Greenhouse Gas Emissions from the Informal Sector in India

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Executive Summary

India is the third largest Greenhouse Gas (GHG) emitter, after USA and China. This is mainly attributed to India's energy dependence on fossil fuels over renewable sources, with coal as the key contributor. Fossil fuels are consumed by thermal power plants as well as iron and steel, cement and other energy-intensive manufacturing industries (MoC, 2017). The GHG emissions from these sectors accounted for 78% of the total emissions in 2010 (MoEFCC, 2016). Policies and schemes have been implemented in these sectors for improving their energy efficiency and reducing the carbon footprint (BEE, 2016).

Another category of the manufacturing sector that consumes fossil fuels is the informal sector, consisting of Micro, Small and Medium Enterprises (MSME) and other unorganised manufacturing units. Major manufacturing units in this sector are food and agro-processing, coal and coke briquetting, foundries, lime/limestone processing and brick kilns. Unlike the energy-intensive industries, emissions from this sector were not analysed in detail in the previous emission inventories, even though this sector contributed 45% of the total manufacturing output of the country, in 2017 (Department of Industrial Policy and Promotion, 2017). Given the commitments of the Paris Agreement, India has to reduce its carbon emissions intensity per unit of GDP by 33–35%, as compared to 2005 levels, by 2030 (PIB, 2015). Therefore, it is essential to evaluate the GHG emissions of less-explored areas like the informal sector.

This study presents the analysis of the carbon footprint of the informal sector due to fossil fuel consumption. Historic GHG emissions, owing to coal and petroleum products, were estimated for the period 2008–09 to 2015–16.

Some of the key observations and results of the analysis are presented below:

- The informal sector consumed around 13% (81 Million tonnes, or Mt) of the total coal/lignite, 7% (8.5 Mt) of petroleum products and 8% (3.3 Billion Cubic Metres, or BCM) of the natural gas supplied in India, in 2015–16 (MoC, 2017), (CSO, 2017).
- According to CSTEP's estimates, the informal sector in India emitted 110 $MtCO_2e$ (million tonnes of CO_2 equivalent) in 2015–16, owing to fossil fuel usage. Emissions from the informal sector are lesser than those from the energy-intensive sectors (around 6% of the total GHG emissions). However, considering the Paris Agreement and growing concerns over climate change, it is essential to monitor the environmental performance of the informal sector.
- From the emission estimates, it was observed that the use of liquid fuels, such as diesel oil and furnace oil, in the informal sector has decreased in the between 2008 and 2016. However, the use of coal, lignite and natural gas has increased. This might be due to the increase in the growth of the informal sector, coal and lignite exploration and natural gas imports.

Based this analysis, CSTEP recommends the implementation of policies and schemes that will enable sustainable growth for the informal sector. Policies, similar to those of the energy-intensive sectors, are required to improve the energy efficiency of this sector. This will not only decrease fuel consumption but also reduce GHG emissions. Promoting higher deployment of renewable energy utilities in this sector is another option for reducing GHG emissions. Moreover, monitoring systems, to record industry-wise fuel consumption data, are essential for setting up effective schemes for reducing the carbon footprint of the informal sector.

Acknowledgements

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Abbreviations

Abbreviation	Full form
BCM	Billion Cubic Metres
BEE	Bureau of Energy Efficiency
BUR	Biennial Update Report
CAGR	Compounded Annual Growth Rate
CSO	Central Statistical Office
GDP	Gross Domestic Product
GHG	Greenhouse Gas
INCCA	Indian Network for Climate Change Assessment
IPCC	Intergovernmental Panel on Climate Change
kt	Kilo tonnes
kt/TJ	Kilo tonne/Tera Joule
LULUCF	Land Use, Land Use Change & Forestry
MMSCM	Million Metric Standard Cubic Metres
MoC	Ministry of Coal
MoEFCC	Ministry of Environment, Forest and Climate Change
MSME	Micro, Small and Medium Enterprises
Mt	Million tonnes
$MtCO_2e$	Million tonnes of CO_2 equivalent
Mtoe	Million tonnes of oil equivalent
NMEEE	National Mission for Enhanced Energy Efficiency
PAT	Perform, Achieve and Trade
PJ	Peta Joule
SNA	State Nominated Agencies
UNFCCC	United Nations Framework Convention on Climate Change
ZED	Zero Effect, Zero Defect

1. Introduction

Ever since the economic liberalisation of India in 1991, the country's GDP has been growing at a rapid rate, seeing a five-fold increase by 2016 (Singh, 2016). Owing to the vast production of commodities, there is an increase in the demand for energy resources for electricity generation, heating purposes and various industrial activities. Since 2006, the production of total primary energy sources in India increased at a Compounded Annual Growth Rate (CAGR) of 3.46% (refer Figure 1). Of this, production of solid fuels such as coal and lignite, which are abundant and cheaply available in India, grew at a more rapid pace (CAGR of 4.02%), contributing 74% of the total energy supplied during 2015–16 (CSO, 2017).

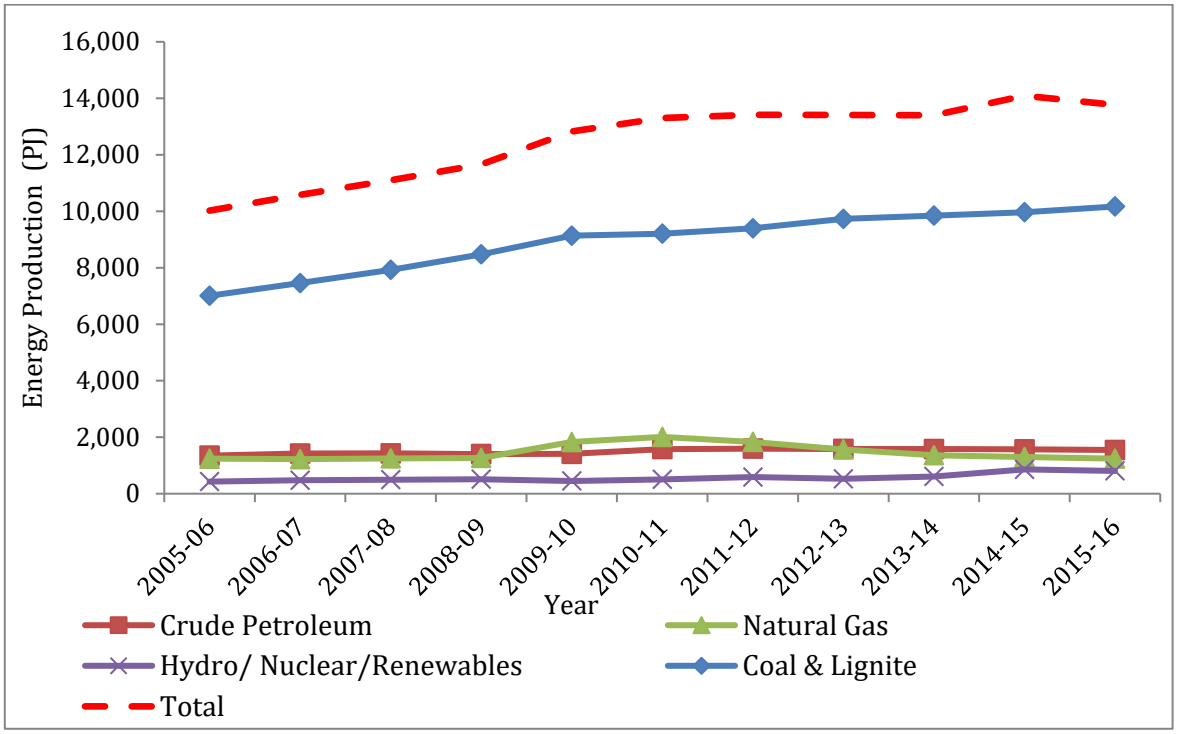

Figure 1: Year-wise energy production in India by primary sources (CSO, 2017)

The increase in fuel consumption has led to an increase in GHG emissions in India. Since coal is the major supplier of energy, the increase in the concentration of GHG emissions in the atmosphere can be attributed to the growth in its consumption. As per India's first Biennial Update Report (BUR) to the United Nations Framework Convention on Climate Change (UNFCCC), the net GHG emission in India was 1884 $MtCO_2e$ in 2010 (MoEFCC, 2015). The carbon intensity of GDP has reduced by 12% in 2010, over 2005 levels (MoEFCC, 2016). This reduction can be attributed to the implementation of energy efficiency techniques and emission control measures implemented in the thermal power generation, transportation and energy-intensive manufacturing sectors. The Bureau of Energy Efficiency (BEE) launched the National Mission for Enhanced Energy Efficiency (NMEEE) as a part of this initiative. The objective of NMEEE is to promote policies and business models for developing and sustaining markets for energy efficiency technologies (MoP, 2009). The Perform, Achieve and Trade (PAT) scheme was implemented to improve energy efficiency in energy-intensive sectors; it is based on a market-based mechanism to enhance energy savings (BEE, 2016). This has led to the reduction of specific energy consumption in these sectors by 4–5% (overall reduction of about 31Mt of CO_2) in 2015, as against 2012 levels (MoEFCC, 2015) (Patil, 2017) (Urmi Goswami, 2017).

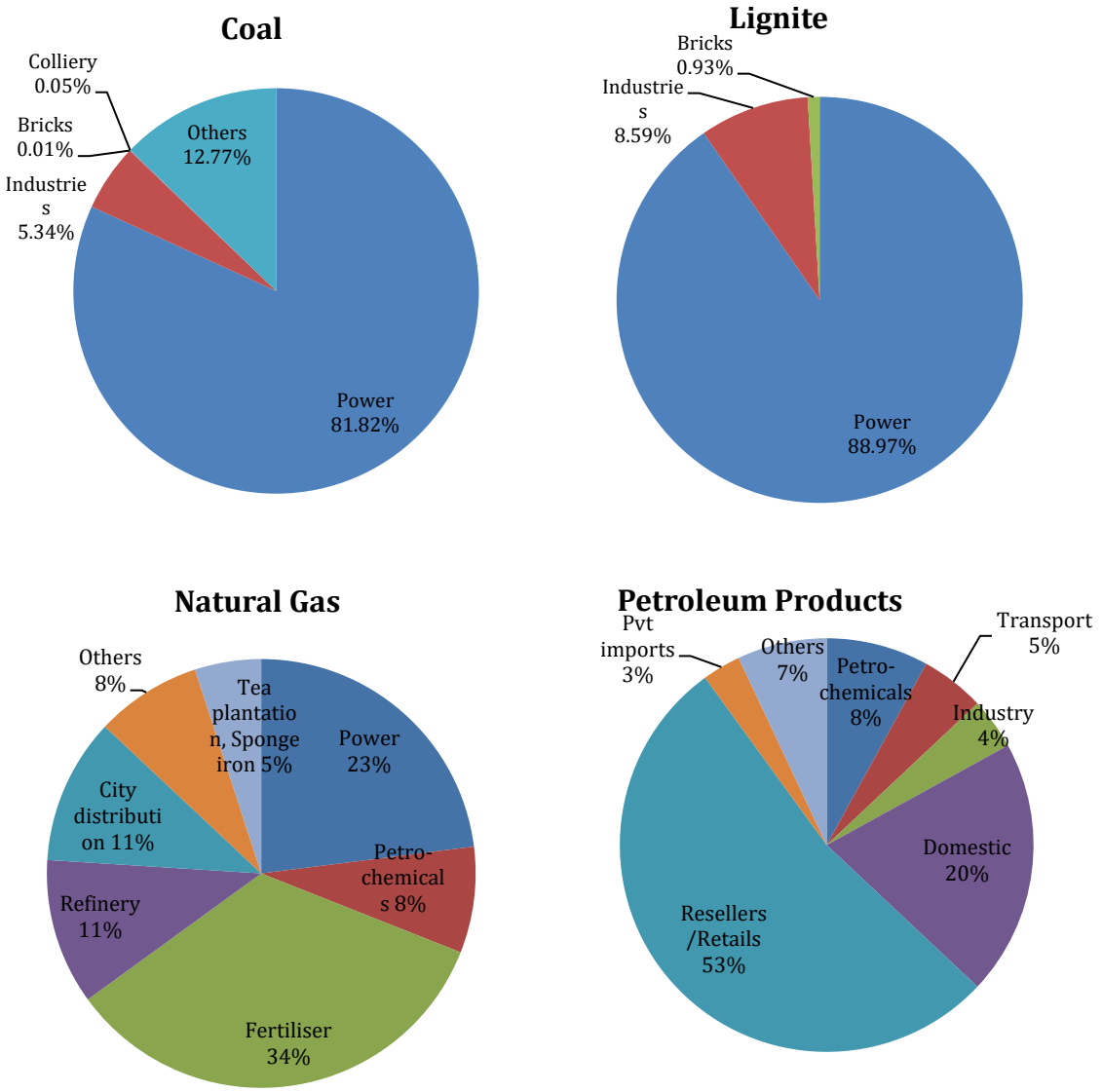

Figure 2: Despatch of fuels to various sectors in 2015-16 (CSO, 2017) (MoC, 2017)

The sector-wise fuel consumption in 2015–16 is shown in Figure 2. Around 81% of the coal is consumed by power plants, 0.01% is consumed by brick kilns and 5.35% is consumed by industries such as iron and steel, cement, pulp and paper, textile, fertiliser, chemical and basic metal plants. Around 0.053% of the coal is used internally within the collieries (refer Figure 2). The remaining coal is consumed by 'others', accounting for 81 Million tonnes (Mt), in 2015–2016 (MoC, 2017). The case with petroleum products and natural gas is similar. Around 7% of petroleum products and 8% of natural gas supplied in India are consumed by 'others' (refer Figure 2). The sectors specified as 'others' are informal manufacturing units consisting of Micro, Small and Medium Enterprises (MSMEs), brick kilns and unorganised manufacturing units. The major manufacturing units in the informal sector are food and agro processing, coal and coke briquetting, coir industry, brick kilns, foundries, potteries and ore/mineral processing industries. The MSME sector contributes 7% to India's GDP, accounting for 45% of the total manufacturing output and 40% of exports (Department of Industrial Policy and Promotion, 2017). Though MSMEs play a significant role in enhancing economic growth in rural and backward areas of the country, monitoring the environmental performance in MSMEs and other informal industries has not been given a high enough priority.

2. Background

Detailed data on fossil fuel consumption by the informal sector is not available, as compared with that for the energy-intensive manufacturing sectors. According to a study conducted by BEE, the total energy consumed by the MSME sector was around 19. 9 Million tons of oil equivalent (Mtoe). However, the study included only 19 sub-sectors, covering 36 clusters (TERI, 2012). Given the diversity and distribution of MSME clusters in India, the overall energy consumed by the sector is expected to be higher, if all the clusters were to be included in their entirety.

Though detailed information on energy consumption and emission is not available for the informal sector, policies and schemes introduced by the Ministry of MSME and BEE, for sustainable growth, are appreciable. BEE's programme on improving energy efficiency in Small and Medium-sized Enterprises (SME) aims to reduce energy consumption by 1.75 Mtoe during the 12th Five Year Plan (2012–17) (MoP, 2012). The Small Industries Development Bank of India (SIDBI), which works on supporting financial and developmental requirements in the MSME sector, has started providing support for sustainable development of this sector (SIDBI, 2016). MSMEs can use this scheme for implementing energy savings, waste management and emission-reduction technologies. Another scheme—Zero Effect, Zero Defect (ZED), launched in 2016—aims to reduce the adverse effects of MSME products on the environment (MSME, 2016). Despite having several schemes and policies aimed at this sector, the lack of information on current energy consumption and GHG emissions will be a major challenge in implementing these schemes.

The study undertaken by CSTEP analysed the carbon footprint of the informal sector due to fossil fuel consumption. The study yielded policy interventions that can be considered for the substantial growth of the informal sector, while reducing the carbon footprint.

3. Methodology for Estimating GHG Emissions from Informal Sectors

The carbon footprint of the informal sector has been assessed using the Intergovernmental Panel on Climate Change (IPCC), AR5 as guidelines (IPCC, 2007) (Myhre, et al., 2013). Fossil fuels are consumed mainly for heating purposes or as raw material, by this sector. Emission of each GHG is estimated from fuel-consumption data, the calorific value of the fuel used and corresponding emission factor of each gas in tonne/Tera Joule (t/TJ). The default emission factors from IPCC publications have been used wherever country–specific emission factors were not available.

As detailed records on types of industries with fuel consumption are not available, data is mostly derived from various published reports. The data is collected from various government reports (MSMC, 2017), (MoC, 2016), (CSO, 2017), (CSO, 2016). In this study, we have quantitatively estimated GHGs such as CO_2, CH_4 and N_2O. Figure 3 provides a diagrammatic representation of the approach taken for GHG estimation in the informal sector.

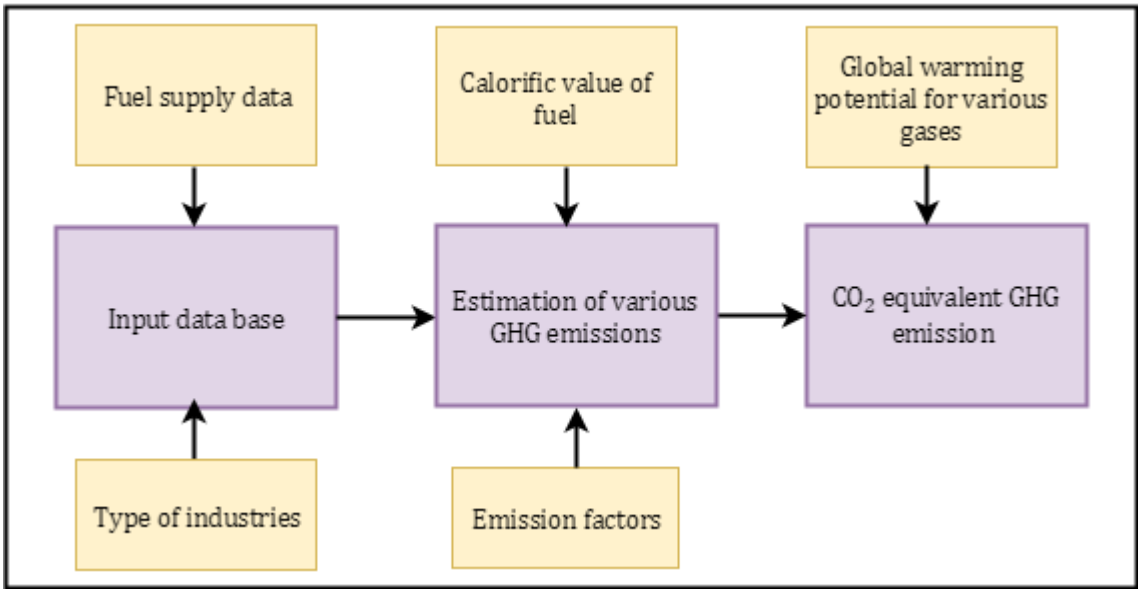

Figure 3: Diagrammatic representation of approach for GHG estimation in the informal sector

The major industries in the informal sector that consume coal are coking, coal/coke briquetting, potteries, agro/food processing, textile (finishing and dyeing), brick kilns and rubber. Unlike the core industries such as cement and steel manufacturing, the type of coal (coking and non-coking) varies depending on its availability in the informal sector. The types of industries considered in this analysis and the available data on annual coal consumption are listed in the Annexure.

The petroleum products used by the informal sector are kerosene, diesel oil, furnace oil, Low Sulphur Heavy Stock (LSHS) and Liquefied Petroleum Gas (LPG). For petroleum products, the industry-wise fuel consumption data is not available. The overall GHG emissions are calculated using the equations given below:

Equation 1

$$CO_2\ emissions\ (kt) = \left(\sum_{i=1}^{n} Emission\ factor\ of\ CO_2\left(\frac{kt}{TJ}\right) * fuel\ consumption_i(kt)\ * NCV\left(\frac{TJ}{kt}\right)\right)$$

Equation 2

$$CH_4\ emissions\ (kt) = \left(\sum_{i=1}^{n} Emission\ factor\ of\ CH_4(\frac{kt}{TJ}) *\ fuel\ consumption_i(kt)\ * NCV(\frac{TJ}{kt})\right)$$

Equation 3

$$N_2O\ emissions\ (kt) = \left(\sum_{i=1}^{n} Emission\ factor\ of\ N_2O(\frac{kt}{TJ}) *\ fuel\ consumption_i(kt)\ * NCV\ (\frac{TJ}{kt})\right)$$

Where, *i* is the type of sectors or industries.

Equation 4

$$Total\ GHG\ emissions\ (MtCO_2e) = [\ CO_2\ emissions\ (kt) + (CH_4\ emissions\ (kt) * GWP\ of\ CH_4) + (N_2O\ emissions\ (kt) * GWP\ of\ N_2O)] * 10^{-3}$$

Where, GWP is the Global Warming Potential[1] that converts gas emissions, other than CO_2, to a CO_2 equivalent form. The GWP for major gases are shown in Table 1 (Green House Gas Protocol , 2014) (Myhre, et al., 2013).

For gaseous fuels (such as natural gas), we have used the fuel consumption data and calorific value, in terms of volume, for the required estimation. The general equation to estimate emission of pollutant *A* for gaseous fuels is given as:

Equation 5

$$Emission\ of\ pollutant\ A(kt) = \left(\sum_{i=1}^{n} Emission\ factor\ of\ pollutant\ A\ (\frac{kt}{TJ}) * fuel\ consumption_i(MMSCM) * Net\ Calorific\ value\ of\ fuel\ (\frac{TJ}{MMSCM})\right)$$

Table 1: Global warming potential for various GHGs

GHGs	GWP
CH_4	28
N_2O	265

Assumptions Made for the GHG Analysis

Based on the available fuel consumption data for the informal sector, assumptions were for estimating the GHG emissions. Based on the type of assumption, they have been divided into process-based and product assumptions.

[1] Global warming potential of a gas is its total warming impact, relative to CO_2, over a given period, usually 100 years.

The major processes in the informal sector include coking of coal, coal/coke briquetting and process heating. Coking of coal involves the heating of raw coal in the absence of air at 2,000^{0}C in a coke oven to remove all the impurities and produce coke (a pure form of carbon).

Coking coal is mainly used as a reducing agent in the iron and steel industry. Another industry that processes coal is the briquetting industry. Small blocks of agglomerated coal or coke are produced by mechanical pressing and binding, with cow dung as the key binder. The briquettes made by this process are used primarily for domestic purposes. The key assumptions made for the analysis are given below.

Process-Based Assumptions

- The GHG emission factor of coal during the coking process is derived from the composition of the coke oven gas (USEPA, 2015).
- Zero GHG emissions are considered for briquetting as it involves only physical processes.
- Data on the quantity of different coal grades[2] supplied to the informal sector is not available; therefore, a country-specific emission factor for sub-bituminous coal was considered for all combustion processes.

Resource/Product-based Assumptions

Out of the 80.79 Mt of coal consumed by the informal sector in 2015–16, the classification based on the type of industries is available only for 45.7 Mt (accounting for consumption in states such as West Bengal, Maharashtra, Madhya Pradesh, Odisha and Gujarat). Among them, the informal sector in West Bengal is the largest consumer. Similarly, for 2014–15, the industry-wise data for 45% of the coal supplied to the informal sector is available (refer Table 6). The percentage shares of fuel consumed for each process were derived from the data available for 2015–16.

- It was observed from the 2015–16 data that the coal/coke briquettes industries are located mostly in West Bengal. Therefore, for our analysis, it was assumed that all the coal and coke briquetting industries are located in this state. Also, 28% of the total coal supplied to the informal sectors in 2015–16 was consumed by the coal briquetting industries. This percentage was used in all the other years for GHG estimation.
- The share of coal consumed for coking coal production was also unavailable. Therefore, it has been assumed that the available coal data captures the total coal usage for the coking process. The percentage thus obtained from 2015–16 data (~0.03%) has been used for GHG estimation in all the years.
- The emission factors for three GHGs are shown in
- Table 2 (USEPA, 2015), (IPCC, 2014), (Ramachandra, Aithal, & Sreejith, 2015).

Table 2: GHG emission factor for solid fuel-based processes

Process	Emission factor (kt/TJ)		
	CO_2	CH_4	N_2O
Coal combustion[3]	95,810	10	1.5
Coking process[4]	44,410	0. 45	9.48E-08
Coal/Coke briquetting	0	0	0
Lignite combustion[3]	92,600	1	1.5

[2] Emission factors depends on coal composition and calorific value
[3] (Ramachandra, Aithal, & Sreejith, 2015)
[4] (USEPA, 2015)

GHG estimation, owing to the consumption of other petroleum products, was also carried out. The quantities of LPG, naphtha, kerosene, HSDO, LDO, FO, LSHS/HHS and natural gas consumed by the informal sector have been collected from various publications by the Ministry of Petroleum and Natural Gas (MoPNG, 2014-15) (CSO, 2017), (CSO, 2016). The overall emissions from this sector were estimated based on the methodology discussed earlier. The emission factors for three GHGs were collected from various sources (USEPA, 2015) (IPCC, 2014) and have catalogued in Table 3.

Table 3: GHG Emission Factor for various Petroleum Products

Fuel	Emission factor (kt/TJ)		
	CO_2	CH_4	N_2O
Liquefied Petroleum Gas (LPG)	63,100	5	0.1
Naphtha	73,300	3	0.6
Kerosene	71,900	10	0.6
High Speed Diesel Oil (HSDO)	74,100	3	0.6
Light Diesel Oil (LDO)	74,100	3	0.6
Furnace Oil	77,400	3	0.6
Low Sulphur Heavy Stock (LSHS)	73,300	3	0.6
Natural gas	56.100	1	0.6

The Net Calorific Value (NCV) for different petroleum fuels is given in Table 4 (Ramachandra, Aithal, & Sreejith, 2015).

Table 4: NCV for different fuels

Fuel	NCV (TJ/ kt)
Sub-Bituminous Coal	19.6
Lignite	14.2
Liquefied Petroleum Gas (LPG)	47.3
Naphtha	44.5
Kerosene	43.8
Diesel Oil (LDO/HDO)	43.3
Furnace Oil	40.2
Low Sulphur Heavy Stock (LSHS)	40.1
Natural Gas	48.6

4. Results and Discussion

The overall GHG emission from the informal sector was estimated based on the methodology described earlier. The trends in year-wise coal consumption by the informal sector are shown in Figure 4.

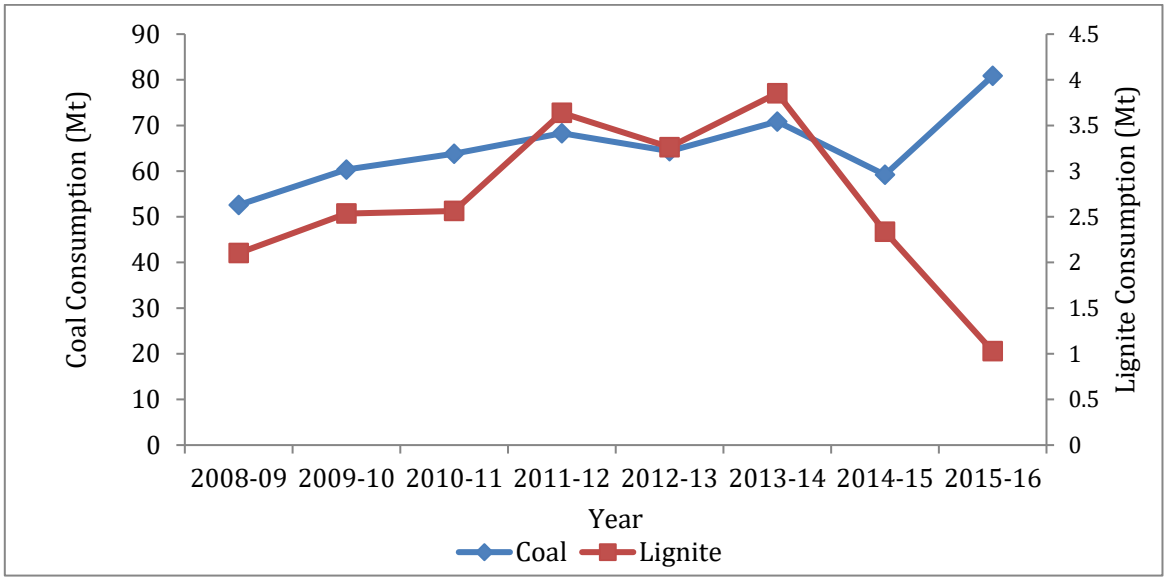

Figure 4: Year-wise coal and lignite despatch to the informal sector

The coal and lignite consumption by the informal sector varied at a CAGR of 6.34% and –9.7%, respectively, since 2008–09. Based on the coal consumption data, GHG emissions from this sector were estimated as per the IPCC methodology. The carbon footprint, in $MtCO_2e$ (shown in Table 5) has been calculated from GHG emissions, using Equation 4.

Table 5: GHG emissions from informal sectors due to solid fuels

Year	Quantity (Mt)				GHG emissions $MtCO_2e$				Total GHG emissions
	Coal	Lignite	Coking process	Coal/Coke briquetting	Coal	Lignite	Coking process ($\times 10^{-2}$)	Coal/Coke briquetting	$MtCO_2e$
2008–09	37.81	2.10	0.02	14.78	60.38	2.78	1.38	0	63.18
2009–10	43.38	2.54	0.02	16.95	69.27	3.35	1.58	0	72.64
2010–11	45.88	2.56	0.02	17.93	73.26	3.39	1.67	0	76.67
2011–12	49.11	3.64	0.02	19.19	78.42	4.81	1.79	0	83.25
2012–13	46.28	3.26	0.02	18.08	73.90	4.31	1.68	0	78.23
2013–14	50.95	3.85	0.02	19.91	81.36	5.10	1.85	0	86.48
2014–15	42.56	2.34	0.02	16.63	67.97	3.09	1.55	0	71.08
2015–16	58.14	1.03	0.03	22.72	92.85	1.36	2.12	0	94.23

The overall GHG emission due to coal consumption has increased from 63 $MtCO_2e$ to 94 $MtCO_2e$. Using the available data on industry-wise coal supply, in 2014–15 and 2015–16, for 27 categories, the emissions were calculated and the results are provided in Table 6. A detailed table on the types of industries is included in the Annexure. It was observed that within the informal sector, coal/coke briquetting, pottery, textile and the food industry are the major consumers of coal.

Table 6: Industry-wise GHG emissions due to coal consumption

Industries within the informal sector	Coal (Mt)		GHG ($MtCO_2e$)	
	2014–15	2015–16	2014–15	2015–16
Agro processing	0.025	0.031	0.047	0.058
Animal feed/products	0.026	0.013	0.049	0.025
Brass	n/a[5]	0.004	n/a	0.007
Brick	0.091	0.037	0.172	0.070
Cement	n/a	0.002	n/a	0.005
Ceramic	3.168	0.052	5.985	0.098
Chemical/Fertilisers	1.827	0.048	3.451	0.090
Construction products	0.068	0.018	0.128	0.033
Cookware/Domestic appliances	n/a	0.003	n/a	0.006
Food processing	4.221	3.101	7.974	5.858
Textile	6.400	n/a	12.090	0.078
Limestone powder/Lime	n/a	0.016	n/a	0.030
Machine manufacture	0.189	0.032	0.357	0.061
Milk products	0.341	0.003	0.644	0.006
Mineral processing	n/a	0.015	n/a	0.028
Mining/Ore processing	0.183	0.010	n/a	0.019
Palm products	n/a	0.008	n/a	0.016
Paper/Crafts	1.870	0.011	3.533	0.021
Pharmaceutical	0.822	0.008	1.553	0.016
Pottery	n/a	2.352	n/a	4.442
Printing	0.003	0.004	0.006	0.008
Refractories	n/a	0.016	n/a	0.030
Rubber	0.010	0.007	0.019	0.013
Welding equipment	n/a	0.004	n/a	0.008
Plastic products	n/a	0.001	n/a	0.002
Other industries/Individual buyers	n/a	17.045	n/a	32.200
Coal briquettes / Coke briquettes	n/a	22.722	0.000	0.000
Coal processing	n/a	0.035	0.000	0.000
Coke oven manufacture	0.009	n/a	0.008	n/a
Coking	n/a	0.028	n/a	0.024
Foundries	0.003	n/a	0.006	n/a
Soaps/Detergents	4.997	n/a	9.440	n/a
Total	**24.25**	**45.67**	**45.46**	**43.25**

The overall GHG emissions from the industries within the informal sector that consume petroleum and natural gas were estimated using the fuel supply data and IPCC methodology. A summary of the GHG emissions is given in Table 8.

[5] n/a means data is not available.

Table 7: Petroleum Product Consumption in the Informal Sector

Year	Consumption (kt)							MMSCM
	LPG	Naphtha	Kerosene	HSDO	LDO	FO	LSHS/HHS	Natural gas
2008–09	63	693	128	1,469	179	3,848	526	3,420
2009–10	62	559	134	1,603	150	3,653	320	7,272
2010–11	73	154	139	2,170	179	3,516	482	7,546
2011–12	70	163	123	2,262	178	2,916	291	9,064
2012–13	44	203	115	2,319	174	2,356	149	7,976
2013–14	45	240	48	1,425	181	1,984	44	7,479
2014–15	52	207	117	1,748	164	2,175	47	5,934
2015–16	60	37	113	1,922	184	2,564	29	4,110

Table 8: GHG emissions from the informal sector due to the consumption of petroleum products

Year	$MtCO_2e$ for the informal sector							
	LPG	Naphtha	Kerosene	HSDO	LDO	FO	LSHS/HHS	Natural Gas
2008–09	0.19	3.63	0.41	4.70	0.58	11.95	1.55	6.60
2009–10	0.19	2.02	0.42	5.13	0.48	11.35	0.94	14.03
2010–11	0.22	1.33	0.44	6.94	0.57	10.92	1.42	14.56
2011–12	0.21	0.59	0.39	7.23	0.57	9.06	0.86	17.48
2012–13	0.13	1.08	0.37	7.42	0.56	1.09	0.44	15.38
2013–14	0.14	0.68	0.15	4.56	0.58	0.96	0.13	14.41
2014–15	0.16	0.63	0.37	5.59	0.53	0.61	0.14	11.44
2015–16	0.22	0.16	0.36	6.14	0.59	0.84	0.09	7.90

The year-wise overall GHG emissions from the informal sector have been summarised in Figure 5. On the y-axis of Figure 5, the gaseous fuel comprises natural gas; liquid fuel includes LPG, naphtha, kerosene, diesel oil and furnace oil; and solid fuel refers to coal and lignite.

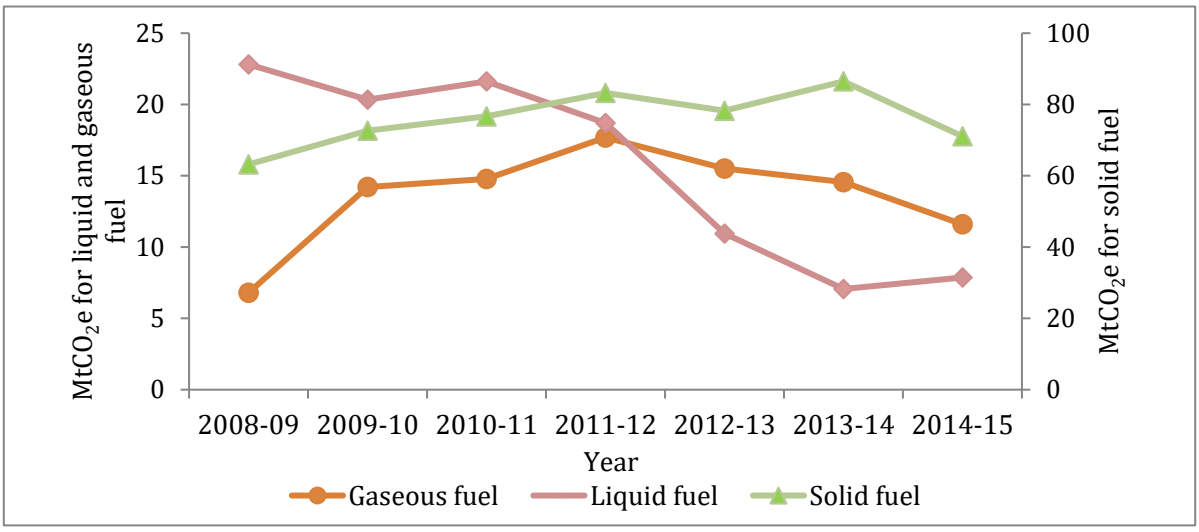

Figure 5: GHG emissions from the informal sector

GHG emissions in 2010 (calendar year) from the informal sector due to conventional fuel consumption were estimated at 112 Mt (6% of the total net emissions specified in the first BUR report). Of that, solid fuels such as coal and lignite contributed the maximum share, with a CAGR

of 5.8% in 2015–16, as compared to 2008–09. The consumption of gaseous fuels has increased, leading to an increase in the import of natural gas and domestic natural gas exploration.

Comparison with other Inventories

GHG emissions from non-specific industries were compared with India's BUR and the results are provided in Table 9.

Table 9: Comparison with Other Inventories

Year	GHG ($MtCO_2e$)	
	CSTEP Estimate	**BUR**
2010	113	130 (MoEFCC, 2015)
2007	93*	88 (INCCA, 2010)

**2008–09 estimation*

The difference in values can be attributed to the assumptions made for the analysis.

Limitations

Lack of publicly available data and the complexity and diversity of the sector posed major challenges in our attempts to estimate the GHG emissions from India's informal sector.

The industry-wise data on consumption of petroleum products and natural gas was not publicly available. Also, industry-wise data for only 55% of the total coal consumed by this sector was accessible.

Policy Implications

India plans to reduce its carbon emissions intensity per unit of GDP by 33–35% from the 2005 levels by 2030, given its commitments to the Paris Agreement (PIB, 2015). Therefore, it is important to understand and analyse the GHG emissions of relatively under-explored areas such as the informal sector. Prioritising the establishment and implementation of policies and schemes to improve energy efficiency in this sector will not only decrease fuel consumption, but also reduce GHG emissions. Promoting the use of renewable energy is another suitable option to reduce GHG emissions. Subsidies and finances can be provided extensively to set up off-grid renewable energy utilities in MSME units.

Additionally, a transparent monitoring system to record fuel consumption by various industries in the informal sector is required. This will aid in the accurate estimation of energy consumption and related emissions, thereby facilitating the implementation of effective policies for the growth of the informal sector with a minimal carbon footprint.

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6. Annexure

Type of industries, with sub-categories, considered for the analysis, with coal consumption.

Industries within the informal sector	Coal 2015-16 (Mt)
Agro processing	**0.03096**
Animal products	**0.013**
Feed	0.005
Other products for animals	0.008
Brass	**0.0039**
Brick	**0.03718**
Cement	**0.00240**
Ceramic	**0.05212**
Chemical/fertilisers	**0.04753**
Industrial chemicals	0.04468
Metals	0.00286
Construction products	**0.01760**
Tiles	0.004
Steel fabrications	0.00826
Pigments	0.00329
Other construction products	0.00192
Cookware manufacturing	**0.0030**
Food processing	**3.1008**
Oil milling	0.0196
Milk products	0.0029
Other food processing industries	0.0343
Gur (Jaggery)	3.0440
Textile	**0.0414**
Dyeing	0.0042
Printing	0.0042
Other textile processing	0.0330
Limestone/lime	**0.016**
Machine manufacture	**0.03235**
Metal parts	0.02400
Other machine parts	0.00835
Mineral processing	**0.0147**
Mining	0.01050
Ore processing	0.00420
Palm products	**0.008**
Paper/crafts	**0.011**
Pharmaceutical	**0.00835**
Pottery	**2.35164**
Printing	**0.004**
Refractories	**0.016**
Rubber	**0.007**

Welding equipment	**0.004**
Plastic products	**0.001**
Other Industries/individual buyers	**17.045**
Briquetting	**22.722**
Coal	9.048
Coke	13.673
Coke manufacturing	**0.028**
Coal processing	**0.02704**
Total	**45.67**

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