

23rd WORKSHOP ON GHG INVENTORIES IN ASIA (WGIA23)

Applying Higher Tier Methods in India

Country-specific emission factors and disaggregated activity data in the energy sector of India's First Biennial Transparency Report

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Energy sector

Energy emissions nearly doubled between 2005 and 2022 and dominate the national total.

3,396,372

Gg CO₂e

total emissions excluding LULUCF, 2022

73.4%

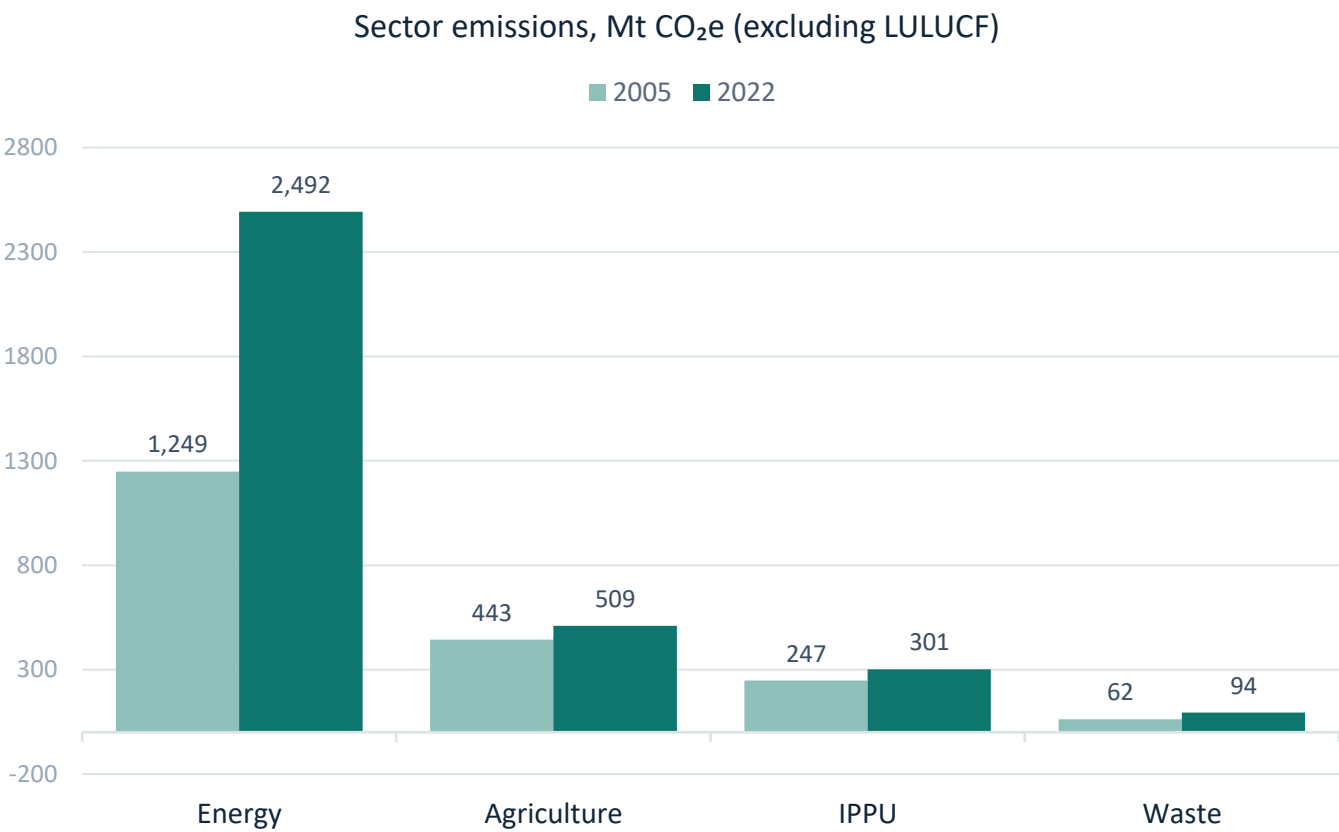
of the national total

contributed by the energy sector

+98.4%

growth, 2005–2022

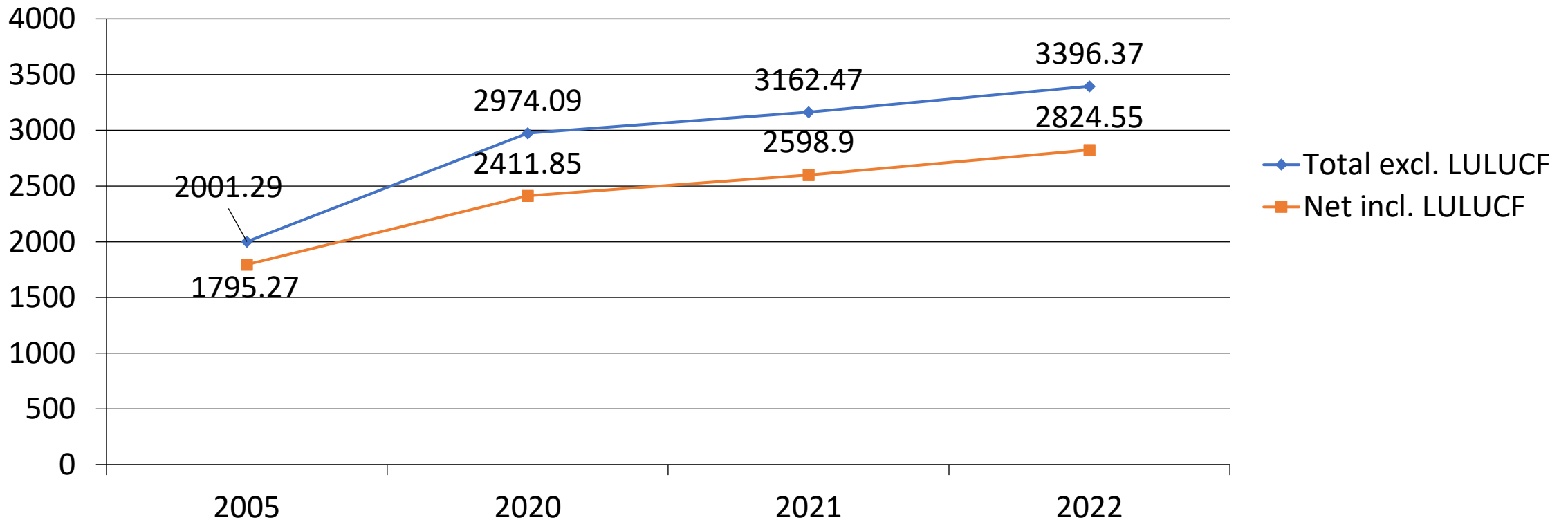
energy sector, against +69.7% nationally



LULUCF is a net carbon sink: -571.82 MtCO₂e

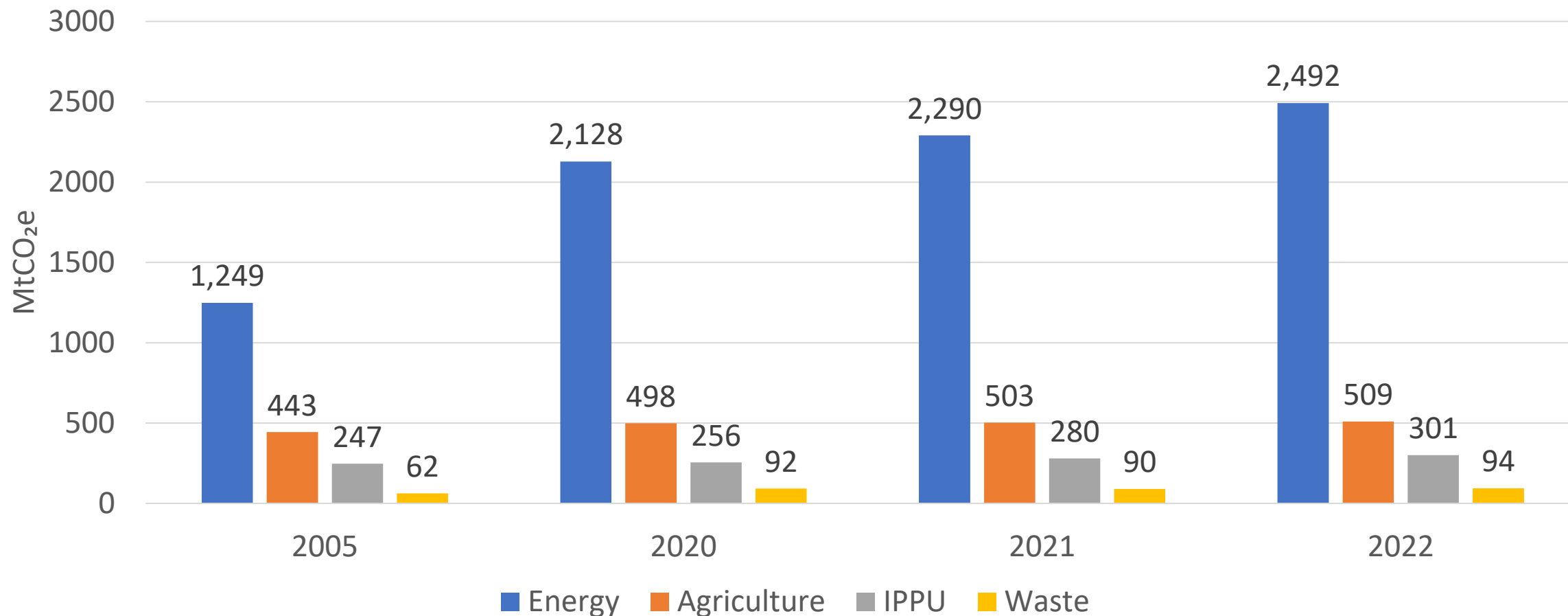
Source: India BTR-1, Table 1.4 and Section 1.5.1.

National GHG Emissions Trend



- 2005–2022 total emissions: +69.7%
- Net emissions: +57.3%
- LULUCF sink increased by 177.6%
- Energy sector is the main driver

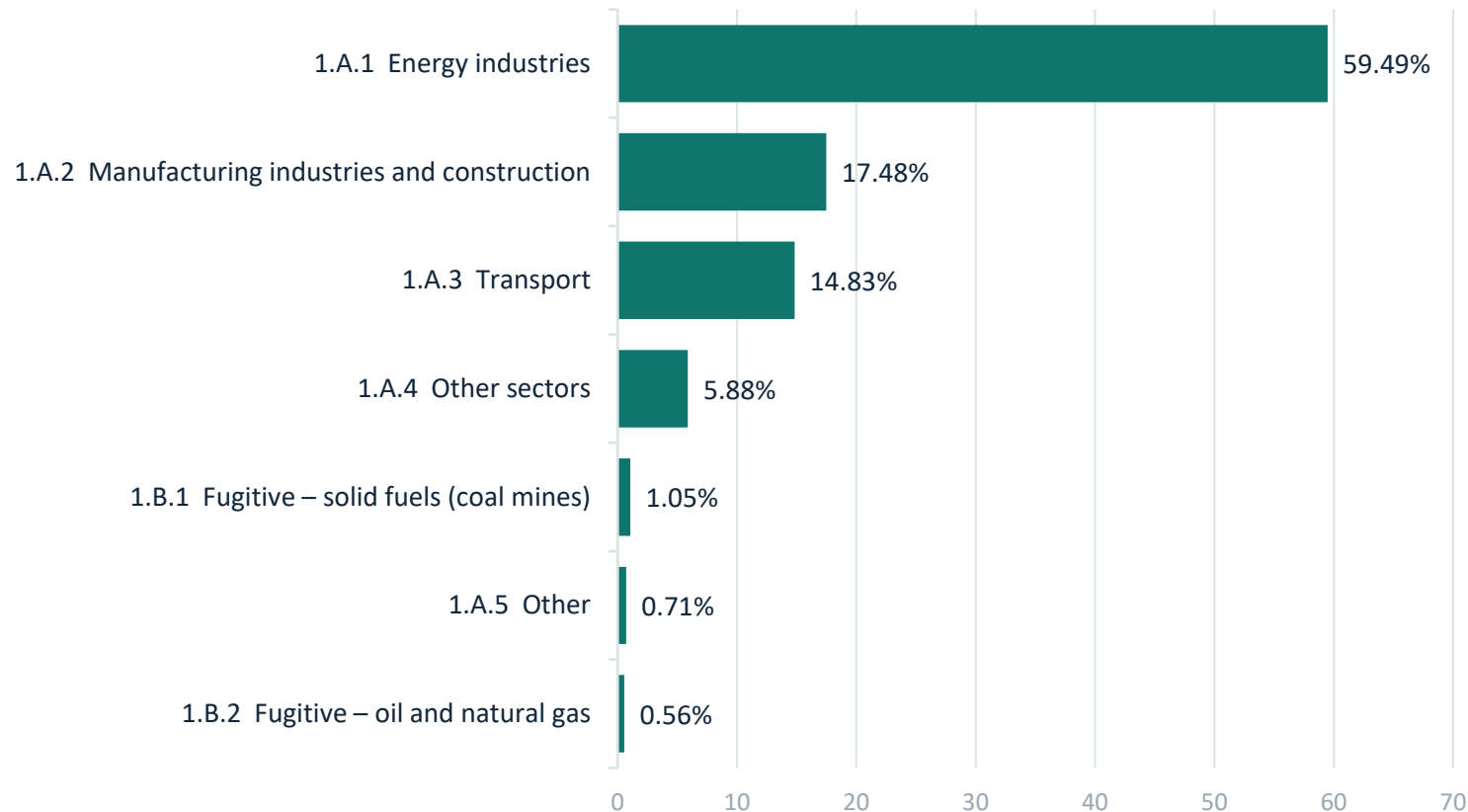
Sector-wise Emissions, 2005–2022



Energy Sector Emissions : Nearly doubled between 2005 and 2022
Steady increase after 2020.
Reflects growing energy demand.

Where does the 2,492,069 Gg CO₂e come from

Higher tiers were built for the two sub-sectors — coal combustion in 1.A.1/1.A.2, and coal-mine methane in 1.B.1.



78%

of energy-sector emissions fall in categories where India applies a country-specific or sector-specific emission factor.

Fugitive methane, in perspective

1.05% of energy-sector CO₂e comes from coal mines — but that single category is **63%** of all methane in India's energy sector (931 of 1,476 Gg CH₄).

Small in CO₂e terms. Decisive for the methane picture.

Source: India BTR-1, Figure 1.4 and Appendix I. Shares computed from Appendix I values in Gg CO₂e.

India's energy-sector tier and emission-factor map

Reported exactly as in BTR-1 Table 1.2. Higher tiers are concentrated where a category is both large and measurable.

IPCC category	CO ₂ method	CO ₂ EF	CH ₄ method	CH ₄ EF	N ₂ O method	N ₂ O EF
1.A.1 Energy industries	T1, T2, T3	D, CS, SS	T1, T2	D	T1, T2	D
1.A.2 Manufacturing industries and construction	T1, T2, T3	D, CS, SS	T1, T2	D	T1, T2	D
1.A.3 Transport	T1	D, CS	T1	D	T1	D
1.A.4 Other sectors	T1	D	T1	D	T1	D
1.A.5 Other	T1	D, CS	T1	D, CS	T1	D, CS
1.B.1 Fugitive emissions – solid fuels	NA	NA	T2	CS	NA	NA
1.B.2 Fugitive emissions – oil and natural gas	T1	D	T1	D	T1	D
1.C CO ₂ transport and storage	NO	NO	—	—	—	—

Reading the table

T1/T2/T3 = tier. D = IPCC default. CS = country-specific. SS = sector-specific. NA = not applicable. NO = not occurring.

Summary

India is at Tier 2 or Tier 3 for combustion CO₂ in the two stationary categories, and Tier 2 for coal-mine CH₄. Everywhere else in the energy sector — including transport CH₄ and N₂O, and oil and gas fugitives — the estimate is Tier 1 with IPCC defaults.

Source: India BTR-1, Table 1.2 — Summary report for methods applied to India's GHG inventory for the first BTR (energy rows reproduced in full).

ENERGY SECTOR: Methodologies Applied

Sub-category	Methodology
Fuel Combustion (1.A)	
- Energy Industries (1.A.1) - Manufacturing Industries and Construction (1.A.2) - Other sectors (Residential and Commercial/Institutional (1.A.4)	Combination of Tier 1 and Tier 2
<i>Transport (1.A.3)</i>	
• Domestic Aviation (1.A.3. a)	Tier 1
• Road Transport (1.A.3.b)	Tier 1
• Railways (1.A.3. c)	Combination of Tier 1 and Tier 2
• Domestic Navigation (1.A.3. d)	Tier 1
Fugitive Emissions (1.B)	
Solid Fuels (1.B.1)	Tier 2
Oil and Natural Gas (1.B.2)	Tier 1

ENERGY SECTOR: Methodologies Applied

Fuel Combustion (1.A)

Source Category	Country-specific Parameter	Developed by	First Reported
Coking Coal	CO ₂ emission factor	CSIR-CIMFR	BUR-2
Non-coking Coal	CO ₂ emission factor	CSIR-CIMFR	BUR-2
Lignite	CO ₂ emission factor	CSIR-CIMFR	BUR-2

ENERGY SECTOR: Methodologies Applied

Fugitive Emissions from Coal Mining (1.B.1) - CH₄ emission factor

Source Category	Mine Type	Year of Submission/ Reported	Developed by
1.B.1.a.i Underground Mines	Mining – Degree I	2016	CSIR-CIMFR
	Mining – Degree II	2016	CSIR-CIMFR
	Mining – Degree III	TNC (2023)	CSIR-CIMFR
	Post-mining – Degree I	2016	CSIR-CIMFR
	Post-mining – Degree II	TNC	CSIR-CIMFR
	Post-mining – Degree III	TNC	CSIR-CIMFR
1.B.1.a.ii Surface Mines	Mining	2020	CSIR-CIMFR
	Post-mining	TNC	CSIR-CIMFR

Tiers follow key category analysis

Seven of India's eleven key categories (excluding LULUCF) are energy-sector fuel combustion CO₂.

Key category, 2022	Gg CO ₂ e	% of total	Method at parent category (BTR-1 Table 1.2)	Higher tier?
1.A.1.a.i Electricity generation	1,383,394	40.73%	T1, T2, T3 · D, CS, SS	Yes
1.A.3.b Road transportation	325,039	9.57%	T1 · D, CS	No
3.A Enteric fermentation	300,170	8.84%	T1, T2 · D, CS (agriculture)	Yes
1.A.2.g.viii Other, non-specified industry	181,728	5.35%	T1, T2, T3 · D, CS, SS	Yes
1.A.2.a Iron and steel	159,898	4.71%	T1, T2, T3 · D, CS, SS	Yes
2.A.1 Cement production	152,265	4.48%	T1, T2 · D, CS (IPPU)	Yes
1.A.4.b Residential	98,165	2.89%	T1 · D	No
3.C Rice cultivation	97,920	2.88%	T2 · CS (agriculture)	Yes
1.A.1.b Petroleum refining	82,740	2.44%	T1, T2, T3 · D, CS, SS	Yes
3.D.1 Direct N ₂ O, managed soils	64,617	1.90%	T2 · CS (agriculture)	Yes
1.A.2.f Non-metallic minerals	51,898	1.53%	T1, T2, T3 · D, CS, SS	Yes

The rule India applied: invest measurement effort where the level assessment says it will change the national number. Key category analysis used IPCC Approach 1 (level) with an 85% threshold, availing the flexibility for developing countries in paragraph 25 of the MPGs. The two remaining Tier 1 energy key categories — road transportation and residential — are named improvement priorities.

Source: India BTR-1, Table 1.6 (level assessment without LULUCF) cross-referenced with Table 1.2. Methods shown are those reported at the parent category.

Institutional model

Country-specific factors are developed by mandated scientific institutions and used by the compiling Ministry.

Coordination & approval

MoEFCC / NATCOM IPMU
National Steering Committee
Technical Advisory Committee

Emission-factor work

CSIR-CIMFR for coal
combustion and coal-mine
methane
Other expert institutions by
sector

Activity data

Line ministries and statutory
bodies provide energy, coal,
petroleum, transport and
industrial statistics

Strength is continuity: Same institutions can rebase factors when fuels, technologies or data systems change.

Coal combustion CO₂

Three generations of India-specific coal factors

2004 / base year 1994

India-specific NCV and CEF for coking coal, non-coking coal and lignite.

2018 / base year 2007

CSIR-CIMFR rebased factors using about 8,000 coal samples across Indian coalfields.

2015 / power sector

Sector-specific NCV–CEF–COF added measured oxidation for coal-fired power stations.

Country-specific factors are dated measurements of a fuel system — not permanent constants.

Coal CO₂ method

India replaced three default terms with measured values

$$\text{Coal quantity} \times \text{NCV} \times \text{CEF} \times 44/12 \times \text{COF}$$

NCV

Net calorific value measured for Indian coal categories.

CEF

Carbon emission factor derived from coal carbon content.

COF

Power-sector oxidation factor measured using unburnt carbon in ash.

Key design rule: use fuel categories that activity statistics can also report.

Coal CO₂ result

A higher-tier factor materially changed a major category

139 Tg CO₂

lower estimate for coal-based electricity generation in 2015 compared with 1994 vintage factors

The correction was larger than India's entire waste-sector emissions in 2022.

For the largest category, a default factor can conceal nationally significant uncertainty.

The purpose is not a lower number; it is a better-bounded and reviewable estimate.

Maintenance lesson

Budget for re-basing, not just development

Coal grading changed

Non-coking coal moved to GCV-based grading and pricing from 1 January 2012.

Coal quality changed

Deeper seams and mechanisation changed ash and moisture profiles.

Combustion changed

Plant efficiency and boiler technology altered the oxidation factor.

A factor stops being country-specific when the underlying fuel system has moved on. Permanent institutional capacity makes re-basing possible.

Fugitive CH₄ from coal mining

The only country-specific methane factor in India's BTR-1 energy sector

931 Gg CH₄

Fugitive methane from solid fuels in 2022.

26,065 Gg CO₂e

Equals 1.05% of energy-sector emissions at AR5 GWP of 28.

63%

Share of energy-sector CH₄ from solid fuels.

Why Tier 2 was feasible: mine-safety law already required gassiness classification and ventilation monitoring.

Coal-mine CH₄ method

Safety classification becomes inventory stratification

1. Stratify

Underground mines: Degree I, II and III by methane release per tonne of coal.

2. Measure

Ventilation-air methane for underground mines; flux chamber measurements for surface mines.

3. Apply activity data

Production is matched cell-by-cell: mine type, degree of gassiness, mining and post-mining.

Transferable idea: use a statutory classification that already has mine records and production data attached to it.

Remaining gaps

The constraint is mostly activity-data resolution

Road transport

CH₄/N₂O needs a fleet split by vehicle type, age, and emission-norm stage, reconciled with fuel sales.

Oil & gas fugitives

Need facility and equipment counts plus leak detection data across dispersed systems.

Other sectors

Residential and commercial fuel use, including biomass, remains survey-dependent.

For BTR-1, India used the IPCC Approach 1 key-category analysis with the flexibility under paragraph 25 of the MPGs.

Transferable lessons

Six ideas from India's higher-tier experience

- Let key-category analysis choose the tiers.
- Use classifications that already exist in law or statistics.
- Match emission-factor categories to available activity data.
- Designate institutions, not projects.
- Plan for periodic rebasing.
- Report D, CS and SS clearly for review.

Thank you

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Happy to take questions.