

National Level Greenhouse Gas Estimates

2005 to 2018

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**Methodology Note for
Emissions Estimates
of Captive Power Plants**

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Key Highlights¹

- The total installed capacity of captive power plants (CPP) in India for 2017- 18² was 54.93 GW and it increased by ~37% to total 75.21 GW installed captive power capacity in 2018-19³ (see Table 1).

Year	Steam (Coal)	Diesel	Gas	Wind	Solar	Hydro	Total
2017-18	32.85	13.15	7.16	1.51	0.22	0.05	54.93
2018-19	47.68	15.57	8.79	2.00	1.06	0.10	75.21

- In 2018, the fossil-fuel powered CPP generated 199,753.18 GWh of electricity in India. The contribution of Steam, Gas and Diesel generation to fossil-fuel powered captive generation was 87.18%, 10.51% and 3.02%, respectively.
- The total emissions from CPP increased at a rate of 7.94% (compounded annually), from 75.20 Mt CO₂e in 2005 to 203.07 Mt CO₂e in 2018. Its share in total Energy sector emissions in 2018 was ~8.27%, and in economy-wide emissions was ~6.88%.
- Within the CPP emissions, almost 94% of all-India emissions emanated from coal-powered plants in 2018. This was followed by emissions from gas-based power plants (~5%) and diesel-based power plants (~2%).
- Table 2 shows that CO₂ was a leading GHG in CPP emissions

CO ₂	CH ₄		N ₂ O	
202.15 Mt	0.003 Mt	0.062 Mt CO ₂ e	0.003 Mt	0.854 Mt CO ₂ e

¹ GHG Platform India (GHGPI), is a collective civil-society initiative providing an independent estimation and analysis of India's greenhouse gas (GHG) emissions across key sectors. In this Phase, GHGPI provides national and state level emissions estimates from 2005 to 2018.

² 1st April 2017 to 31st March 2018

³ 1st April 2018 to 31st March 2019

1. Methodology Note

1.1 Category Description

The category of Captive Power Plants falls under the Fuel Combustion sub-sector of the Energy sector. CPP provides a localised source of power to its owners. Emissions in this category pertain directly to the amount of fossil fuels (coal, oil and gas) used for generating electricity in captive (non-utility) power plants.

1.2 Activity Data

Fuel-wise and state-wise electricity generation data was obtained from Central Electricity Authority’s (CEA) General Review books with information for the years 2004-05 to 2010-11, and 2012-13 to 2019-20.

CEA General Review (GR) reports use ‘Steam’ and ‘Coal’ interchangeably to denote the primary fuel source⁴.

The activity data used for this estimation is considered to be high quality, as it is directly sourced from the government reports. The net calorific value (NCV) and emission factor (EF) of fuels used in generating captive power (through steam/coal, diesel and gas) were sourced from Indian Network on Climate Change Assessment Report (INCCA) (GoI, 2010) and Biennial Update Report III. Density of fuels used for calculation are as per a report published by the Petroleum Planning & Analysis Cell (Ministry of Petroleum and Natural Gas). While the carbon dioxide (CO₂) emission factors of fuels are country-specific, that of methane (CH₄) and nitrous oxide (N₂O) are default values reported by the IPCC. Hence, the quality of emission factors could be considered of medium quality.

IPCC ID	GHG source categories	CO ₂		CH ₄		N ₂ O	
		Method Applied	Emission Factor	Method Applied	Emission Factor	Method Applied	Emission Factor
1	Energy						
1A	Fuel Combustion						
1A1	Energy Industries						
1A1c ii	Other Energy Industries	T2	CS	T1	D	T1	D

Note: T1-Tier 1; CS-Country-specific; D-IPCC default

⁴ This was confirmed by comparing Table 3.1: All India Installed Electricity Generation Capacity Mode-wise Utilities and Non- Utilities of General Review 2012-13 and Table 1: Sector-wise Installed Capacity (MW). The installed capacity for Steam in the former and Coal in the latter in 2011-12 was identical- 112,022.38 MW.

1.3 Methodology

To calculate GHG emissions from non-utility captive generation, a combination of Tier 1 and Tier 2 approaches of IPCC 2006 Methodology was adopted. Details on emission factors used and approaches adopted are tabulated below.

Table 4: Net Calorific Value and Emission Factors Used				
INCCA & BUR III			IPCC (CH₄, N₂O)	
	NCV (Tj/kt)	CO₂ EF (t/TJ)	CH₄ EF (kg/TJ)	N₂O EF (kg/TJ)
Non-coking coal	17.09	96.76	1.00	1.40
Diesel / LDO	43.00	74.10	3.00	0.60
CNG	48.00	56.10	1.00	0.10

Table 5: Density of fuel used in emissions estimates		
Density of fuel	Value	Unit
Diesel (HSD)	1.21	KL/t
Natural gas	0.76	kg/SCM

Emissions from CPP are a product of fuel consumed, net calorific value (NCV) of the fuel, and the corresponding emission factor for each gas. Consumption of fossil fuels by captive power plants (CPP) in industries having demand of 1 MW & above were assessed using aggregated State-wise all India electricity generation data of CPP and Specific Fuel Consumption (SFC)⁵.

Equation 1

$$\text{Emissions}_{\text{Gas}} = \text{Fuel-wise electricity generation} \times \text{Specific Consumption}_{\text{Fuel}} \times \text{NCV}_{\text{Fuel}} \times \text{Emission factor}_{\text{Gas}}$$

Emissions in terms of CO₂e (both GWP and GTP) were calculated using the following equations:

Equation 2

$$\text{Emissions}_{\text{SCO}_2\text{e}} (\text{GWP}) = \text{Emission}_{\text{SCO}_2} + (\text{GWP}_{\text{CH}_4} \times \text{Emission}_{\text{SCH}_4}) + (\text{GWP}_{\text{N}_2\text{O}} \times \text{Emission}_{\text{SN}_2\text{O}})$$

Equation 3

$$\text{Emissions}_{\text{SCO}_2\text{e}} (\text{GTP}) = \text{Emission}_{\text{SCO}_2} + (\text{GTP}_{\text{CH}_4} \times \text{Emission}_{\text{SCH}_4}) + (\text{GTP}_{\text{N}_2\text{O}} \times \text{Emission}_{\text{SN}_2\text{O}})$$

Activity data provided in the General Review is in financial year (FY) format. This was converted to calendar year (CY) format using the following formula:

Equation 4

$$\text{CY Activity data} = [\frac{1}{4} * \text{FY Activity Data}_{\text{Preceding year}}] + [\frac{3}{4} * \text{FY Activity Data}_{\text{Succeeding year}}]$$

⁵ SFC (kg/kWh) was derived from the fuel consumption data and corresponding electricity generation provided in Central Electricity Authority's All India Electricity Statistics General Review (2021).

Assumptions and Calculations:

- Since CEA's General Review was not published in 2013 (activity data for 2011-12 was not available). Therefore, the activity data was interpolated from 2012 and 2014 data.
- For estimating SFC, pan-India fuel consumption data and corresponding electricity generation of 2019-20 were used. Specific diesel consumption was estimated from the generation and fuel consumption data of diesel power plants, including both Low Sulphur Heavy Stock (LSHS) and Diesel Oil. This was done so by taking into account the nominal differences between the Gross Calorific Value (GCV) of LSHS, Light Diesel Oil (LDO) and High-Speed Diesel (HSD). Similarly, since the gas-based power was almost entirely generated from consumption of natural gas, the specific gas consumption was estimated based on natural gas consumption and the corresponding electricity generated.
- For coal/lignite (steam) based generation, year-wise SFC were provided in General Review 2021 for the years 2009-'10 to 2019-'20. Mean of these values were used as SFC for other years in the reference period.