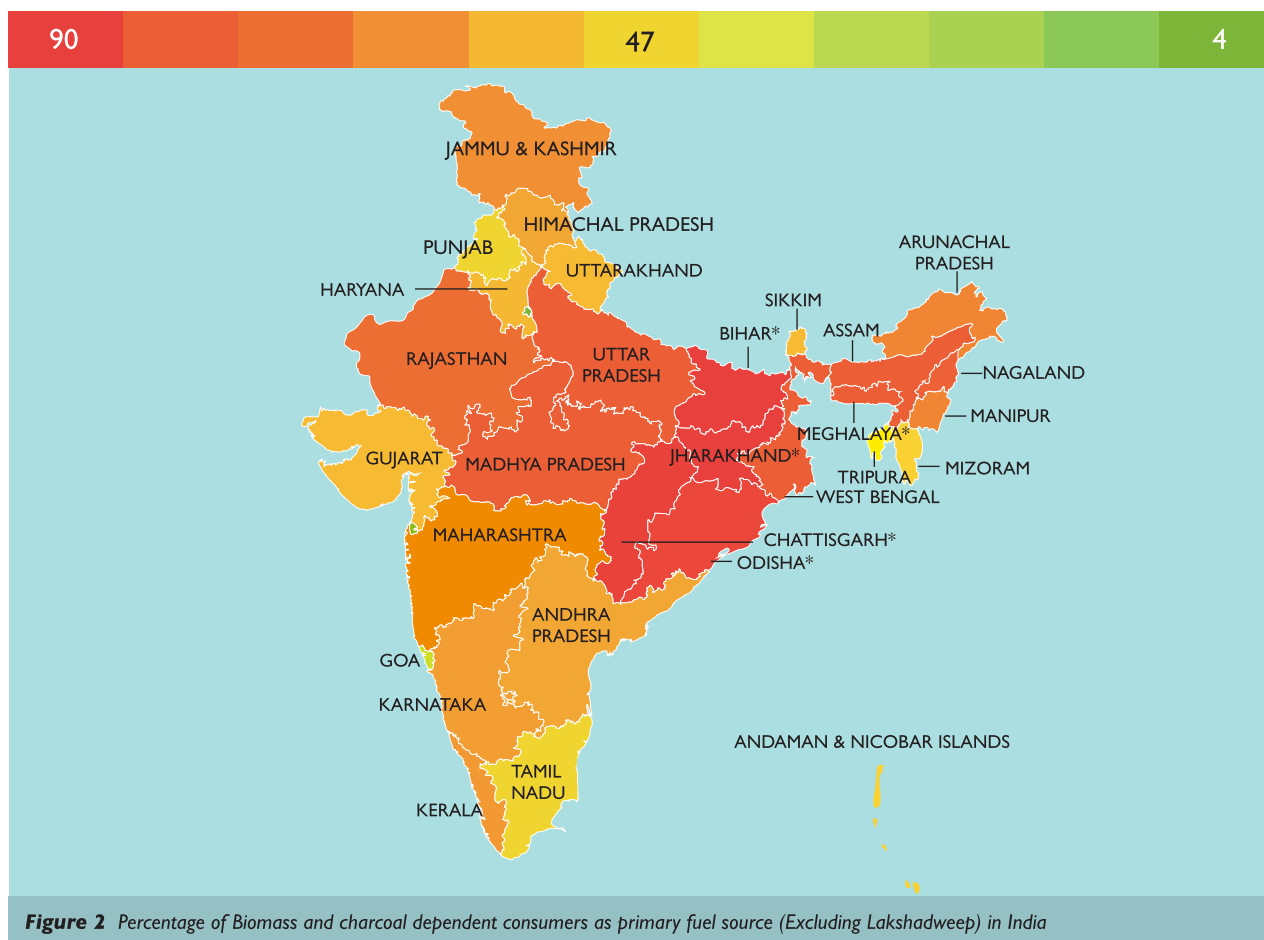


Figure 2 Percentage of Biomass and charcoal dependent consumers as primary fuel source (Excluding Lakshadweep) in India

⁴ United statute environment protection agency (<https://www3.epa.gov/blackcarbon/basic.html>)

Approximately 90% of the total population in state relies on traditional solid fuels and the remaining 10% of population uses fuels like LPG, Kerosene etc (Fig3). The main use of traditional energy (such as cow dung, agricultural residues and

fuel wood) and intermediate (such as charcoal and kerosene) energy in households is for cooking, followed by lighting and heating in state. Moreover, they are principally collected locally.

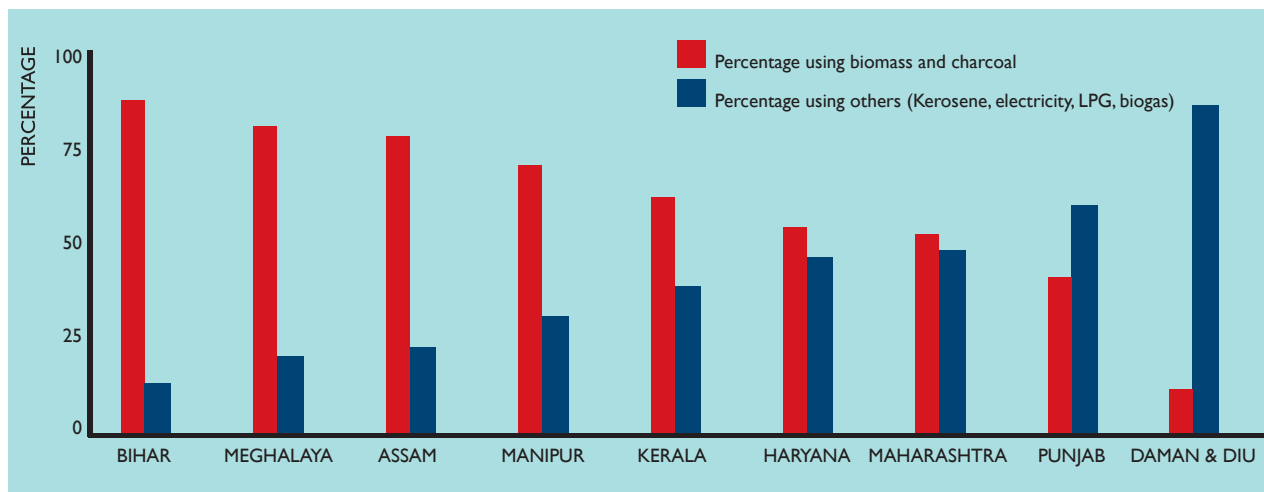


Figure 3 Share of primary fuel use for cooking among households

The fuel consumption pattern in Bihar is consistent with the stylized 'Energy ladder' theory, that states the use of modern fuel increases with income improvement. The factors like

educational attainment, socio-demographic aspects are other important determinants of fuel choice in state.

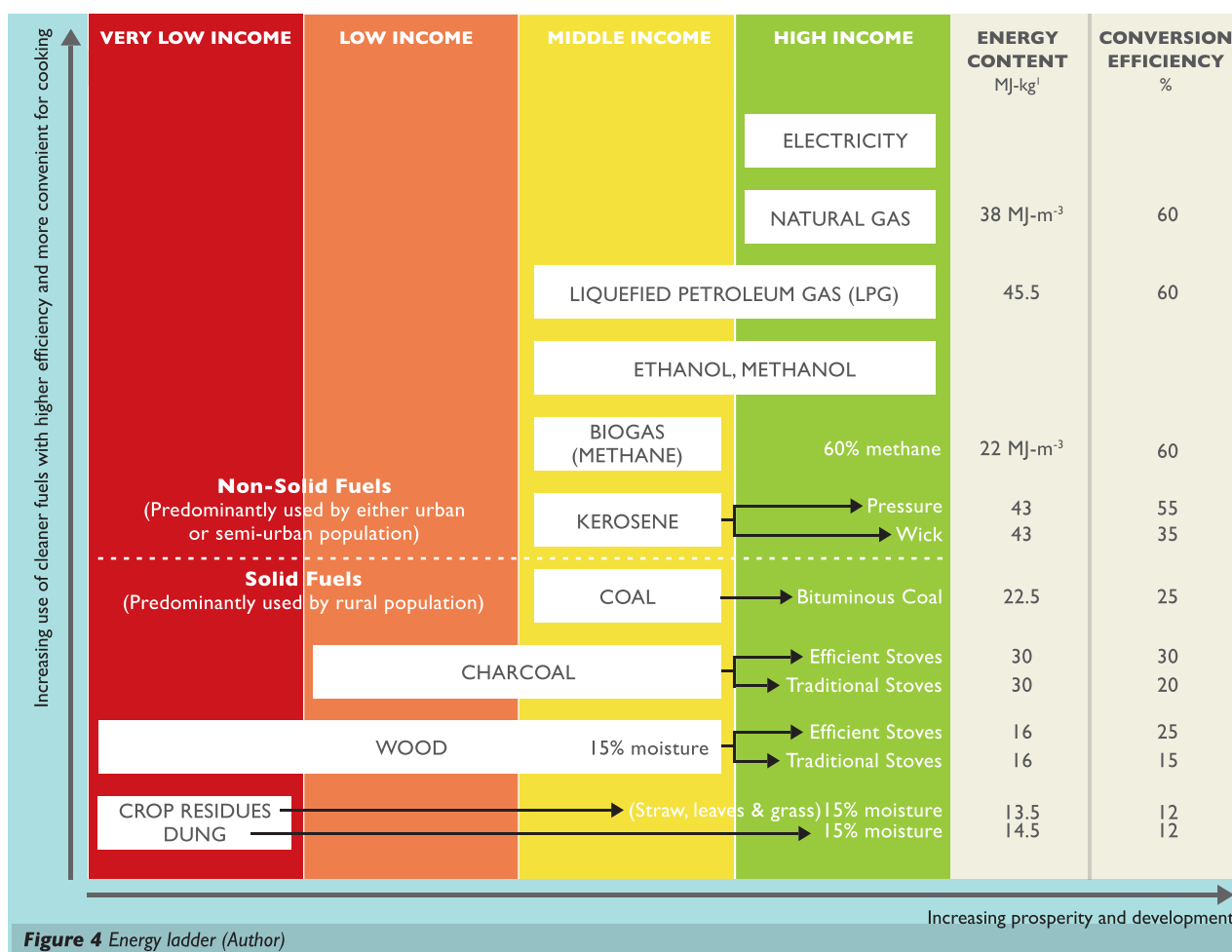


Figure 4 Energy ladder (Author)

Bihar presently has maximum number of households without effective access to modern cooking fuels and among 37 districts of Bihar the most intense consumption of traditional solid fuel is observed in Patna followed by Begusarai, Gopalganj and Madhubani⁵.

The traditional solid fuel usage in domestic cooking is concluded as one of the major culprits for overwhelming concentration of PM2.5 in city⁶ and being already branded as the second most polluted in terms of PM2.5⁷. The pattern of consumption of traditional solid fuel in households of Patna raised concerns on the responsiveness. The problem will persist

without adequate recognition and commitment to change the pattern of consumption.

The report through its household energy survey derived the consumption factor of traditional solid fuel for cooking and lighting in the Patna Urban Agglomeration Area (PUAA) and will modeled the pollutant's (PM2.5 and Black carbon) emission due to the usage. Further, the trend and projection of solid fuel's consumption and emission of pollutant for year 2011-2051 is also presented in the report. The report also looks at the possible alternatives and interventions that will help in overcoming the severe implications caused by the constant usage of solid fuel in city.



A family using a traditional chullah for boiling paddy

⁵ Census 2011

⁶ Guttikunda, S.K. and P. Jawahar, 2014. "Characterizing Patna's Ambient Air Quality and Assessing Opportunities for Policy Intervention", UrbanEmissions.Info(Ed.), New Delhi, India

⁷ WHO Report, 2011

CHAPTER - 2

STUDY AREA AND METHODOLOGY

Bihar shows variation in the mix of fuels used for cooking. The Census Survey, 2011 clearly presented Bihar as the largest consumers of traditional solid fuel and not unexpectedly, households with higher per capita income generally opting for convenient and cleaner fuels in the presented number. The state is reliant on solid based fuels and the maximum

consumption of traditional solid fuel is observed in Patna followed by Begusarai, Gopalganj and Madhubani (Fig. 5).

The dominant fuel in Patna in reference with Census Survey 2011 was coal/charcoal followed by crop residue, fuelwood and cow dung.

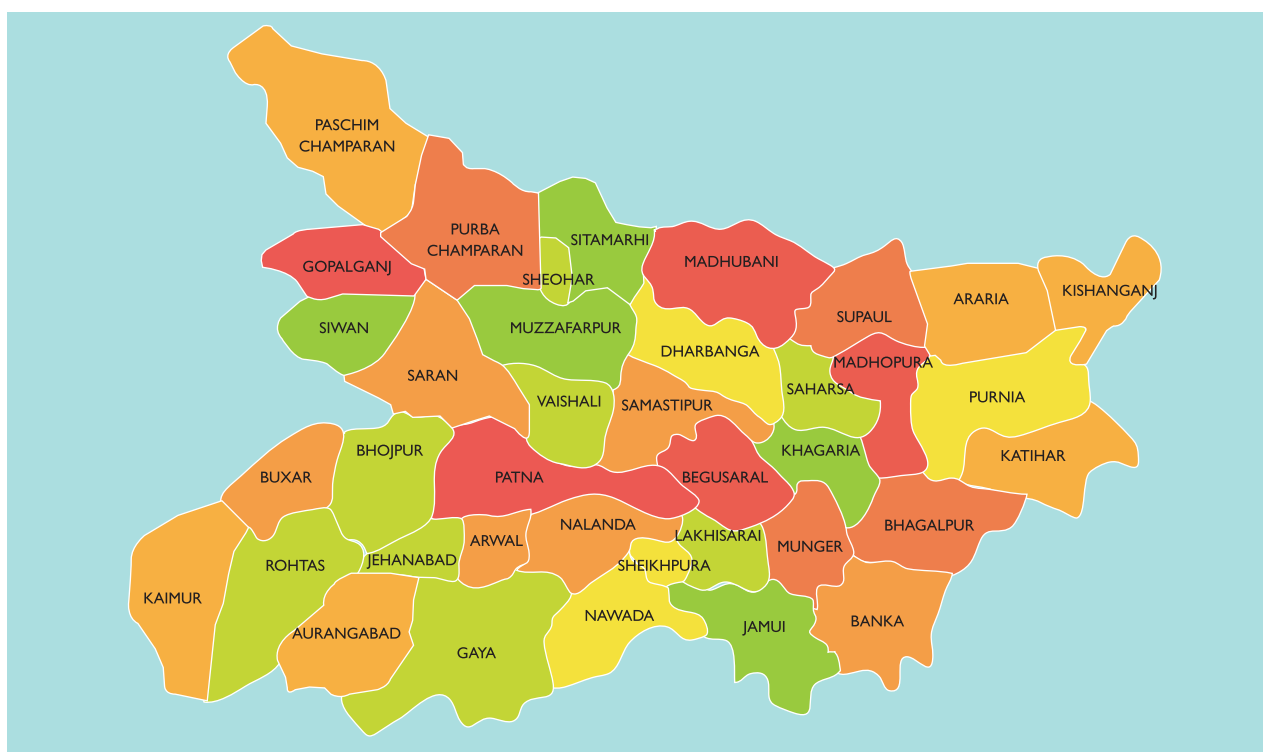


Figure 5 District Map of Bihar showing intensity of biomass and charcoal consumption

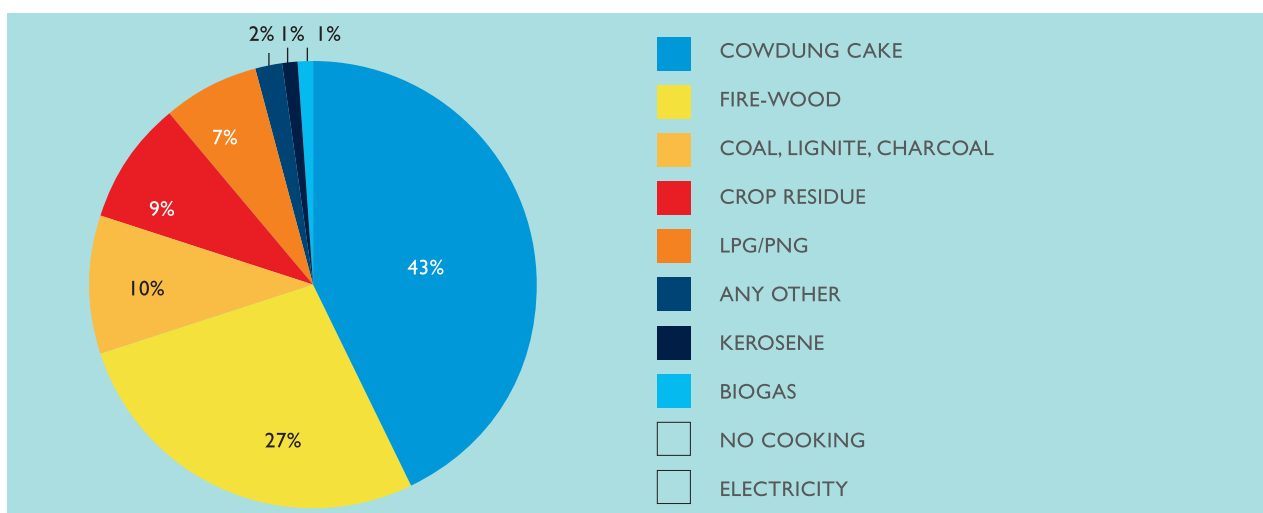


Figure 6 Share of Household Fuel consumption in Patna (Census, 2011)

The Census survey data on usage of traditional solid fuel for Patna district, which comprises of six sub divisions namely, Barh, Danapur, Masaurhi, Paliganj, Patna City, and Patna Sadar. About 56.93 percent of population of Patna lives in rural regions.

Though many reports conclude the dependence on solid fuel in rural areas but it is to be noted that it is not confined only to rural populations. To understand the actual consumption and contribution of urban population in the adversity because of burning of traditional fuel, the study was undertaken in Patna Urban Agglomeration Area.

The PUAA level estimates are importance of improving the inventories and developing sound mitigation strategies at manageable smaller scales.

2.1 Objectives and Study Area

The study was conducted in Patna Urban Agglomeration Area (PUAA) to understand the following;

A. To estimate the consumption factor of year 2016 through

household energy surveys

B. To calculate and present the trend/projection of consumption and the emission of pollutant (PM2.5 and Black carbon) of solid fuel (2011-2051).

The Patna Agglomeration Area as defined by 2001 Census constitutes the following area within Patna District:

- Patna Municipal Corporation Area (PMC)
- Patliputra Housing Colony (Out Growth of PMC)
- Digha-Mainpura (Out Growth of PMC)
- Sabazpura (Out Growth of PMC)
- Khalilpura (Out Growth of PMC)
- Badalpura (Out Growth of PMC)
- Phulwari sharif (Nagar Panchayat)
- Danapur Nizamut (Nagar Parishad)
- Danapur Cantonment Area
- Khagaul (Nagar Parishad)
- Saidpura (Outgrowth of Khagaul)

Samples were taken from each of designated areas of PUAA to conduct field surveys to know the current practices of cooking. The entire field survey was divided into 18 clusters covering 11 main areas of PUAA. Field survey, focused group discussion and participatory methods were used to find the current situation.

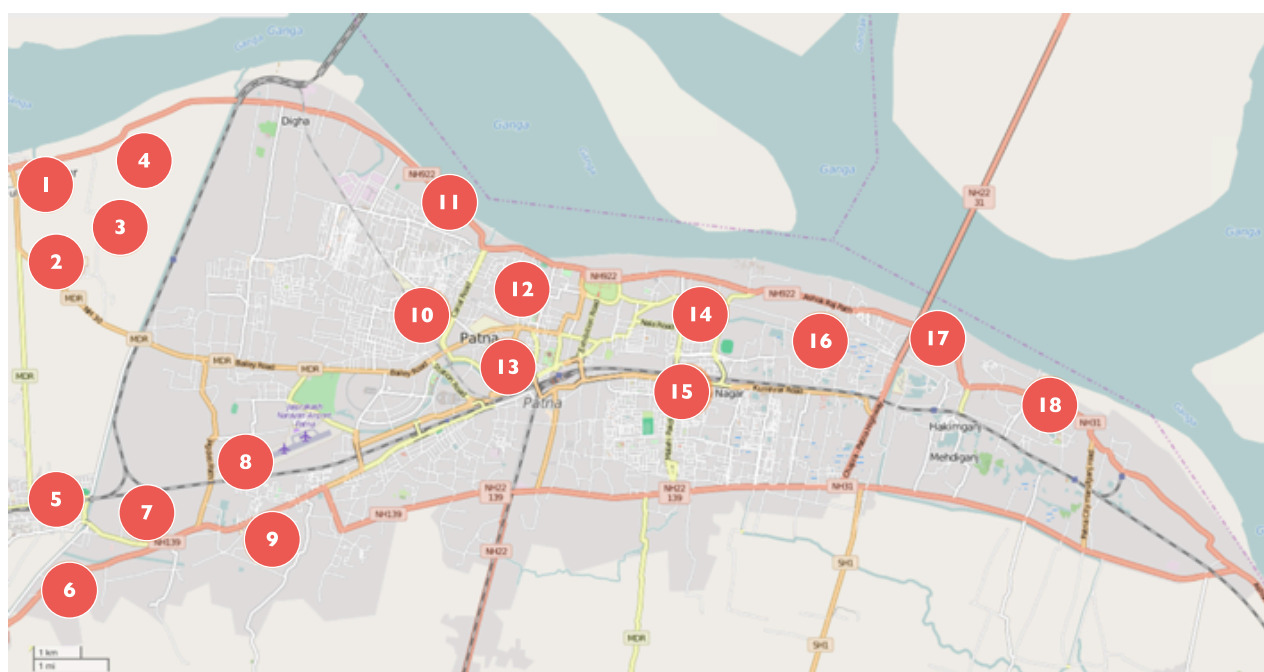


Figure 7 Household energy Survey areas (The list of surveyed area is in Annexure)

2.2 Household Energy Survey

Our study takes an explicitly multilevel approach to understand the consumptions. Many reports and energy ladder theory implies income as a major determinant for the dependency on traditional solid fuels in domestic cooking. Therefore, household energy surveys undertaken in the study were targeted for population belonging to lower income groups.

The household energy surveys quantify the state of household fuel usage in PUAA. The consumption pattern of traditional solid fuel, income level, number of dependents, household behaviors, health effect and other sociological factors were accounted in the field survey. The survey was conducted with the intention of deriving equal portions of qualitative and quantitative data.

Purposive Sampling was employed for conducting survey, with an objective to focus on a particular segment of population that are of interest and which will be best able to answer the research curiosity.

2.3 Data collection and analysis

Data was collected and further analyzed using varied statistical tools and techniques. The Consumption Factor was computed through the data acquired from the household survey and then it was modeled to estimate the emission of PM_{2.5} and black carbon using Emission Factor standards accepted nationally. The emission coefficients are sourced from The Indian National Initiative for Advanced Biomass Cook stoves: The benefits of clean combustion.

	PM _{2.5} (g/kg)	BC (g/kg)
FUEL WOOD	1.5	0.41
CROP WASTE	3.88	0.47
DUNG CAKE	5.04	0.25
CHARCOAL	17.9	5.42

Table 1 Emission factors for various solid fuel types



A rural stove using biomass cakes, fuelwood and trash as cooking fuel

Population projection for households was done using Census Data of 1991, 2001 and 2011. To reach the most possible scenario, an average of arithmetic projection, geometric projection and incremental increase projection was taken for analysis of collected data. Taking consideration of fact i.e. The decrease in the population of traditional fuel dependents with urbanization, final conclusions for the projected emission counts was drawn.

The projections have been finally used to attain two basic but vital results i.e. Emission projection for Black Carbon and PM_{2.5} till year 2051. Finally, recommendations have been proposed taking into considerations the final conclusions of the report regarding the possible mitigation strategies for the ever-degrading air quality of Patna.



Charcoal on the roads of Patna

CHAPTER - 3

FINDINGS AND INTERPRETATION

The data from CEED’s household energy survey was analyzed to determine the underlying report’s objectives; solid fuel consumption factor of households for year 2016, and projections till year 2051. The resultant data analysis were also used to portray the consequences deriving from burning of solid fuel and its impact on ambient air quality, health effect and livelihood. The following findings were determined through generalisation of area based data using weightage for the whole of Patna.

3.1 Consumption factor of solid fuel (2016)

In the total surveyed households, crop waste was found to be the most widely used fuel followed by dung cake, fuelwood and charcoal. This trend was observed in areas that are part of the Patna urban agglomeration area and despite having excellent connectivity. Further, cultural value and education are also reasons for this observed pattern.

	FUELWOOD (kg/HH)	CROP WASTE (kg/HH)	DUNG CAKE (kg/HH)	CHARCOAL (kg/HH)
CONSUMPTION FACTOR	5.06	7	5.23	3.02

Table 2 Consumption Factor for various solid fuel types

Source CEED 2016

3.2 Future projections

3.2.1 Dependent households and consumption pattern of solid fuel

Rampant use of solid fuel for cooking in PUAA area is big threat to air pollution and human health. Women and children are exposed to a toxic situation on a daily basis. It was also observed that children and infants are at a bigger risk.

According to analysis 1.38 lakh households in Patna district is still using solid fuel as its main source for cooking. On current trends, it is estimated that 8.6 lakh households in year 2051 will remain dependent on solid fuel. The dependency of household on solid fuel for domestic cooking will increase from 1.21 lakh to 8.60 lakh in year 2011-2051.

The study also indicates that in the following years dependency of households on coal/charcoal, fuel wood and crop residue will

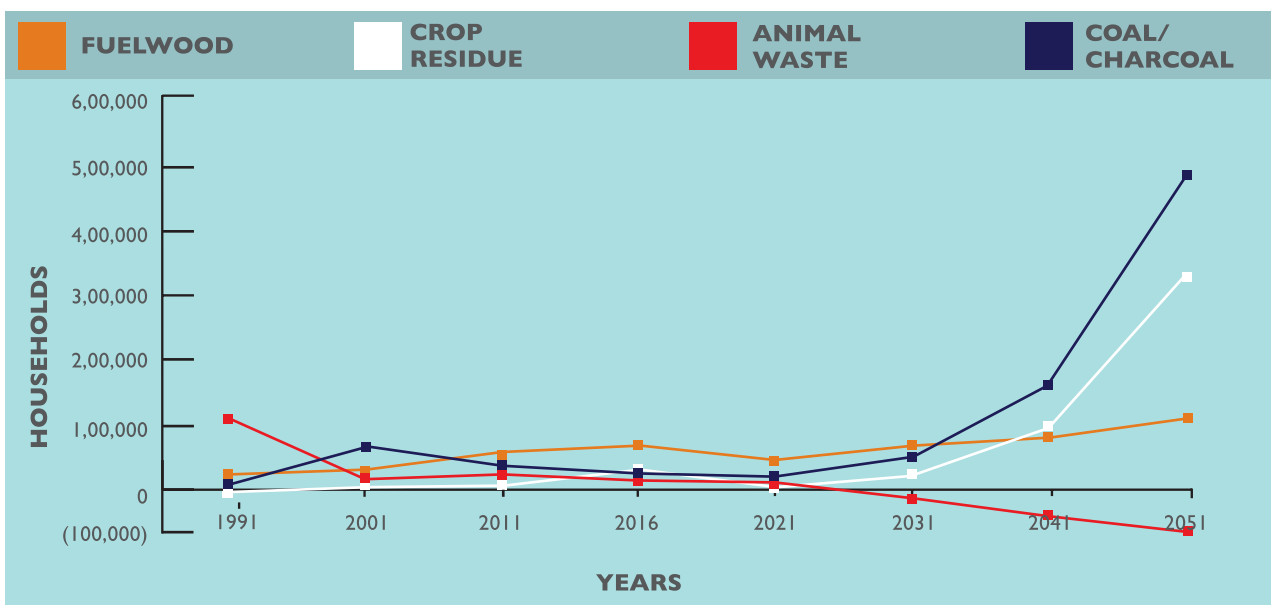


Figure 8 Population Projection of Households in Patna Urban Area using solid fuel for cooking and heating purposes (household using solid fuel)

increase but consumption of animal waste over the years will decline and possibly get nullified itself by 2031. The screened dependence on charcoal is intelligible with rapid urbanization in PUAA; coal/charcoal demand is positively correlated with urbanization.

The exponential increase of Coal/Charcoal consumption in the Patna Urban Agglomeration Area will upsurges the challenge for satisfying the rising electricity demand in Patna, as Coal is also the main fuel in thermal power generation.

In addition, among all four types of biomass fuel, coal/charcoal is having an upper hand in terms of emitting PM and Black carbon. **The emission coefficient for per kg of charcoal is higher as 17.9 g/kg for PM2.5 and 5.42**

g/kg for Black Carbon. Therefore, more burdens on environment and human health due to the consumption of traditional fuels are waiting for Patna.

3.2.2 Particulate Matter (PM2.5) projection and PUAA's ambient air quality

The local/regional level of ambient air quality in terms of particulate matter^{2.5} is frequently affected by open solid fuel burning in the city. And the computed result from our survey raises serious concern on the air quality of Patna. **Solid fuel burning is emitting 831.54 tons of particulate matter in year 2016 and it will reach to alarming high of 13214.3 tons of particulate matter (PM2.5) in year 2051.**

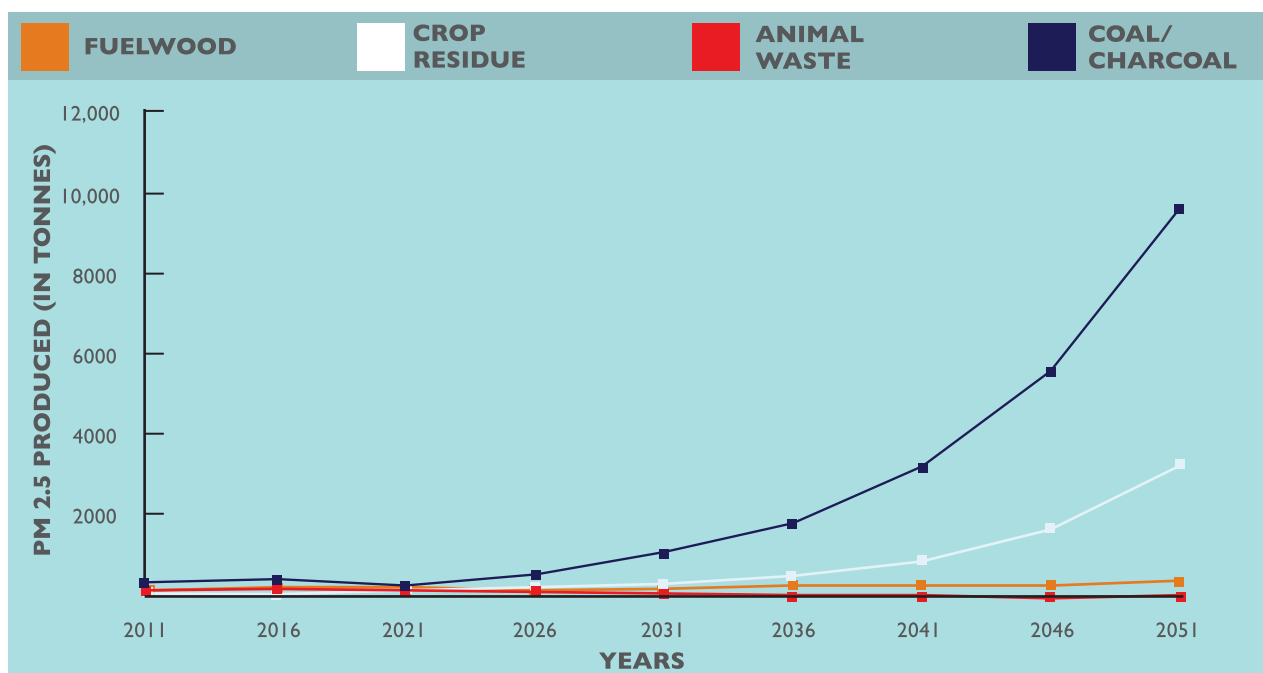


Figure 9 Projected trends of PM 2.5 produced by Households in Patna Urban Area using solid fuel for cooking and heating purposes.

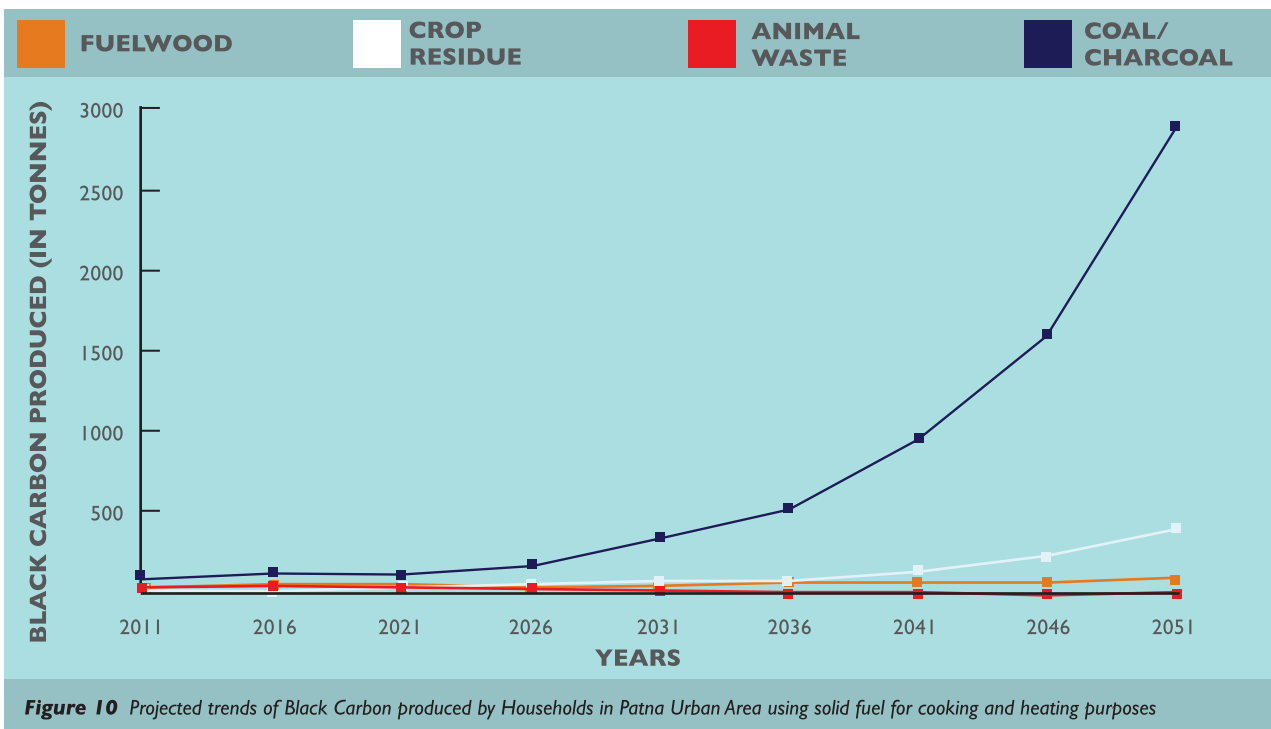
Moreover, it is discernable that adding emissions from other sources responsible for the concentration of PM2.5 in Patna will expand the limit of problems. Patna is already positioned as the second most polluted city with the highest concentration of PM2.5 (400microgram/cubic meter noted in December 2015) and is no longer in a situation to cope with this trend. Solid fuel cooking should be controlled through policy implications and technology advancements. Patna district must adopt a time bound phase out plan to move towards clean cooking.

3.2.3 Black carbon and Climate Change

Primarily solid fuel is considered as a renewable energy source

but its inefficient burning has serious implications on local as well as the global environment. At present, Patna district is emitting 232 tons of black carbon and more than 15 times increase is projected by year 2051, if we continue to be on solid fuel for cooking. Based on current trends, it is **projected that amount of Black carbon in Patna's ambient air stands at 3,395 tons in year 2051.**

Black carbon (BC)—a fine, solid particle dispersed in the air because of incomplete combustion of solid fuel is one of the principal agents of global warming. The global warming effect of black carbon is estimated at 27–55 percent that of CO₂ (Ramanathan and Carmichael 2008) and is believed to have a



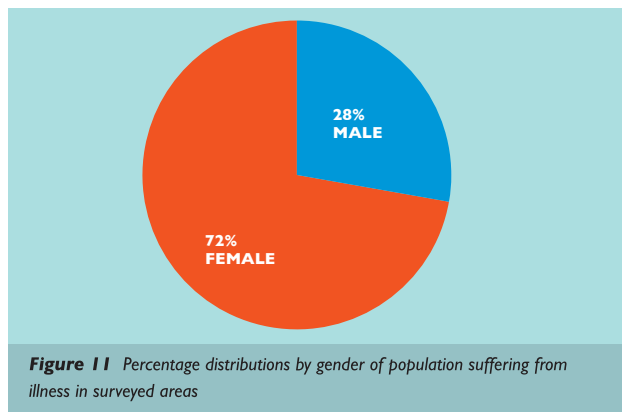
warming effect of about 1.1 Watts per square meter (W/m^2)⁸.

The increasing concentration of black carbon, attributed to domestic burning of solid fuel in PUA, will tend to increase the average temperature locally and to some extent globally. Although the lifetime of BC (1-2 weeks) is very less, its overlong accumulation can cause pronounced impact.

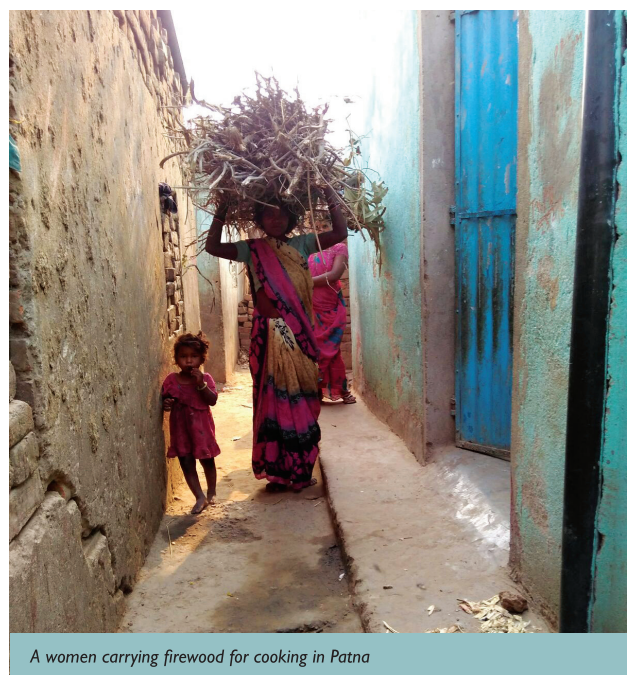
The significant implications of household energy for climate change is a relatively new issue but it requires greater attention to maintain the environment sustainability of Patna.

3.2.4 Air Pollution and Human health

High concentration of PM_{2.5} and Black Carbon can lead to adverse health impacts in PUA and especially women and young children are at higher risk. It was observed that children and infants playing in the cooking area are directly exposed to toxic smoke.



The households survey indicates the predominance of health worries in almost all samples. The health complains is noted for eye irritation, visual impairment, watery eyes, muscles fatigue and respiratory problems. And mostly female member of households is at stake, it accounts for 72% where male health implications was found as 28% in the total population's health worries. More cases of female health's outcome are because of longer time spent indoors, prolonged exposure and closer proximity to burning of fuels. Consistent problem of asthma, various allergies and motor issues were also noticed in numerous households during the survey.



⁸ <https://onlinelibrary.wiley.com/doi/10.1002/jgrd.50171/abstract>

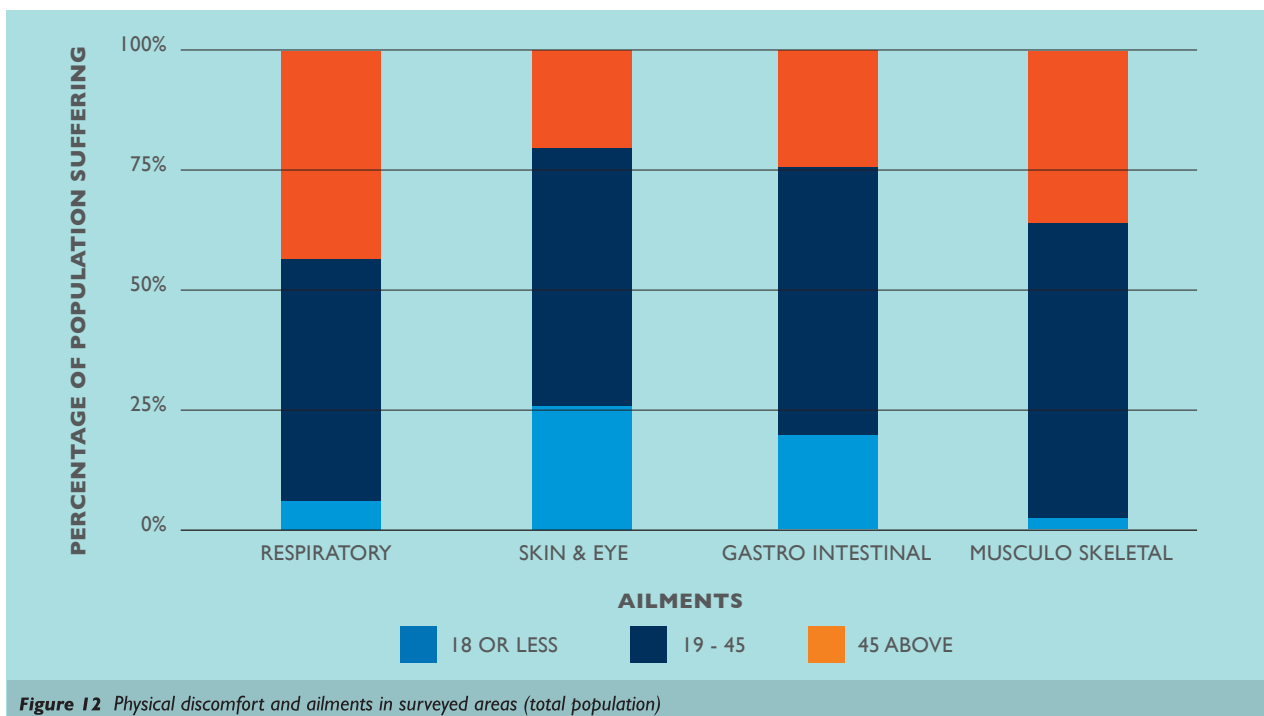


Figure 12 Physical discomfort and ailments in surveyed areas (total population)

The analysis also pointed the age distribution among the ailed, where population below age of 18 complained for Skin/ Eye and gastrointestinal ailments frequently while 19-45 aged people found out to be suffering mainly from musculoskeletal problems (Fig 12).

The numbers are presented to give the preliminary idea of health impact of users in PUAA, but further research on the risk factor should be undertaken to present a more representative picture.

The impact caused by exposure to indoor air pollution also depends on the design of cook stoves and dispersion (housing and ventilation). **The report through its survey also concludes that poor ventilation of households is adding to the health consequences.**

3.2.5 Economic

On an average each household spend 50-75 rupees per day on fuel as drawn from household survey where the monthly income was found to be in range of 2500⁹ to <15000⁹ in PUAA fig 13.

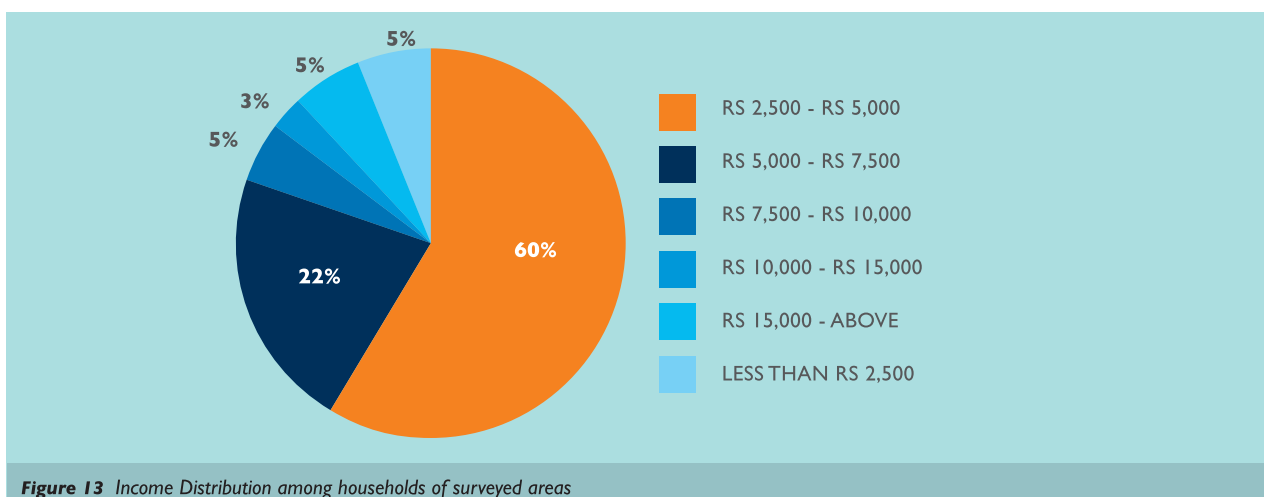


Figure 13 Income Distribution among households of surveyed areas

The monetary constrain of solid fuel can further be credited to the time spent by women and children for fuel collection. In India, the time spent collecting fuel is estimated at an hour per day (World Bank 2002). Though our survey framework doesn't include the time spent, but it can be concluded that if the solid

fuel dependency is replaced by clean fuel the freed time of women can be used in a range of ways. It will facilitate women's labor participation, their economic productivity at home and also increase the study hours of children involved.

⁹The income above 15000 was noted among households (families sharing the same kitchen) having 5 or more earning members with an average of 3000 INR per earner.

CHAPTER - 4

CONCLUSIONS AND RECOMMENDATIONS

The impact of using traditional solid fuel in PUAA warrants transition to cleaner/sustainable forms of energy and technology advancements.

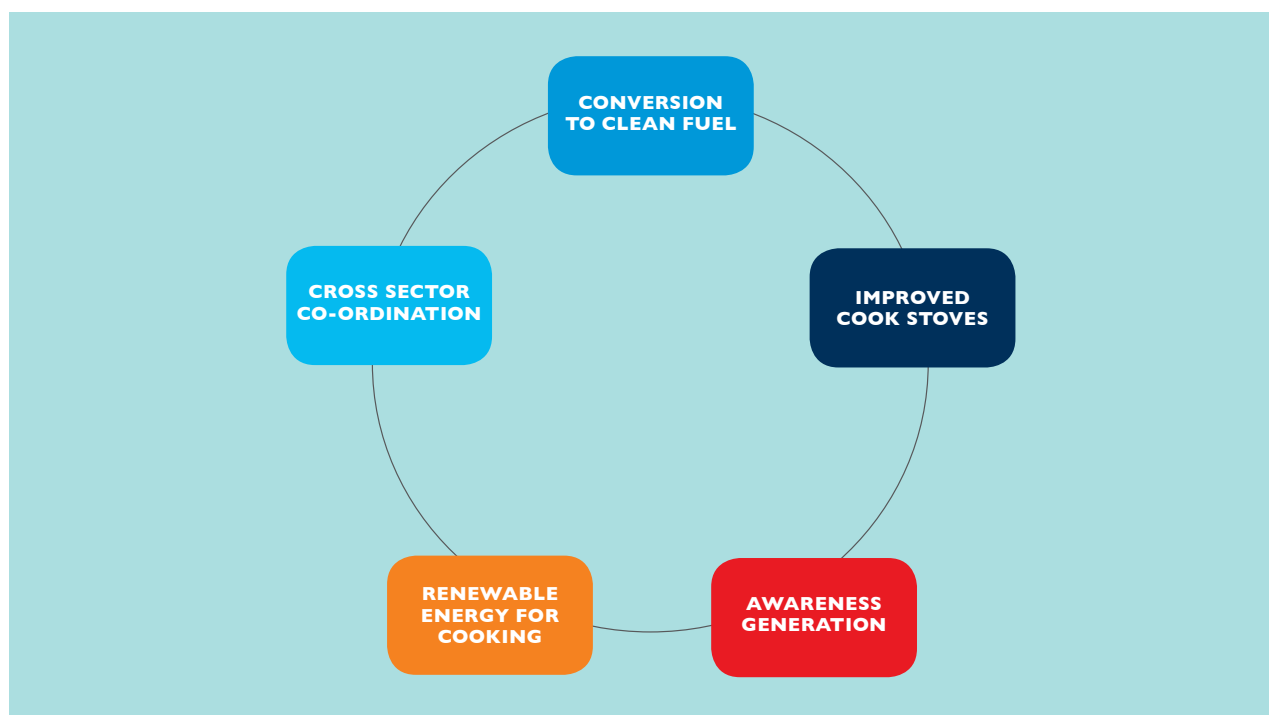
Switching of fuel choices on a large scale will not occur unless there are more government interventions in a planned way. Bihar, especially Patna is progressing with a faster growth rate but this has not translated into cleaner source of domestic cooking. The number of households relying on traditional solid fuel as their main source for cooking will continue to increase in coming years. The state government need to addressed the issue of solid fuel for cooking more vigorously.

In order to improve the scenario and transit towards clean cooking some good steps were taken by the Government of India. They can be acknowledged as National Biomass cook stove initiative in 2009, under which 3000 cook stoves were distributed in Jharkhand, Bihar and Orissa. However, it was not enough to cover all households in affected areas. The LPG subsidy support under Ujjwala scheme and the concession of

Rs. 1,600 to cover BPL families for cooking gas connections is a welcome step. However, the benefits of these initiatives drawn for Patna can't be evaluated because the exact data of beneficiaries are not available.

While some steps have been taken by the government of India, however, the state government still lacks the initiatives especially a system that **collates technological up gradation, implementation plans, monitoring strategies, proper timelines and inclusion of Patna Urban population under one program for domestic cooking. The transition to clean cooking is not very approachable without a set of strong new policies to expand the access to cleaner fuels.**

The programs for development of clean cooking remain fragmented and sporadic and such issues being solved in a decentralized way won't influence much. To shift to clean cooking in Patna following measures are suggested



4.1 Cross-sector co-ordination

To take the lead in scaling up access to clean cooking solutions in Patna Urban Agglomeration Area the role of institution is very important **and considering the cross-sectorial effect of burning of solid fuels, coordinated initiatives from various government departments is required**, a close coordination or interministerial committee represented by following departments is key towards clean cooking solution in Bihar.

- Health and Family welfare
- Bihar Renewable Energy Development Agency (BREDA)
- Women and Child Development
- Rural development

The role for each department needs to be defined in tangible manner to gauge the impact and speedy transition towards clean fuel for cooking. For ex, the interventions of women and child welfare department will help getting in gender mainstreaming to sustainably embed clean cooking technology. Health and welfare departments will be instrumental in health awareness campaigns associated with solid fuel burning and community education. BREDA, the nodal agency for implementing clean fuel in state will be the main contributory for the transition etc.

4.2 Solid fuel to clean cooking fuel conversion

The solid fuel will remain at the center of kitchen of low-level income group in PUAA given the fact that both supply and demand side barrier for LPG access is left unnoticed. Though subsidy and gas connection's concession is facilitating the shift but infrequent delivery of refill cylinders serves as an impediment in switching. Even the concessions and subsidy has not helped BPL households to afford it.

Two different slabs of subsidy and gas connection concession in BPL population (BPL-I & BPL-II) should be outlined to increase the cost affordability of lowest income households. It should be crafted after exhaustive research on the affordability of BPL families. The creation of slabs would positively influence the demand of even the lowest income household and at this context carbon finance can be fitted, it offers an additional alternative for reducing the price and increasing the demand on cleaner fuel.

Barriers in demand side like low per capita

income, lack of awareness, cultural habits and short term outlook for energy planning among low income groups is another challenge for clean cooking. Governments must plan an intensive campaign in the affected areas of PUAA and also must consider the flexible LPG scheme to fit into the short term basis. A smaller LPG cylinders must be considered for low income groups because their purchasing capacity is determined by daily or weekly income. A piped gas supply can also be considered and subsidy can be linked to beneficiaries' short term buying capacity.

4.3 Improved cook stoves program

To shift to clean cooking, measures that 'make the clean available' are important but technologies that 'make the available clean' cannot be ignored. It is important to support initiatives that ensure solid biomass fuels are used in the safe, low-emission, high efficient manner possible. The promotion of improved stoves as a second approach for lowering the solid fuel implications is implemented by central government but state action plan should also be enforced. The efficiency of solid fuel use will improve through better cook stoves. State government should also start a program for improved cook stoves and the program can also be linked with women livelihood. Training programs from designing to installing of cook stoves will help in achieving the transition and also contributeww to livelihood and women empowerment.

The provision of enhanced ventilation is also efficient but it's a cost effective measure. Therefore, program for ventilation enhancement should be implemented after peer review. State government should also popularize other improved cook stoves technologies like 'retained heat' cookers, fan stoves and 'rocket' stoves.

4.4 Awareness generation and education

Simple measures like educating about the health risks of indoor air pollution, public awareness of changes that reduce smoke levels should also be given emphasis to promote clean cooking fuel.

Government can also implement a demonstrative model at one community to validate the

information on the potential fuel, potential providers, experience of community after shifting, estimate of ability and willingness to pay etc.

Assessment of the health and environment implications of improved National cook stove program should be done. This will ease the shift to cleaner fuel in Patna by providing reliable information about the actual changes produced by it.

4.5 Renewable energy for cooking

Bihar government needs to install or implement biogas plants in PUAA under National Biogas and Manure Management Programme of MNRE.

The program facilitates the installation of household biogas plants at subsidized rates for rural and semi urban households. Setting up infrastructure that produce gaseous and liquid fuels from biomass should be encouraged. At this approach local entrepreneurs can play an efficient role. The spread of these

advanced and efficient forms of distributed energy supplies that are locally managed will have several positive effects.

Solar cookers are another important technique, which encourages the transition.

All these suggestions would be a beginning of transition to cleaner fuel in Patna Urban Agglomeration Area though more analysis and review on the recommended steps is needed. The implementation of these suggested policies can switch away the trend of using traditional solid fuel for cooking from Patna in its first phase

It is evident from the above recommendations that government of Bihar need to phase out dirty fuel from cooking to safeguard the health of women and children. It must be implemented in phased manner and cluster wise in PUAA area. A combination of technology depending on adoptability, affordability and potential should be encouraged.



A Solar Cooker

ANNEXURE - 1

SAMPLE AREA

ISAPUR
AIRPORT AREA
HARDASPURA
PURANIA
AIIMS AREA
LAL KOTHI
PIPA PUL
GAJHADHAR CHOWK
JHAKARI MAHADEV
DUJRA
DIGHA HALT AREA
BINDA TOLI
GAI GHAT
KARMA SINGH NAHAR
SHARIFAGANJ
KAMLA NEHRU NAGAR
PUNAICHAK
BORING ROAD

ANNEXURE - 2

SURVEY QUESTIONNAIRE

Name of Surveyor					
Date of Survey (DD-MM-YYYY):					
Name of Area Surveyed			Tentative Location		
I. End – User Profile					
Name					
Family Members		Adult		Children	
Gender		Female	Male	Female	Male
Working members in family		Occupation		Monthly Income	
Total Family Income*		Occupation*		Monthly Income	
II. End User's Fuel Consumption Pattern					
a.	Cooking Device	Primary		Secondary	Other
b.	Place for cooking	Indoor		Open	Semi – Open
c.	Type of Fuel used	Yes/No		Quantity used per day	Distance travelled to access them
	Fuel wood				
	Charcoal				
	Coal				
	Kerosene#				
	LPG				
	Other				
d.	Type of livestock owned	Yes/No		Waste used as Fuel? Yes/ No	If bought, distance travelled to access them
	Cow				
	Buffalo				
	Pig				
	Goat				
	Other				
e.	Type of Crop Residue available	Yes/No		Used as Fuel? Yes/ No	If bought, distance travelled to access them
	Rice				
	Wheat				
	Maize				
	Sugarcane				
	Others				
III. Health Issues in the Household+					
Respiratory Disease			Gastro – intestinal Disease		
Skin and eye problems			Musculo-skeletal problems		
Any other health problem					

*to be filled if more than one working member in the family

+ Note gender and age of the ailed

If kerosene is used as lighting fuel, note how many lamps are lighted and how long per day. Also note the number of tungsten bulbs present in the household.

ANNEXURE - 2

BASE AREA SURVEY

(ONE QUESTIONNAIRRE PER AREA TO BE FILLED)

Type of Fuel	Price	Measuring Unit / (day/month/year)
Fuel wood		
Charcoal		
Coal		
Kerosene		
Other		
Other		
Crop Residue		
Rice		
Wheat		
Maize		
Sugarcane		
Others		
Animal Waste		
Dung Cake*		

*If animal waste by animal type are sold, note them separately.



About CEED

Centre for Environment and Energy Development(CEED) is a solution driven non-profit organization that works towards creating inspiring solutions to maintain a healthy, rich and diverse environment. CEED is dedicated to finding solutions for Climate and Energy, Hazardous free future and for Clean and Safe water.

The idea of CEED was conceived by a group of young professionals with vast amount of experience in the field of environment. CEED was registered in November 2012 as non profit organization under section 25, Companies Act, 1956.

Contact:

AI-248,2nd floor
Safdurjung Enclave,
New-Delhi - 110029, India

B/194,2nd floor
Shri Krishna Puri,
Patna - 800001, India

Visit:

www.ceedindia.org
www.facebook.com/ceedindia.org
www.twitter.com/ceed_india.org

Write to us at

info@ceedindia.org