

Sector: Energy



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This document contains the scope of time-series emission estimation for India covered by CSTEP, the sub-sector wise data sources and methodology used, results and comparisons with official emission estimates.

Scope

For the first phase of India GHG Platform, CSTEP's task was to obtain a bottom-up emissions estimation between 2007 and 2012 (inclusive of both) for the following sub-sectors in Energy, as per Inter-Governmental Panel for Climate Change's (IPCC) reporting structure (refer Figure 1):

1. 1A1a- Electricity Generation
2. 1A3- Transport
3. 1A4- Other Sectors
4. 1B- Fugitive Emissions

In addition, a comparison with the official GHG emission estimates available for 2007 and 2010 was undertaken. The official reports referred to are the India Greenhouse Gas Emissions 2007 prepared by Indian Network for Climate Change Assessment (INCCA), Ministry of Environment and Forests (MoEF) and the First Biennial Update Report to United Nations Framework Convention for Climate Change prepared by MoEF.

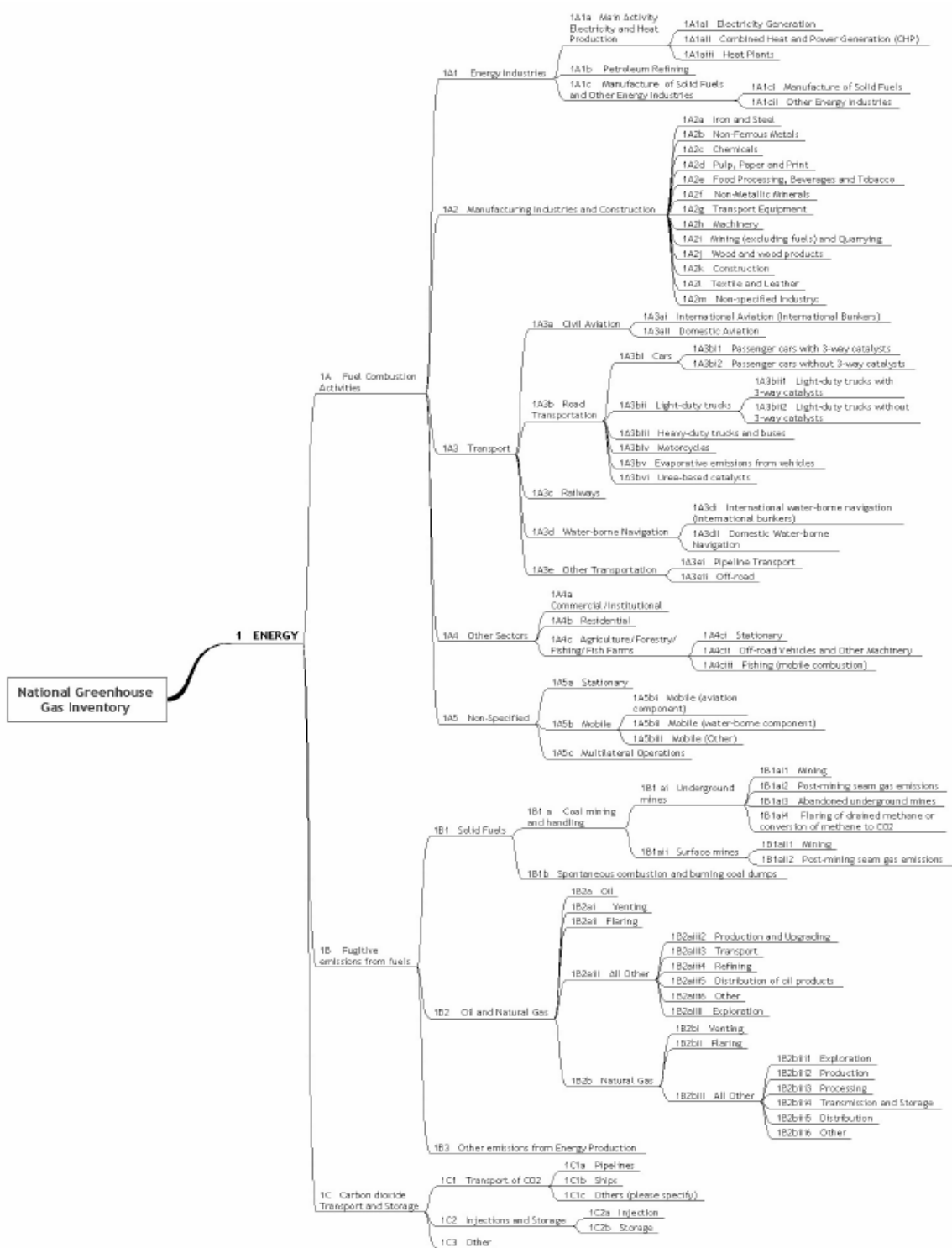


Figure 1: Activity and Source Structure in the Energy Sector (IPCC 2006)

Data Sources and Methodology

IPCC 2006 methodology has been followed for calculating emissions from the sectors mentioned above. The reporting structure followed is similar to INCCA (2010) report. Emissions are obtained by multiplying activity data for a specific fuel or fuel type with its associated Emission Factor (EF).

Emissions = Activity Data * Emission factor

A mix of Tier I and Tier II EF's are used from national and IPCC default EFs and IPCC Good Practice Guidance documents. The GHGs accounted for are Carbon Dioxide (CO₂), Methane (CH₄) and Nitrous Oxide (N₂O). Fuel calorific values are obtained from INCCA (2010) report. In case of liquid and gaseous fuels, density assumptions are taken from the Ministry of Petroleum and Natural Gas (MoPNG).

Electricity Generation

Emissions in this sector pertain directly to the amount of fossil fuels (coal, oil and gas) used for generating electricity in utility-based and captive (non-utility) power plants of 1 Mega-Watt (MW) or above.

Utilities

- Year-wise activity data is obtained from CEA General Review Reports 06-07 to 14-15. Data for the Financial Year (FY) 2011-12 was not available and the emissions for this year are interpolated using previous and next years' values.

Non-Utilities

- Year-wise data on electricity generation from captive power plants (except for FY 2011-12) was obtained from CEA General Review.
- To estimate fuel use, heat rates in captive plants were taken to be five percent higher than utilities for each fuel type, based on International Development Finance Corporation's (IDFC) India Infrastructure Report.
- Data on heat rates from utility plants was obtained from CEA General Review reports (for coal), CEA CO₂ baseline studies (for diesel) and CSE's Challenge of the New Balance (2010) report (for gas).

General Information:

- CEA General Review (GR) reports use 'Steam' and 'Coal' interchangeably to denote the primary fuel source. We confirmed this by comparing *Table 3.1: All India Installed Electricity Generation Capacity Mode-wise Utilities and Non- Utilities 31.03.2013* of General Review 2012-13 and *Table 1: Sector-wise Installed Capacity (MW) as on 31.03.2012*. The installed capacity for Steam in the former and Coal in

the latter in 2011-12 was identical- 112,022.38 MW. Moreover, steam-based captive generation from Waste Heat Recovery is reported separately in the GRs, and we have not included this in the activity data for coal/steam in electricity generation.

- For secondary fuel use in Coal power plants, the GRs report 'LDO/HSD' or 'LSHS/HHS' among the secondary fuels. In this case, an average of the fuel properties (density, NCV, EF) is used by default. Fuel properties for HHS are not available, so the properties for LSHS, which is also a heavy distillate, are used.

Transport

Emissions in the transport sector are categorised into four modes: Road, Rail, (Civil) Aviation¹ and Shipping. Within each of these modes, emissions from different fuels is separately estimated

Road

- Fuels used: Motor Spirit (petrol), High Speed Diesel Oil (HSDO), Liquefied Petroleum Gas (LPG), Light Diesel Oil (LDO), Furnace Oil (FO), and Compressed Natural Gas (CNG)
- The main source for fuel consumption estimates was MoPNG's Indian Petroleum and Natural Gas Statistics (2011-12 to 2014-15)
- For FY 2006-07, sector-wise and mode-wise fuel estimates are not available in the reports mentioned above due to differences in the reporting structure. In this case the 2007-08 shares of different fuels were attributed to 2006-07
- For HSDO, it was discovered only direct sales are reported in the MoPNG statistics and the retail shares are reported under 'miscellaneous' category. In such a case, the All India Sectoral Demand of Diesel and Petrol report by Petroleum Planning Analysis Cell (PPAC) was used to estimate the share of HSDO for retail consumption in road transport in FY 2011-12 and 2012-13. For the remaining years, statistics from National Institute of Public Finance and Policy's (NIPFP) paper on Diesel Pricing in India (2012) were used.
- For CNG, MoPNG statistics on Natural Gas Activities in India for FY 2007-08 to 2011-12 and Ministry of Statistics and Programme Implementation's (MoSPI) All India Electricity Statistics for FY 2012-13 were used. FY 2006-07 and 2007-08 data on CNG consumption was abnormally low as per these reports, so historical consumption trends were interpolated to attribute the fuel-use, which turned out to be roughly 64% of total CNG consumption in the domestic sector.

Railways

- Fuels Used: HSDO, LPG, LDO, FO and coal (for traction).

¹ 'Aviation' refers to civil aviation only since military aviation is neither reported nor considered in the national GHG inventories.

- The main source for the fuel consumption estimates was the Ministry of Petroleum and Natural Gas' (MoPNG) Indian Petroleum and Natural Gas Statistics (2011-12 to 2014-15)
- For FY 2006-07, sector-wise and mode-wise fuel estimates are not available in the above reports due to difference in the reporting structure. In this case the 2007-08 shares of different fuels were attributed to 2006-07.
- Coal use for traction was obtained from the Ministry of Railways, Indian Railways Year Books 2006-07 to 2013-14
- HSDO consumption from railways sector was cross-checked with the Indian Railways Statistical Publications

Aviation

- Fuels Used: Aviation Turbine Fuel (ATF) and HSDO
- The main source for the fuel consumption estimates was the Ministry of Petroleum and Natural Gas' (MoPNG) Indian Petroleum and Natural Gas Statistics (2011-12 to 2014-15)
- For FY 2006-07, sector-wise and mode-wise fuel estimates are not available in the reports mentioned above due to difference in the reporting structure. In this case, the 2007-08 shares of different fuels were attributed to 2006-07.
- The final CO₂ emission estimates was cross-checked with the Directorate General on Civil Aviation's Carbon footprint of Indian Aviation report and the IPCC default emission factors for mobile combustion with International Civil Aviation Organisation's Guidance Material for the Development of State Action Plan report (2011)

Navigation

- Fuels Used: HSDO, LDO, and FO
- The main source for the fuel consumption estimates was the Ministry of Petroleum and Natural Gas' (MoPNG) Indian Petroleum and Natural Gas Statistics (2011-12 to 2014-15)
- For FY 2006-07, sector-wise and mode-wise fuel estimates are not available in the reports mentioned above due to difference in the reporting structure. In this case the 2007-08 shares of different fuels were attributed to 2006-07.

Others

Other sub-sectors include energy consuming activities in residential, commercial, agricultural and fisheries sectors. The activity data for this sector represents the fuel consumption used for specific applications such as cooking, lighting, heating, use of small (< 1 MW) Diesel Generator (DG) sets, drying of field produce, operation of tractors, diesel pump-sets, other farm implements, and fishing fleet.

Residential and Commercial

Fuelwood, Coke Coal and Charcoal

- Per Capita Monthly Consumption (PCMC) from rural and urban households obtained from NSSO's 61st (2004-05), 66th (2009-10) and 68th (2011-12) rounds
- PCMC from NSSO's 64th round was cited in TERI Energy Data Directory & Yearbook (TEDDY) 2010
- PCMC for remaining years was linearly interpolated, and PCMC for 2012-13 was assumed to be the same as that for 2011-12
- India State of Forest (2011) report published by Forest Survey of India (FSI) also reported some data on household fuel-wood consumption, and this was found to be in line with NSSO's consumption surveys.
- The PCMC was converted to aggregate absolute fuel consumption using population data from Census 2001 and 2011 rounds and World Bank Database, and year-wise urbanisation rate from United Nations Department of Economic Affairs (2014).

LPG

- Data for FY 2007-08 to 2012-13 obtained from MoPNG's Petroleum and Natural Gas Statistics Reports of 2013-14 and 2014-15
- Data for FY 2004-05 was obtained from an MoPNG presentation titled India LPG Market Prospects (2010)
- Data point for 2006-07 was linearly interpolated between the data of 2004-05 and 2007-08.

Kerosene

- Data for FY 2007- 08 to 2012-13 obtained from MoPNG's Petroleum and Natural Gas Statistics Reports of 2013-14 and 2014-15
- Data for 2006-07 was obtained from an International Institute for Sustainable Development (IISD) report titled Kerosene Subsidies in India (2014).

Natural Gas

- Piped Natural Gas (PNG) was calculated as a residual after deducting transport sector's share from the total domestic fuel consumption category in MoPNG statistics

Diesel

- Diesel consumption from DG sets is not directly available.

- Total number of DG sets under different capacity categories (1-15 kilo-Watt (kW), 15-75 kW, and 75-800 kW) and diesel consumed in 2012-13 were obtained from a Shakti report titled Improving the Efficiency of Diesel Generators.
- DG sets in the categories up to 75 kW are assumed to operate in households; higher sizes used in commercial enterprises.
- Growth in market size of DG sets between 2009-10 and 2012-13 has been used as representative of growth in use, and consequently growth in diesel consumption, assuming similar efficiencies across the years.

Agriculture

Low Sulphur Heavy Stock (LSHS), Furnace Oil and LPG

- Data for FY 2007-08 to 2012-13 obtained from MoSPI's Petroleum and Natural Gas Statistics Reports of 2013-14 and 2014-15. Data for 2006-07 is taken to be the same as 2007-08 (negligible value).

Diesel (HSDO and LDO)

- Bulk sale of diesel to the sector for FY 2007-08 to 2012-13 obtained from MoPNG's Petroleum and Natural Gas Statistics Reports of 2013-14 and 2014-15 and balanced with data from NIPFP's report on Diesel Pricing in India (2012), which reports share of diesel going to agriculture sector for FY 2008-09, 2009-2010, and 2010-11
- Share of diesel consumed from retail sale is obtained from a PPAC report titled All India Study on Sectoral Demand of Diesel and Petrol

Fisheries

Diesel

- Total diesel consumption by Indian fishing fleets in 2005 and 2010 were reported in a Current Science paper titled Carbon Footprint by Marine Fishing Boats of India (2013). The intermediate and future years up to 2013 are obtained through exponential interpolation and extrapolation

Kerosene

- As reported over a telephonic interview with Central Marine Fisheries Research Institute (CFMRI) kerosene consumption has declined to 10% of diesel consumption in the sector due to decline in share of motorised vessels (inboard engines) versus mechanised vessels (outboard engines)
- As per the paper titled Total Factor Productivity Growth in Marine Fisheries of Kerala (2013) published in the Indian Journal of Fisheries, the rate of decline in kerosene share between 2005 and 2010 for the state is taken as representative for India, and absolute kerosene consumption for India is estimated.

Fugitive Emissions

Fugitive emissions are estimated from mining, transportation, storage and processing of solid, liquid and gaseous fuels.

Solid Fuels

- Data for total coal mined from Underground (UG) and Open Cast (OC) mines is obtained from MoSPI's Energy Statistics
- Share of coal extracted from UG and OC mines is taken from Provisional Coal Statistics report by the Ministry of Coal (MoC).

Liquid and Gaseous Fuels

- Data on the number of wells, oil produced and refinery throughput is obtained from MoPNG's Petroleum and Natural Gas Statistics reports
- Data on the amount of natural gas produced, flared, processed, and distributed is also derived from MoPNG's Petroleum and Natural Gas Statistics reports. Natural gas processed is what is available after deducting the portion of gas flared from total production. Own consumption of natural gas is deducted from this figure to arrive at the amount of natural gas distributed. The leakages during the extraction process are taken from a report titled Fugitive Emission and Greenhouse Warming by R. Muller.

Results and Discussion

This section gives the summary results of the exercise and comparison with the official inventories for 2007 and 2010 as provided in MoEF's INCCA (2010) and First Biennial Update (FBU; 2015) reports. While the activity data described in the section above is available in FY terms, the official emissions are reported for the Calendar Years (CY). However, it is not clear from the official documents whether:

1. The activity data used is on FY or CY basis
2. The current or next FY activity is used to report CY emissions in the current year.

Given these information gaps, the results are provided on FY basis and compared with official CY emission estimates. To convert FY into calendar year, the following equation can be used:

$$\text{CY Emissions}_t = (1/4 \times \text{FY Emissions}_t) + (3/4 \times \text{FY Emissions}_{t+1})$$

However, it is difficult to explain any difference on this basis since there is very little information about the activity data used in official estimates.

Electricity Generation

Table 1 shows the total emissions from utility and captive electricity generation plants. Emissions have grown at almost 7% annually, with CO₂ accounting for over 99% of the emissions.

Table 1: Emissions from Electricity Generation

EMISSIONS (MT CO ₂ e)	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13
Utility	639	685	728	765	804	860	932
Captive (>1 MW)	82	86	101	106	124	129	141
Total	721	771	829	871	928	989	1074
MoEF	719			820			

The official estimates provide aggregate emissions from electricity generation in the country. The emissions from utility-based and captive plants are not separately provided. CSTEP's 2006-07 aggregate emission estimates roughly match with the official estimates for 2007. However, the 2009-10 estimates are 6% higher than official numbers. It is worthwhile to note that the 2008-09 estimation is much closer to official estimate for 2010. Since no information about activity data is provided in the BUR, it is possible that the activity data for 2008-09 may have been used in the 2010 official estimates of emissions from electricity generation, or part of the emissions may have been accounted elsewhere (eg. industry).

Transport

Table 2 and Table 3 provide CSTEP's time series estimates and official estimates from MoEF of the emissions from the Transport sector. From CSTEP's estimates, GHG emissions have grown at the rate of 7.5% annually between 2006-07 and 2012-13.

Table 2: Emissions from Transport Sector

Emissions (MTCO ₂ e)	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13
Road	129	144	142	157	170	193	205
Aviation	12	14	14	14	15	17	16
Rail	7	7	8	8	8	9	9
Navigation	3	3	4	4	4	3	2
Total	151	168	168	183	197	221	233

Table 3: Official emission estimates for Transport Sector

Emissions (MT CO ₂ e)	INCCA (2007)	BUR (2010)
Road	124	164
Aviation	10	12
Rail	7	8
Navigation	1	4
Total	142	188

CSTEP's 2006-07 aggregate emission estimates are almost 6% higher than official numbers. However for 2009-10 estimates are lesser by 3% than the official numbers. From the tables above, it is evident that road transport sector is the highest contributor to the total emissions. The higher estimates for 2006-07 can be attributed to the assumption of HSDO retail share from road transport.

Others

The emissions from energy usage in residential, commercial, agriculture and fisheries are categorised as 'other sectors' in the IPCC methodology. Table 2 shows the total emissions from these sectors. The emissions in these sectors grew at 2.19% annually, with CO₂ constituting 79% of total emissions in this sector.

Table 4: Emissions from Other Sectors

EMISSIONS (MT CO ₂ e)	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13
Residential	103	104	104	105	106	107	106
Commercial	6	7	8	9	10	11	11
Agriculture	20	18	20	22	22	26	28
Fisheries	4	4	4	4	4	4	5
Total	132	132	135	140	142	148	151

Table 5 shows the emissions reported in 2007 INCAA and 2010 BUR reports for the residential, commercial, agriculture and fisheries sectors. It can be seen that the emissions from residential and agriculture/fisheries sector have reduced by 15% and 56%, respectively from 2007 to 2010. Given that non-electric energy consumption in these sectors has increased over the years based on official documents, it can be inferred that the reduction

reported between 2007 and 2010 can be attributed to change in accounting and/or reporting method. The emissions from commercial sector have increased by 42% during this period, whereas the overall emissions have reduced by 47%.

Table 5: Official emission estimates from 'Other' Sectors

EMISSIONS (MT CO ₂ e)	INCCA 2007	BUR 2010
Residential	138	85
Commercial	2	5
Agriculture/Fisheries	34	3
Total	173	92

Comparing Table 4 and

Table 5, CSTEP's 2006-07 estimates for residential and agriculture/fisheries sector are 26 and 29% less, whereas the commercial sector estimates are over two times more than official estimates. CSTEP's 2009-10 estimates are 51% higher than the official estimates. The emissions from residential, commercial and agriculture/fisheries sector are higher by 24%, 84% and 786% respectively compared to official estimates.

Our activity data suggests that in the residential sector, while the growth of some dominant fuels such as fuelwood and kerosene was negative 2007 and 2010², others such as LPG, coke, coal, natural gas and diesel registered a healthy growth³. This is owing primarily to increased electrification, higher share of modern cooking fuels (LPG, PNG) and increased use of Diesel Generator (DG) sets. As a result, emissions from this sector have increased between 2007 and 2010. In the commercial sector, our analysis indicates that the use of captive DG sets has been growing at 10% CAGR over the past decade, and they contribute to around 70% emissions from this sector. In the agriculture and fisheries sector, 98% of emissions are from diesel use, which has grown at around 6% CAGR between 2007 and 2010. The retail sales of diesel and other oil products that form a substantial part of end-use are not segregated sector-wise in the annual statistics of MoPNG. This may be the reason why emissions from such activities may not be accounted for in the official documents.

Given the multiplicity of data sources and requirement of making various assumptions and interpolations to arrive at the time series of activity data (due to different reporting formats and incompleteness of data), it is possible that the assumptions between CSTEP's and MoEF's estimates, vary, leading to inconsistent results. CSTEP has used publically available and official sources for activity data to the extent possible. Neither application-wise, nor

² -7% and -2% Compounded Annual Growth Rates (CAGR) respectively

³ 5%, 21%, 13%, 21% and 10% CAGR respectively

sector-wise activity data is provided in any of the MoEF documents for this sector, so any further conjecture on the observed differences is not feasible.

Fugitive Emissions

Table 6 shows the total fugitive emission from solid fuels, oil and natural gas mining. Emissions have grown at almost 0.8% annually between 2004 and 2013.

Table 6: Fugitive Emissions

EMISSIONS (MT CO ₂ e)	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13
Solid Fuels	20	20	21	22	21	21	21
Oil and Natural Gas	16	16	16	24	26	24	20
Total	35	36	37	45	47	44	41
MoEF	32			49			

CSTEP's estimates for 2006-07 and 2009-10 are very close to both 2007 and 2010 estimates published by INCCA and BUR. The slight difference may be due to the assumptions considered for natural gas leakage and distribution.

Bibliography

Anand, M. (2012). *Diesel pricing in India: Entangled in policy maze*. New Delhi: National Institute of Public Finance and Policy.

Bhushan, Chandra. *Challenge of the New Balance*. New Delhi: Centre for Science and Environment, 2010.

CEA. *All India Electricity Statistics, General Review 2007*. New Delhi: MoP, GoI, 2007.

CEA.. *All India Electricity Statistics, General Review 2008*. New Delhi: MoP, GoI, 2008.

CEA.. *All India Electricity Statistics, General Review 2009*. New Delhi: MoP, GoI, 2009.

CEA.. *All India Electricity Statistics, General Review 2010*. New Delhi: MoP, GoI, 2010.

CEA.. *All India Electricity Statistics, General Review 2011*. New Delhi: MoP, GoI, 2011.

CEA.. *All India Electricity Statistics, General Review 2012*. New Delhi: MoP, GoI, 2012.

- CEA. *All India Electricity Statistics, General Review 2014*. New Delhi : MoP, Gol, 2014.
- CEA. *All India Electricity Statistics, General Review 2007*. New Delhi : MoP, Gol, 2007.
- CEA.. *All India Electricity Statistics, General Review 2008*. New Delhi : MoP, Gol, 2008.
- CEA.. *All India Electricity Statistics, General Review 2009*. New Delhi : MoP, Gol, 2009.
- CEA.. *All India Electricity Statistics, General Review 2010*. New Delhi : MoP, Gol, 2010.
- CEA.. *All India Electricity Statistics, General Review 2011*. New Delhi : MoP, Gol, 2011.
- CEA.. *All India Electricity Statistics, General Review 2012*. New Delhi : MoP, Gol, 2012.
- CEA. *All India Electricity Statistics, General Review 2014*. New Delhi : MoP, Gol, 2014.
- IDFC. *India Infrastructure Report 2010*. New Delhi : Oxford University Press, 2010.
- Chandra, A. (2010). *Indian LPG Market Prospects*. Retrieved February 16, 2016, from Petroleum Federation of India: http://petrofed.winwinhosting.net/upload/Apurva_Chandra.pdf
- Chandramouli, D. C. (2011, July 15). *Rural Urban Distribution of Population (Provisional Population Totals)*. Retrieved February 2016, from Census of India: http://censusindia.gov.in/2011-prov-results/paper2/data_files/india/Rural_Urban_2011.pdf
- Clarke, K. (2014). *Kerosene Subsidies in India*. Geneva: IISD.
- CSO. (2015). *Changes in Methodology and Data Source in the New Series of National Accounts Base Year 2011-12*. New Delhi: MoSPI.
- CSO. (2015). *Energy Statistics 2015*. New Delhi: MoSPI, Gol.
- Data: Population growth (annual %)*. (n.d.). Retrieved February 16, 2016, from The World Bank: <http://data.worldbank.org/indicator/SP.POP.GROW>
- Director General of Civil Aviation. (2013). *Carbon footprint of Indian aviation, 2012*. New Delhi: Directorate General of Civil Aviation, India .
- E. Vivekanandan, V. V. (2013, August 10). Carbon Footprint by Marine Fishing Boats of India. *Current Science*, 105(3), 361-366. Retrieved November 2016
- FSI. (2011). *India State of Forest Report 2011*. Dehradun: MoEF; Gol. Retrieved from http://www.indiaenvironmentportal.org.in/files/file/india_state_of_forest_2011.pdf
- IDFC. *India Infrastructure Report 2010*. New Delhi : Oxford University Press, 2010.
- India Network for Climate Change Assessment. (2010). *India: Greenhouse Gas Emissions 2007*. New Delhi: MoEF, Gol.

- ICF International. (2014). *Diesel Generators: Improving Efficiency and Emission Performance in India*. New Delhi: Shakti Sustainable Energy Foundation. Retrieved February 2016, from <http://shaktifoundation.in/wp-content/uploads/2014/02/Shakti-Diesel-Generators-FINAL1.pdf>
- International Civil Aviation Organisation. (2011). *Guidance material for the development of State Action Plans*. Montreal: International Civil Aviation Organisation.
- IPCC. (2006). *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. Kanagawa : IPCC.
- IPCC, WHO, UNEP and IGES. *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*. Montreal: IPCC, 2001.
- Ministry of Coal. (2011-12). *Provisional Coal Statistics*. Coal Controller's Organisation . Kolkata: Ministry of Coal, GoI.
- MoEFCC. (2015). *India First Biennial Update Report to the United Nations Framework Convention on Climate Change*. New Delhi: GoI.
- MoPNG. (2011-12). *Basic Statistics for Indian Petroleum and Natural Gas*. New Delhi: GoI.
- MoPNG. (2012-13 to 2013-14). *Indian Petroleum and Natural Gas Statistics*. New Delhi: GoI.
- MoPNG. (2014-15). *Indian Petroleum and Natural Gas Statistics*. New Delhi: GoI.
- MoR. (2006-07). *Indian Railways Year Book*. New Delhi: GoI.
- MoR. (2006-07). *Indian Railways Year Book*. New Delhi: GoI.
- MoR. (2007-08). *Indian Railways Year Book*. New Delhi: GoI.
- MoR. (2008-09). *Indian Railways Year Book*. New Delhi: GoI.
- MoR. (2009-10). *Indian Railways Year Book*. New Delhi: GoI.
- MoR. (2010-11). *Indian Railways Year Book*. New Delhi: GoI.
- MoR. (2011-12). *Indian Railways Year Book*. New Delhi: GoI.
- MoR. (2014-15). *Indian Railways Statistical Publications*. New Delhi: GoI.
- MoSPI. (2015). *Energy Statistics 2015*. New Delhi: CSO, GoI.
- MoSPI. (2014). *Energy Statistics 2014*. New Delhi: CSO, GoI.
- Muller, R. (n.d.). *Fugitive methane and greenhouse warming* . Memo, Berkeleyearth, 2011.
- N. Aswathy, R. N. (2013). Total Factor Productivity Growth in Marine Fisheries of Kerala. *Indian Journal of Fisheries*, 60(4), 77-80. Retrieved 2016
- Nielson. (2013). *All India Sectoral Demand of Diesel and Petrol*. New Delhi: MoPNG, GoI.

NSSO. (2012). *NSS 66th Round, Household Consumption of Various Goods and Services in India* . New Delhi: MoSPI, Gol.

NSSO. (2014). *NSS 68th Round, Household Consumption of Various Goods and Services in India, 2011-12* . New Delhi: MoSPI, Gol.

TERI. (2010). *TERI Energy Data Directory & Yearbook 2010*. New Delhi: TERI.

World Urbanization Prospects: The 2014 Revision. (n.d.). Retrieved February 16, 2016, from United Nations: <http://esa.un.org/unpd/wup/DataQuery/>

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