

# Trend Analysis of GHG Emissions of GOA

GHG Platform India is a civil society initiative providing an independent estimation and analysis of India's Greenhouse Gas (GHG) emissions across key sectors.

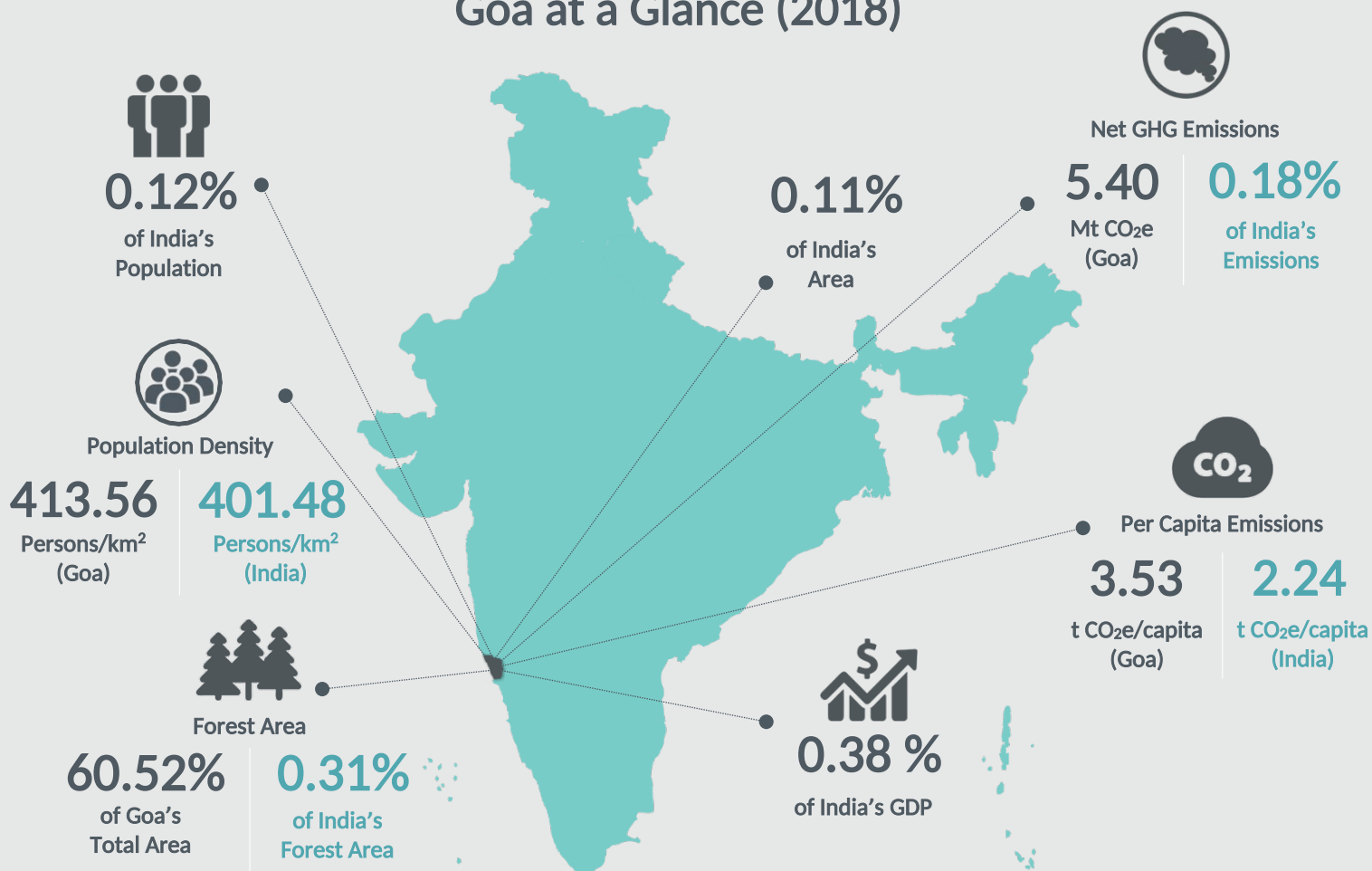
The Platform seeks to add value to the various ongoing GHG emissions estimation efforts by helping address existing data gaps and data accessibility issues, extending beyond the scope of national inventories to state inventories, and by increasing the volume of analytics and policy dialogue on India's GHG emissions sources, profile, and related policies.

The initiative estimates and assesses GHG emissions and removals from the following sectors:



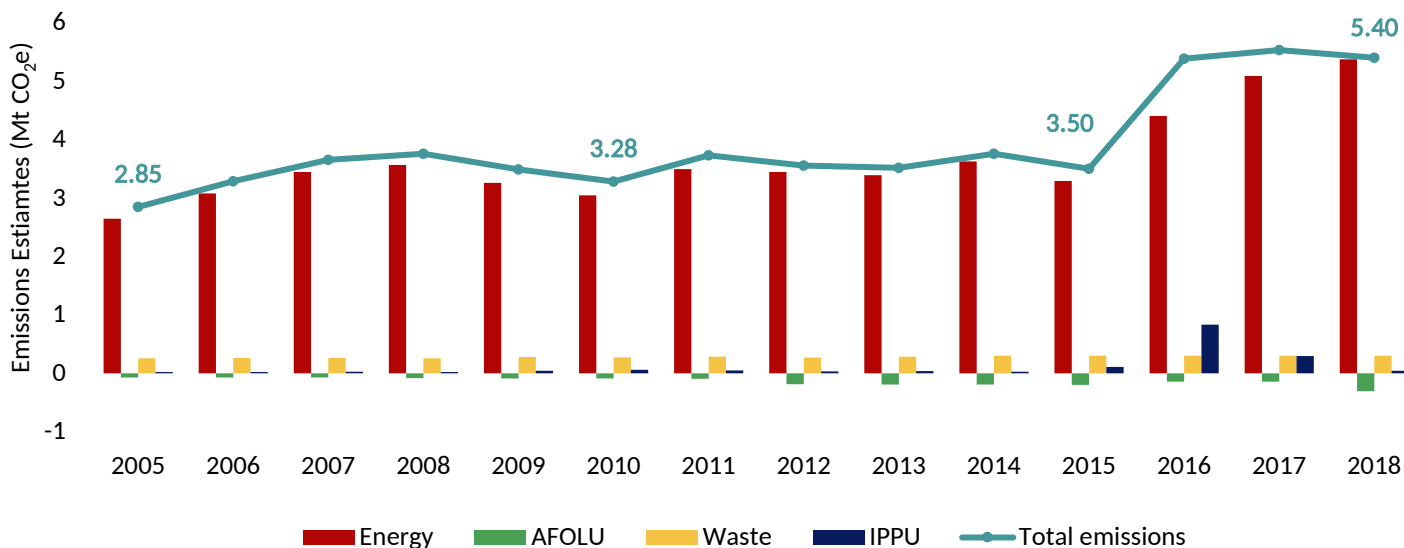
\*Fuel combusted for captive electricity generation (auto-producers) and direct fuel combustion (industrial energy) has been reported under energy sector.

## Goa at a Glance (2018)



# Economy-wide Emissions Estimates

Figure 1: GHG Emissions Estimates of Goa (2005 to 2018)



Emissions from the state of Goa increased at an estimated CAGR of 5.05% from 2.85 Mt CO<sub>2</sub>e in 2005 to 5.40 Mt CO<sub>2</sub>e in 2018. As illustrated in Figure 1, Energy sector was the major contributor to Goa’s economy-wide emissions, throughout the reference period. Notably, the economy-wide emissions dipped slightly in 2010. Another dip was observed in the total GHG emissions in 2015 due to decline in emissions from Energy sector coupled with increase in removals from Agriculture Forestry and Other Land-Use (AFOLU) sector. In 2018, the emissions from Energy sector increased significantly, leading to overall increase in emissions from the state. It is important to note that the entire AFOLU sector was a net sink throughout the reference period.

In 2005, the share of Energy sector in gross economy-wide emissions (excluding AFOLU sector) was ~90%. This was followed by Waste sector (~9%), and Industrial Processes and Product Use (IPPU) sector (~1%). In 2018, the share of Energy sector emissions increased to ~94% of the gross economy-wide emissions. Share of Waste sector declined to ~5%, while the share of IPPU remained nearly the same at ~1%, in 2018.

Figure 2: Sector-wise Contribution (Mt CO<sub>2</sub>e) and Percentage Share in Gross Economy-wide GHG Emissions (excluding AFOLU sector) of Goa

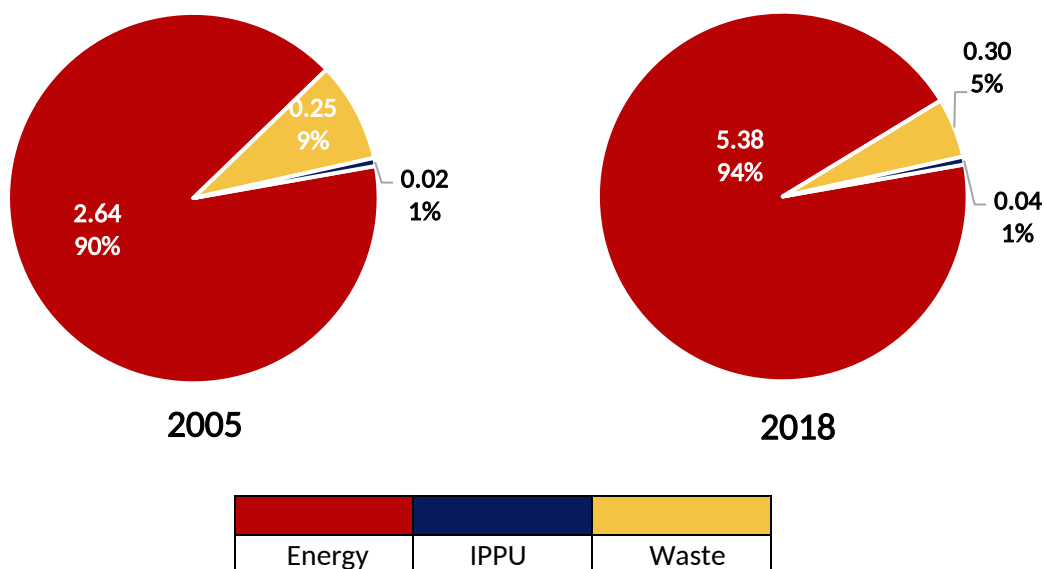
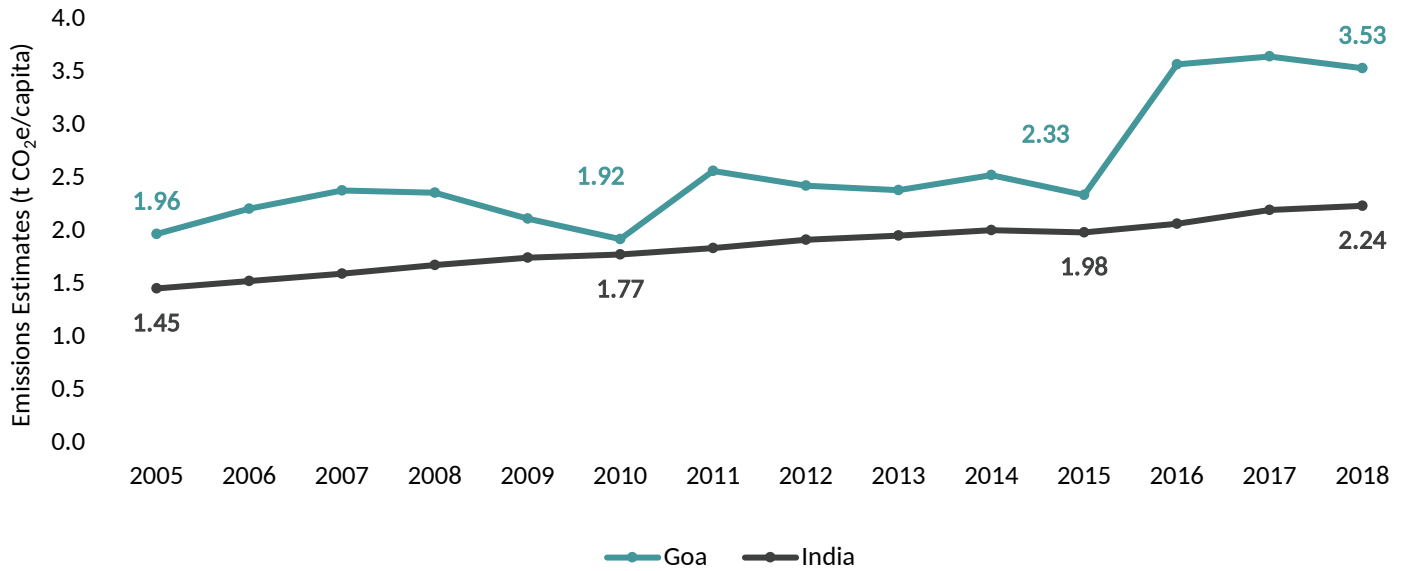


Figure 3: Per Capita Net GHG Emissions of Goa and India (2005 to 2018)



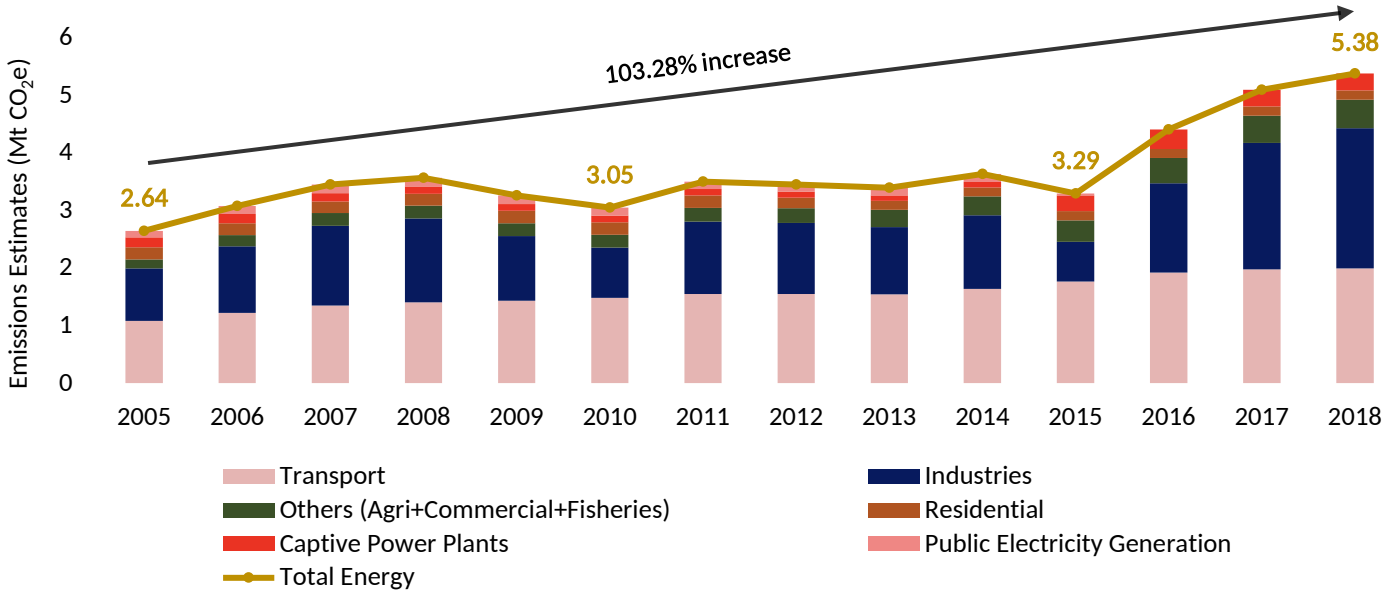
The per capita emissions of Goa were higher than India's per capita emissions, across the reference years (see Figure 3). Notably, the per capita emissions of Goa dipped in the years 2010 and 2015, due to dip in Energy sector emissions in these years. The per capita emissions of Goa grew at a CAGR of 4.61% from 1.96 t CO<sub>2</sub>e/capita in 2005 to 3.53 t CO<sub>2</sub>e/capita in 2018, which is higher than India's CAGR (~3.41%).

# Energy Sector



The Energy sector emissions comprise of emissions from Fuel Combustion and Fugitive Emissions. Fuel Combustion includes emissions from Public Electricity Generation, Transport, Captive Power Plants, Industries, Agriculture, Commercial, and Residential categories. Fugitive Emissions are due to Fuel Production. Energy sector of Goa accounted for ~94% of the gross economy-wide emissions (excluding AFOLU sector) in 2018. Emissions from the Energy sector increased at a CAGR 5.61% from 2.64 Mt CO<sub>2</sub>e in 2005 to 5.38 Mt CO<sub>2</sub>e in 2018 (see Figure 4).

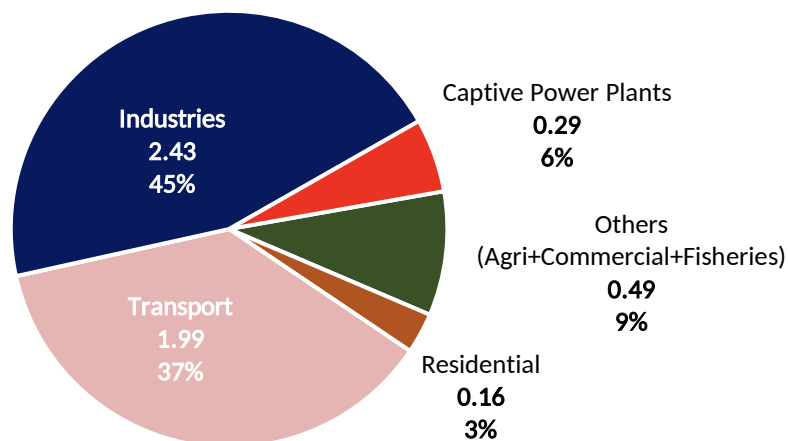
Figure 4: GHG Emission Estimates of Energy Sector - Goa (2005 to 2018)



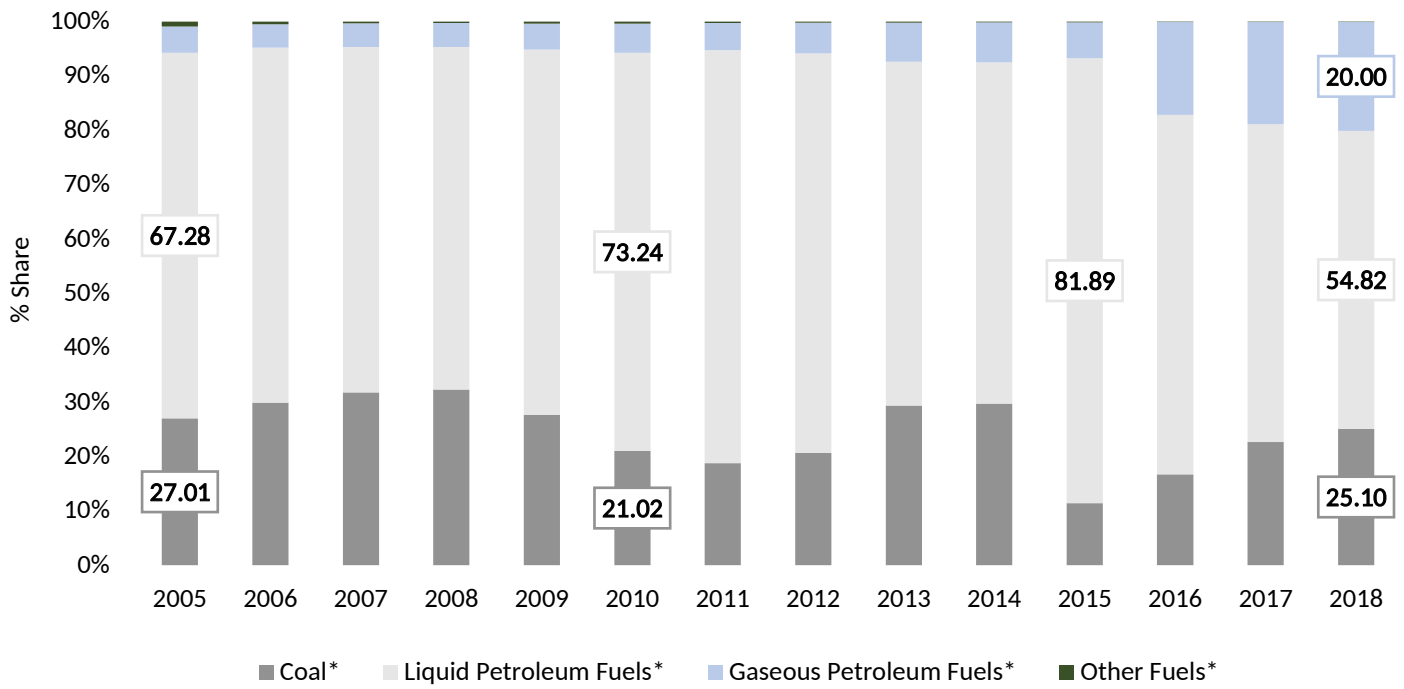
Within the Energy sector, Industrial Energy and Transport categories were the leading contributors to GHG emissions, with shares of ~45% and ~37%, respectively, in the total Energy emissions in 2018. This was followed by Captive Power Plants category with a share of ~6% and Residential category with a share of ~3% in 2018 (see Figure 5).

Within the Fuel-Combustion sub-sector, emissions from Liquid Petroleum Fuels were the major contributor across the reference years, with an average share of ~67%. This was followed by emissions from combustion of Coal, with an average share of ~25% between 2005 and 2018. Gaseous Petroleum Fuels had an average share of ~8%, across the reference period (see Figure 6).

Figure 5: Category-wise Emissions (Mt CO<sub>2</sub>e) and Percentage Share in Total Energy Sector Emissions (2018)



**Figure 6: Percentage Share of GHG Emissions by Fuel Type due to Fuel Combustion in Energy Sector (2005 to 2018)**



**\*Notes -**

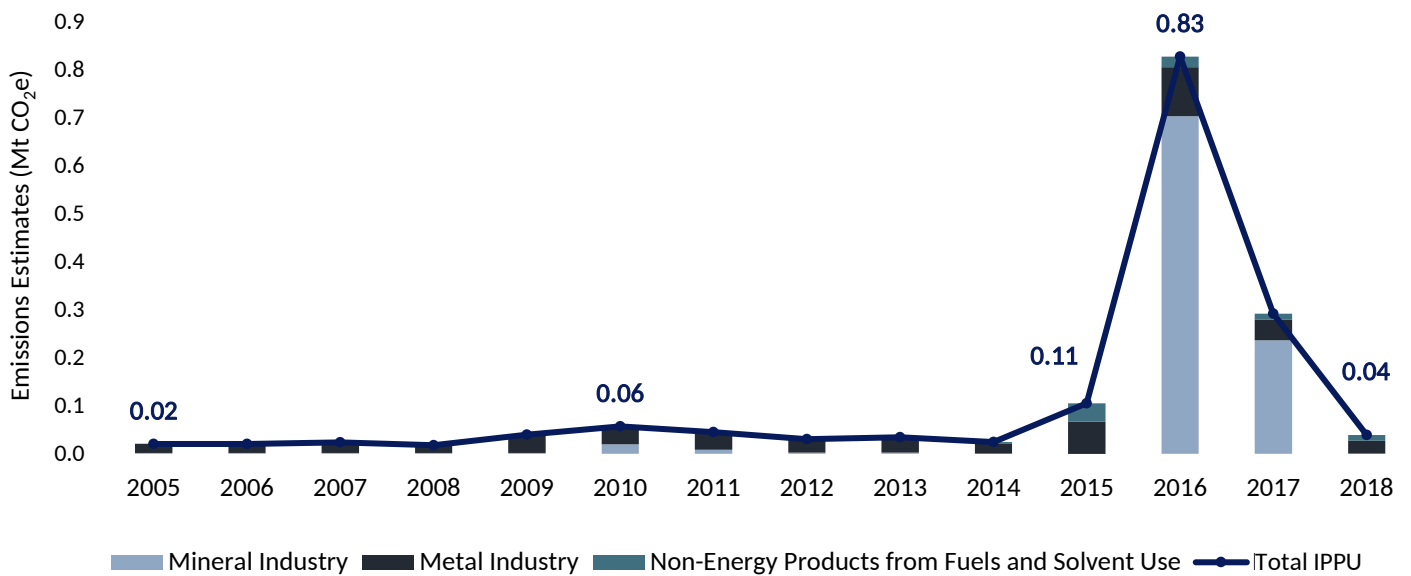
1. Coke is included in Coal because the bifurcation of pet-coke and coke was not available
2. Liquid Petroleum Fuels - ATF, diesel, kerosene, motor spirit and other liquid fuels.
3. Gaseous Petroleum Fuels - natural gas, LPG and other gaseous fuels
4. Other Fuels comprises of firewood and charcoal



# IPPU Sector

Emissions from the Industrial Processes and Product Use (IPPU) sector are largely driven by Chemical, Metal, Mineral Industries and Non-Energy Products from Fuels and Solvent Use. In Goa, the IPPU sector represented ~1% of the gross economy-wide emissions (excluding AFOLU sector) in 2018. Between 2005 and 2018, the overall IPPU emissions increased at a CAGR of 5.11% from 0.02 Mt CO<sub>2</sub>e in 2005 to 0.04 Mt CO<sub>2</sub>e in 2018, owing to the increase in emissions from both Metal Industry (Iron and Steel Production) and Non-Energy Products from Fuels and Solvent Use. A spike was observed in the overall IPPU emissions in 2016 due to a sudden increase in the emissions from the Mineral Industry (primarily from Glass Production) (see Figure 7).

Figure 7: GHG Emission Estimates of IPPU Sector - Goa (2005 to 2018)



Iron and Steel Production was the key driver of GHG emissions in IPPU sector with an average share of ~72% between 2005 and 2018. However, share of emissions from Iron and Steel Production reduced from ~90% in 2005 to 68% in 2018. This was followed by Glass Production with an average share of ~20% across the reference years. Significant emissions were also registered from Lubricant Use and Paraffin Wax Use with average shares of ~6% and ~2%, respectively, during the reference period (see Figure 8 and 9).

Figure 8: Category-wise Emissions (Mt CO<sub>2</sub>e) and Percentage Share in Total IPPU Emissions (2018)

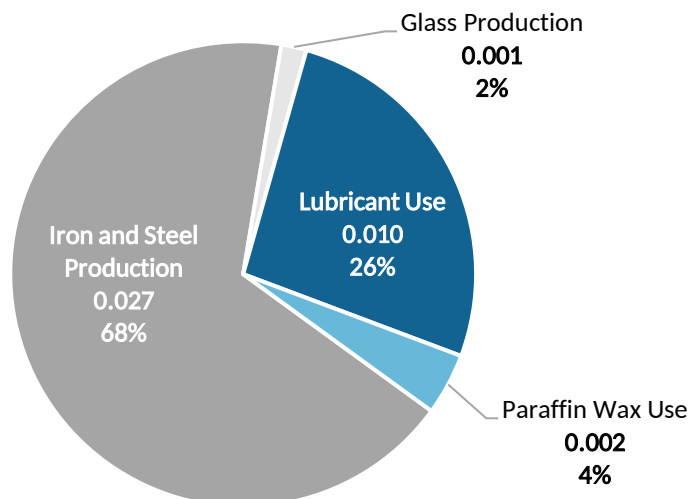
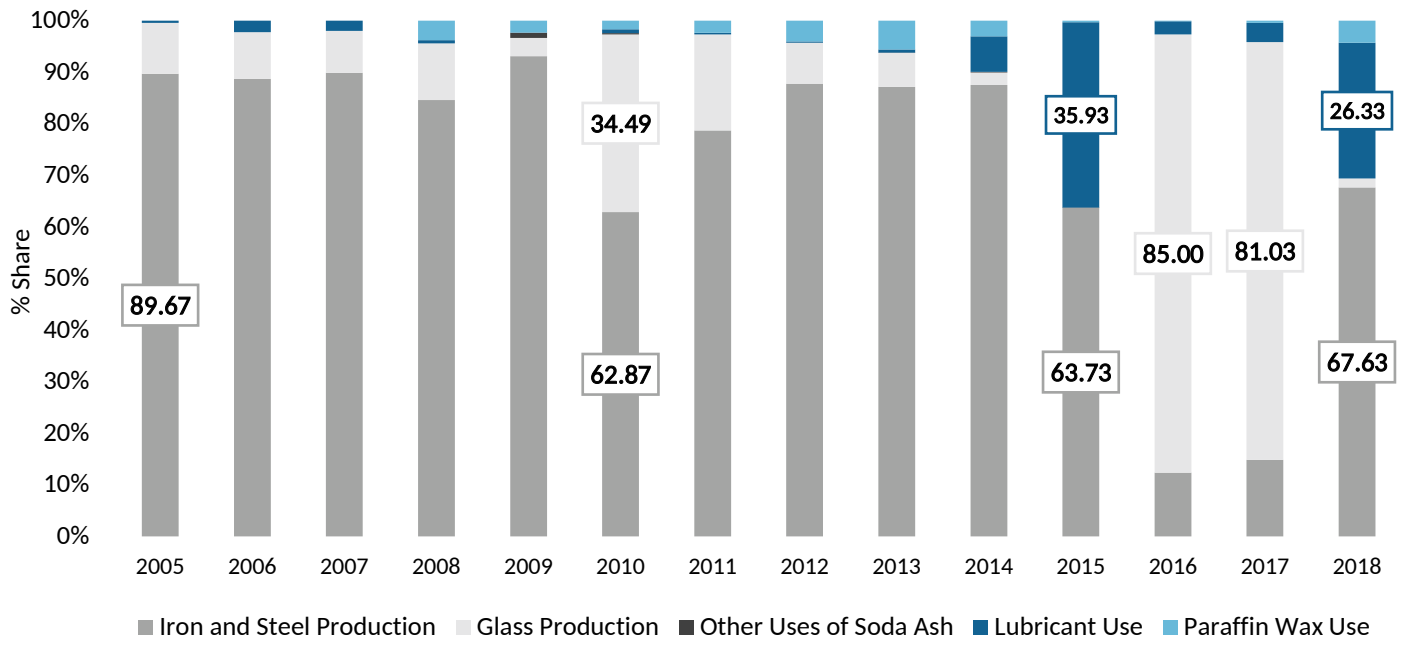


Figure 9: Percentage Share of GHG Emissions from IPPU Categories (2005 to 2018)

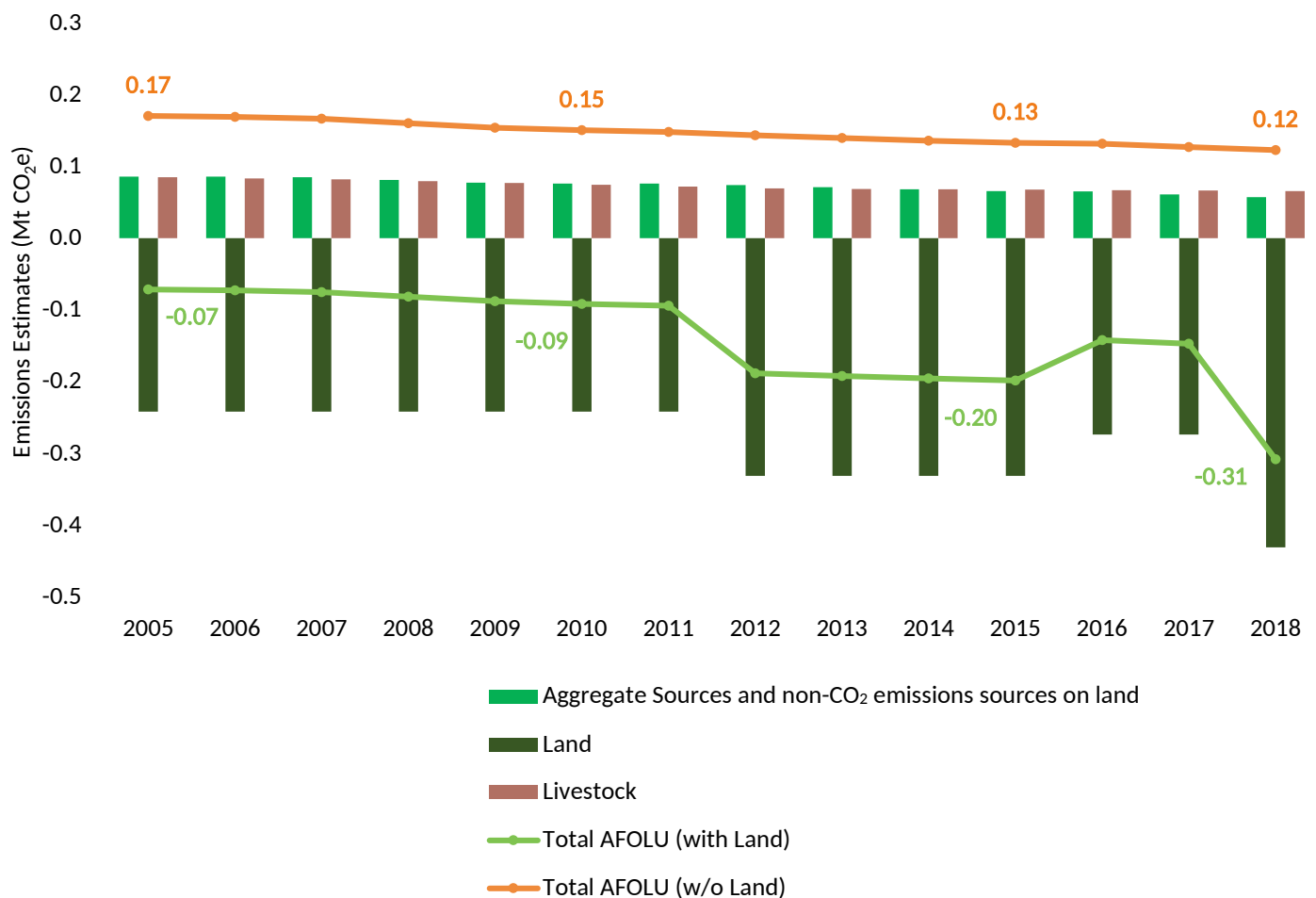




Emissions from the Agriculture, Forestry and Other Land Use (AFOLU) sector arise from three main sub-sectors, namely Livestock, Land and Aggregate Sources and Non-CO<sub>2</sub> Emissions Sources on Land\*. In Goa, AFOLU sector was a net sink of emissions from 2005 to 2018, with the overall removals from the sector increasing at a CAGR of 11.88% from 0.07 Mt CO<sub>2</sub>e in 2005 to 0.31 Mt CO<sub>2</sub>e in 2018.

While the Livestock and Aggregate Sources sub-sectors were net GHG emitters, the Land sub-sector was a sink throughout the reference period. Removals from Land sub-sector increased at a CAGR of 4.54% from 0.24 Mt CO<sub>2</sub>e in 2005 to 0.43 Mt CO<sub>2</sub>e in 2018. Further, there was a decline in emissions from both the Livestock and Aggregate Sources sub-sectors at CAGRs of 1.95% and 3.07%, respectively. The average annual emissions from Livestock and Aggregate Sources sub-sectors were 0.15 Mt CO<sub>2</sub>e that were neutralised by CO<sub>2</sub> removals from the Land sub-sector which was, on an average, annually removing 0.29 Mt CO<sub>2</sub>e during the reference period (see Figure 10).

**Figure 10: GHG Emissions Estimates of AFOLU Sector - Goa (2005 to 2018)**

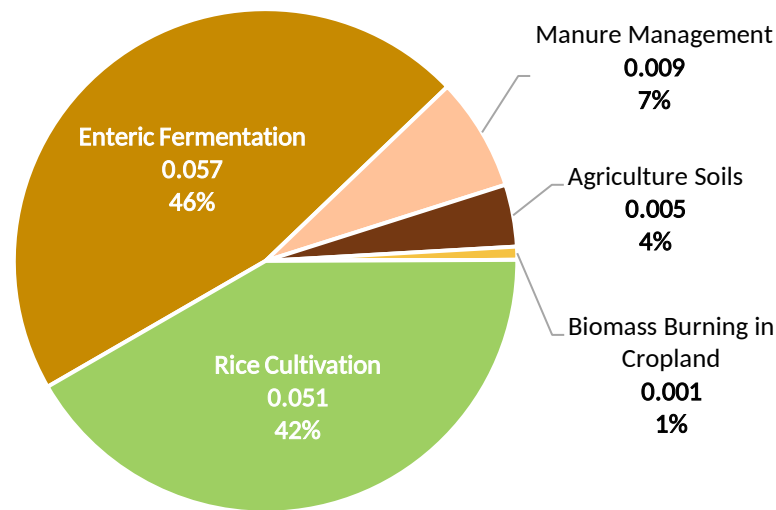


The Livestock sub-sector had the maximum share of ~46% of positive AFOLU emissions (excluding Land sub-sector) in Goa in 2018. Within the Livestock sub-sector, Enteric Fermentation was the major contributor to positive AFOLU emissions across the reference period with an average share of ~43%. The emissions from this category decreased at a rate of 1.73% (compounded annually) from 0.07 Mt CO<sub>2</sub>e in 2005 to 0.06 Mt CO<sub>2</sub>e in 2018.

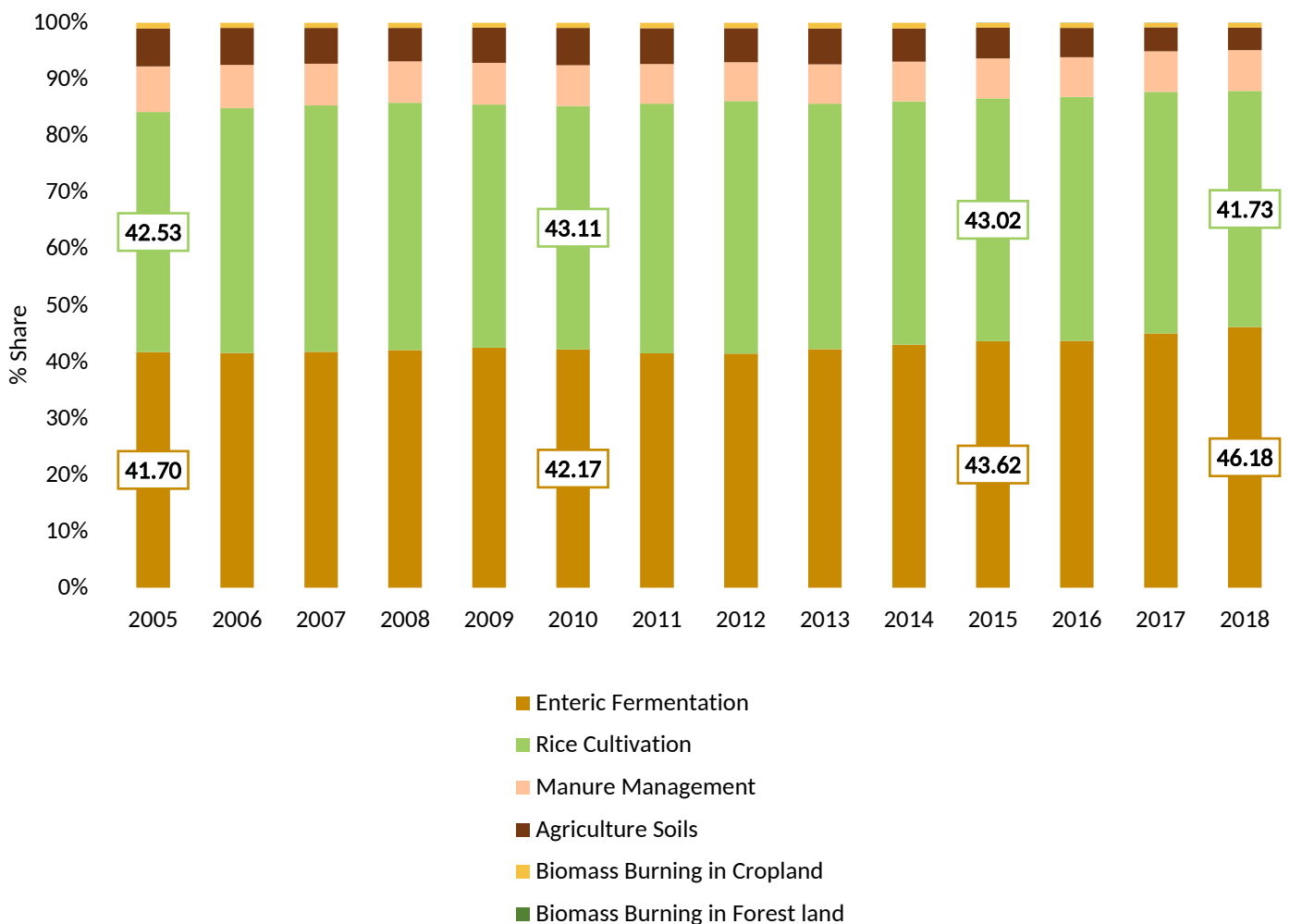
Within the Aggregate Sources sub-sector, the categories of Rice Cultivation and Agriculture Soils were the major GHG contributors to gross AFOLU emissions with average shares of ~43% and ~6% respectively, during the reference years. The share of emissions from Rice Cultivation decreased from ~43% in 2005 to ~42% in 2018 and that of Agriculture Soils decreased from ~7% in 2005 to ~4% in 2018 (see Figures 11 and 12).



**Figure 11: Category-wise Emissions (Mt CO<sub>2</sub>e) and Percentage Share in Positive AFOLU Emissions (excluding Land sub-sector) (2018)**



**Figure 12: Category-wise Share of Positive AFOLU Emissions (excluding Land sub-sector) (2005 to 2018)**



\*The sub-sector called 'Aggregate Sources and Non-CO<sub>2</sub> Emissions Sources on Land' includes emissions from Rice Cultivation, Agriculture Soils, and Biomass Burning in Cropland and Forestland.



## Waste Sector

Solid Waste Disposal, Domestic Wastewater and Industrial Wastewater are the key sources of GHG emissions in the Waste sector. In Goa, Waste sector contributed to almost 5% of gross economy-wide emissions (excluding AFOLU sector) in 2018. Emissions from the Waste sector increased at a CAGR of 1.22% from 0.25 Mt CO<sub>2</sub>e in 2005 to 0.30 Mt CO<sub>2</sub>e in 2018 (see Figure 13).

Figure 13: GHG Emissions Estimates of Waste Sector - Goa (2005 to 2018)

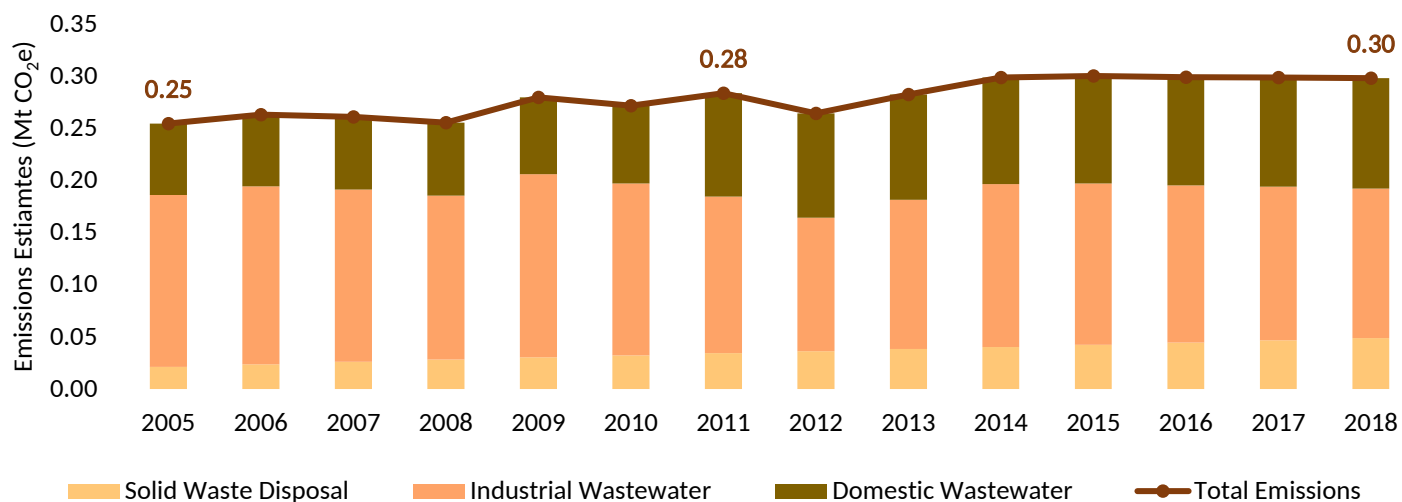
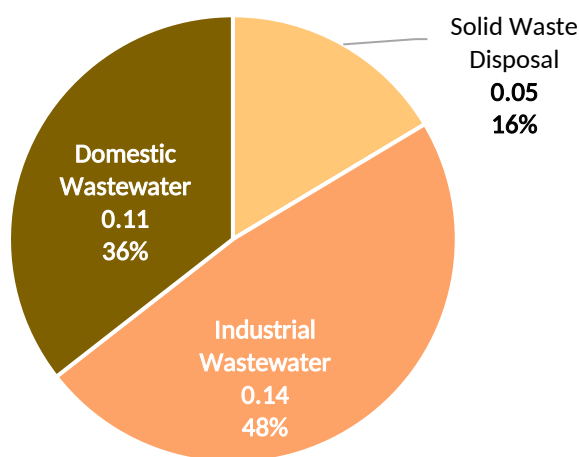


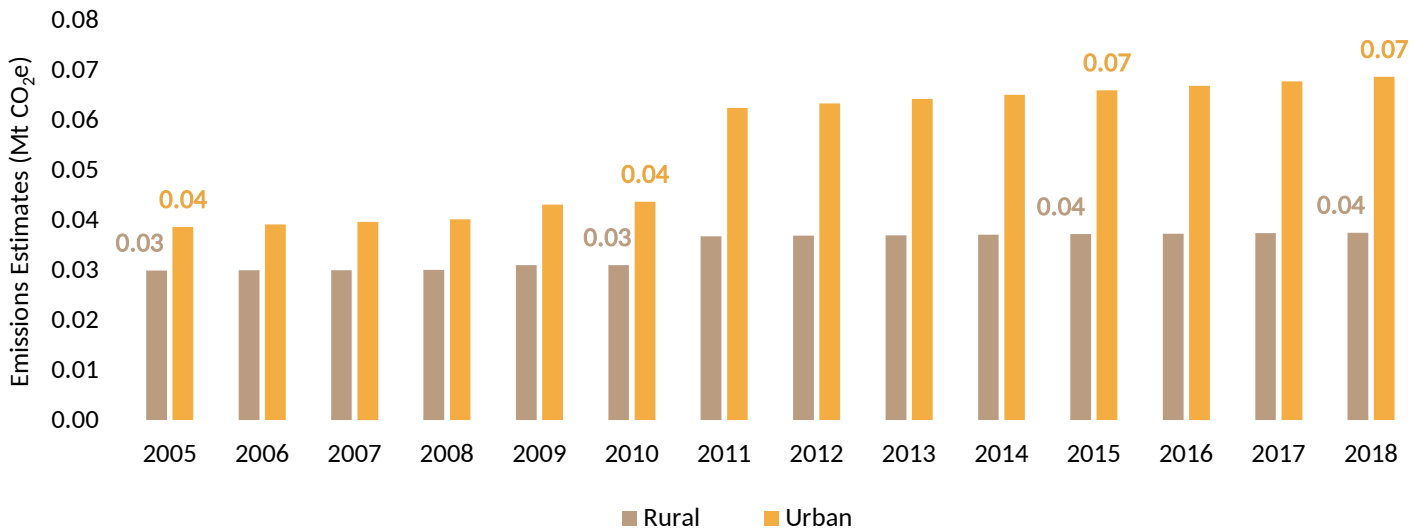
Figure 14: Sub-sector Emissions (Mt CO<sub>2</sub>e) and Percentage Share in Total Waste Sector Emissions (2018)



Discharge of untreated wastewater and use of septic tanks are the key drivers of emissions due to Domestic Wastewater sub-sector. In 2018, Domestic Wastewater had a share of 36% in the total Waste sector emissions. Approximately 16% of the Waste sector emissions were from Solid Waste Disposal, which increased at a CAGR of 6.62% from 0.02 Mt CO<sub>2</sub>e in 2005 to 0.05 Mt CO<sub>2</sub>e in 2018. Industrial Wastewater accounted for the maximum ~48% of total Waste emissions in 2018. Emissions from this sub-sector declined at a CAGR of 1.08% from 0.17 Mt CO<sub>2</sub>e in 2005 to 0.14 Mt CO<sub>2</sub>e in 2018 (see Figure 14).

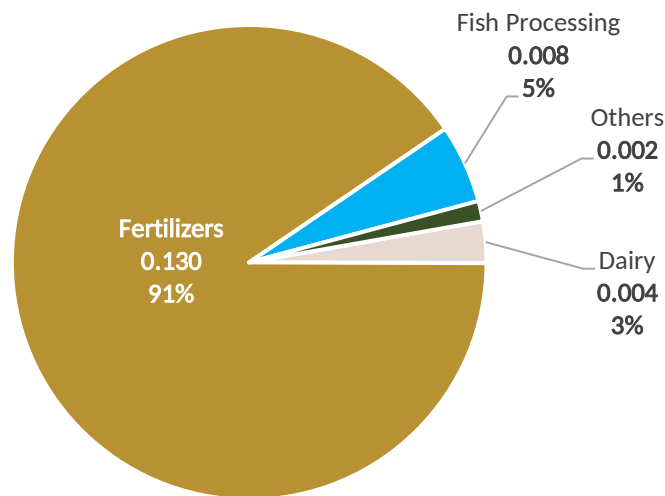
The emissions from Domestic Wastewater of both rural and urban areas grew at a CAGR of 3.42% from 0.07 Mt CO<sub>2</sub>e in 2005 to 0.11 Mt CO<sub>2</sub>e in 2018. Almost ~65% of the Domestic Wastewater emissions were from the urban areas of Goa in 2018 (see Figure 15).

Figure 15: Area-wise GHG Emissions Estimates of Domestic Wastewater (2005 to 2018)



The Fertilizers Industry was the major contributor to Industrial Wastewater emissions with a share of ~91% in 2018. This was followed by Fish Processing and Dairy Industry with shares of 5% and 3%, respectively, as illustrated in Figure

Figure 16: Category-wise Emissions (Mt CO<sub>2</sub>e) and Percentage Share in Industrial Wastewater Emissions (2018)





The GHG Platform India is a civil society initiative providing an independent estimation and analysis of India's Greenhouse Gas (GHG) emissions across key sectors, namely- Energy, IPPU, AFOLU and Waste.

The Platform comprises of the following civil society:



The **Council on Energy, Environment and Water (CEEW)** is one of South Asia's leading not-for-profit policy research institutions. It uses data, integrated analysis and strategic outreach to explain – and change – the use, reuse, and misuse of resources.

The **International Maize and Wheat Improvement Center (CIMMYT)** is the global leader in agricultural research for development in wheat and maize-based farming systems.

**Center for Study of Science, Technology and Policy (CSTEP)** is a not for profit research organisation incorporated in 2005 u/s 25 of The Companies Act, 1956.

**ICLEI - Local Governments for Sustainability** is a leading global network of over 1,500 cities, towns and regions committed to building a sustainable future.

**Vasudha Foundation**, set up in 2010, is a not for profit organisation, working in the clean energy and climate policy space.

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