Sector: Waste

Sub Sector: Industrial wastewater

Prepared by: ICLEI, South Asia

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Introduction

Methane (CH_4) is emitted from waste water when it is treated or disposed anaerobically. Waste water originates from a variety of domestic, commercial, and industrial sources, and may be treated on site, transferred through a sewer to a centralized treatment plant or disposed of untreated in nearby areas or via an outfall. This exercise provides a detailed estimation of the Green House Gas (GHG) emissions (in terms of CO_2 equivalent) from Industrial Wastewater Treatment and Discharge (IPCC code: 4D2) in the Waste sector in India.

The objective is to contribute towards establishment of the 'India GHG platform' – which aims to complement the national reporting process, as well as to drive an informed policy dialogue within the country on the industrial carbon emissions estimation and the possibility to reduce emissions in the decades ahead.

This document provides details on the adopted methodology, data sources, information gaps, and the GHG emission estimations for the time period from 2007 to 2012.

Scope of Assessment, Applicability and Boundary limitations:

The Scope of assessment is limited to only those industrial sectors with substantial generation of wastewater containing organic matter and thereby leading to release of GHG emissions from treatment and/or discharge of such organic wastewater as per IPCC guidelines and the reporting period considered is from the year 2007 to 2012. Based on India's National Communication, related documentation from the National Environmental Engineering Research Institute (NEERI)[1] and the 2006 IPCC guidelines for Wastewater, the industrial sectors considered in the assessment are Iron and Steel, Fertilizers, Meat, Sugar, Coffee, Pulp and Paper, Petroleum, Beer, Soft Drinks, Rubber, Dairy and Tannery.

The other industrial sectors which consume and discharge chemicals or other inorganic matter which are not sources of significant GHG emission, –such as Cement industry, Plastic industry, Pharmaceuticals, Automobile industry etc., are not included in the analysis.

This assessment is applicable for all on-site generation and treatment of industrial wastewater for the industrial sectors listed above within India.

Assessment of CH_4 production potential from industrial wastewater streams is based on the concentration of degradable organic matter in the wastewater, the volume of wastewater generated, and the type of prevalent wastewater treatment systems used by the respective industrial sector.

[1] Inventorisation of Methane Emissions from Domestic & Key Industries Wastewater – Indian Network for Climate Change Assessment, NEERI, 2010. Available at: http://www.moef.nic.in/sites/default/files/M%20Karthik.pdf; Impact of methane emissions from wastewater sector in India through a case study of an effluent treatment plant, NEERI, 2011. Available at: http://www.cseindia.org/userfiles/Karthik.pdf

Based on India's National Communication and related documentation from the National Environmental Engineering Research Institute (NEERI)[2], and datasets available[3] the industrial sectors and product categories indicated in Table 1 have been included in this assessment.

Table 1: Industrial Sectors and products considered

Iron and Steel	Production of Pig Iron, Sponge Iron and Finished steel (alloy & Non-alloy)
Fertilizer	Production of Nitrogenous and Phosphatic Fertilizers (finished product for sale)
Beer	Production of all types of Beer (alcoholic)
Meat	Finished Meat production from all the registered Slaughterhouses
Sugar	Finished Sugar production from cane
Coffee	Production of all types of coffee (Arabica, Robusta and varieties of these) in India
Soft Drink	Production of non-alcoholic soft drinks[4]
Pulp & Paper	Production of paper[5] from all pulp and paper industries in India
Petroleum	Refining and production of Petroleum, Oil and Lubricants[6]
Rubber	Production of Finished Natural and Synthetic Rubber
Dairy	Production of milk in the Dairy Sector in India
Tannery	Production of Raw Bovine, Sheep, lamb, Goat and kid skins and hides

Methodology

As per the 2006 IPCC Guidelines and India's National Communication, the following equations are used to estimate CH_4 emissions from industrial wastewater treatment.

$$CH_4 \ Emissions = \sum_i \left[\left(TOW_i - S_i \right) EF_i - R_i \right]$$

Where:

CH_4 Emissions = CH_4 emissions in inventory year, kg CH_4/yr

TOWi = total organically degradable material in wastewater from industry i in inventory year, kg

COD/yr

i = industrial sector

[2] Inventorisation of Methane Emissions from Domestic & Key Industries Wastewater – Indian Network for Climate Change Assessment, NEERI, 2010. Available at: http://www.moef.nic.in/sites/default/files/M%20Karthik.pdf; Impact of methane emissions from wastewater sector in India through a case study of an effluent treatment plant, NEERI, 2011. Available at: http://www.cseindia.org/userfiles/Karthik.pdf

[3] Refer to section on data sources and assumptions for industrial production

[4] Aerated drinks have not been included in the Soft Drinks sector due to anomaly observed in the data for aerated drinks production which results in extremely high GHG emissions as compared to official National estimates and due to the lack of alternate reliable data sources to plug this information gap. Further details are provided in the section on 'Industrial Production' under 'Data Sources and Assumptions'.

[5] Paper produced from various raw materials – Wood, Agro and Recycled fiber based raw materials which is used for various purposes – writing, printing, newsprint and packaging are all included

[6] Industrial output/production data is considered from petroleum refining and not from crude oil extraction since water consumption and wastewater generation is significant in the refining process. International Petroleum Industry Environmental Conservation Association (IPIECA) (2010): Petroleum refining water/wastewater use and management- Operations Best Practice series

Si = organic component removed as sludge in inventory year, kg COD/yr (Default value 0.35 as per 2006 IPCC Guidelines for Wastewater and India's Second National Communication report)
EFi = emission factor for industry i, kg CH_4/kg COD for treatment/discharge pathway or system(s) used in inventory year
Ri = amount of CH4 recovered in inventory year, kg CH_4/yr

The activity data for this source category is the amount of organically degradable material in the wastewater (TOW), which is a function of industrial output (product) P (tonnes/year), wastewater generation W (m^3/ton of product), and degradable organics concentration in the wastewater COD (kg COD/m^3) as given in the equation:

$$TOWi = Pi \bullet Wi \bullet CODi$$

Where:
TOWi = total organically degradable material in wastewater for industry i, kg COD/yr
i = industrial sector
Pi = total industrial product for industrial sector i, t/yr
Wi = wastewater generated, m3/t product
CODi = chemical oxygen demand (industrial degradable organic component in wastewater), kg COD/m^3

For each industrial sector, the emission factor is estimated using the maximum methane producing capacity and the average methane correction factor (MCF) based on the type of treatment method used by the industry. The MCF indicates the extent to which the CH_4 producing potential (Bo) is realised in each type of treatment method and thereby it is an indication of the degree to which the system is anaerobic.

$$CH4\ EMISSION\ FACTOR\ \ EFj = Bo \bullet MCFj$$

Where:
EFj = emission factor for each treatment/discharge pathway or system used by the industry, kg CH_4/kg COD
j = each treatment/discharge pathway or system
Bo = maximum CH4 producing capacity, kg CH_4/kg COD (Default value 0.25[7])
MCFj = methane correction factor (fraction)

Table 2: Default MCF values for Industrial Wastewater treatment and discharge pathway or system

Type of treatment and discharge pathway or system	Details	MCF
Untreated		
Sea, river and lake discharge	Rivers with high organics loadings may turn anaerobic, however this is not considered here	0.1
Treated		
Aerobic treatment plant	Well managed	0
Aerobic treatment plant	Not well managed. Overloaded	0.3

[7] As per 2006 IPCC Guidelines, Chapter 6: Wastewater Treatment and Discharge and NEERI document on Inventorisation of Methane Emissions from Domestic & Key Industries Wastewater – Indian Network for Climate Change Assessment, 2010. Available at: http://www.moef.nic.in/sites/default/files/M%20Karthik.pdf

Type of treatment and discharge pathway or system	Details	MCF
Anaerobic digester for sludge	CH4 recovery not considered	0.8
Anaerobic reactor (e.g., UASB, Fixed Film Reactor)	CH4 recovery not considered	0.8
Anaerobic shallow lagoon	Depth less than 2 metres	0.2
Anaerobic deep lagoon	Depth more than 2 metres	0.8

(Source: 2006 IPCC Guidelines, Chapter 6 - Wastewater treatment and discharge)

Data Sources and Assumptions

1. Industrial Production (P_i)

The volume of wastewater generated, degradable organic matter and the Methane Correction factor are key parameters required to calculate GHG emissions from industrial wastewater as indicated in the equations in the previous section. Industrial production is a crucial starting point in the activity dataset to estimate the total wastewater generation for each industrial sector using the output based method (i.e. on the basis of m^3 of wastewater generated per tonne of industrial product for each sector).

The Annual Survey of India (ASI), conducted by the Ministry of Statistics and Programme Implementation (MOSPI), is generally acknowledged to be a centralised source of comprehensive industrial data for all registered factories in India across the years. While industrial production data was pulled out from the ASI databaseusing relevant codes as per the standard 'National Industry Classification (NIC)' system[8], the industrial output dataset in the ASI database was found to exist in multiple units of measurement such as tonnes, cu. metre, nos., litres, MW, bags, pairs, rolls etc. for all the identified sectors.

Since the industrial wastewater generation metric (Wi in the equation for estimating TOW as indicated in the previous section) is based on a per tonne of product basis, it is necessary that the activity data for industrial production should be in tonnes. The requisite guidance and conversion factors to normalize or convert the industrial output dataset reported in multiple units into a single unit of 'tonnes' is not available in the ASI database.

Given these constraints and the limitations in the ASI dataset, the ASI database could be used to obtain activity data for industrial production for only the Beer and Soft Drinks sectors and not for the remaining sectors under consideration.

Thus, other alternate nationally acceptable data sources such as the Indian Bureau of Mines, National Dairy Development Board, Rubber Board, Fertilizers Association of India, and the Department of Industrial Policy & Promotion (Handbook of Industrial Policy and Statistics) were used for industrial production data.

[8] 2. All the information reported under the ASI is coded as per the standard 'National Industry Classification (NIC) system' at the most informed five digit level, with specific NIC 2004 and NIC 2008 codes for industrial sectors and sub-sectors applicable over the time period of the GHG emission assessment (i.e. 2007-2012)

The following sources have been used to obtain the Industrial production data for the industrial sectors under consideration (see **Table** 1)

i. **Iron and Steel:**
   - Indian Bureau of Mines- The Indian Minerals Yearbook 2012 (Part- II : Metals & Alloys)[9]
   - Data for 2006-07 has been obtained from Ministry of Steel - Annual Report 2007-08[10]

ii. **Fertilizer:**
   - The Fertilizer Association of India[11]

iii. **Beer:**
   - Annual Survey of Industries, Ministry of Statistics and Programme Implementation, Government of India

iv. **Sugar:**
   - Indian Sugar Mills Association[12]

v. **Coffee:**
   - Coffee Board of India – Database on Coffee[13]

vi. **Soft Drink:**
   - Annual Survey of Industries, Ministry of Statistics and Programme Implementation, Government of India

vii. **Petroleum:**
   - Reserve Bank of India- Handbook of Statistics on the Indian Economy 2013-14[14]

viii. **Dairy:**
   - National Dairy Development Board[15]

ix. **Meat:**
   - Department of Animal Husbandry, Dairying & Fisheries, Ministry of Agriculture, Annual Report 2012-13[16]

x. **Pulp & paper:**
   - Report of the Working group on Pulp & Paper sector for the 12th FYP, Planning Commission of India[17]
   - Data for 2006-07 obtained from PSA – Opportunities for Green Chemistry Initiatives: Pulp and Paper[18]

xi. **Rubber:**
   - Rubber Board, Government of India[19]

xii. **Tannery:**
   - Food and Agriculture Organization of the United Nations- World Statistical Compendium for raw hides and skins, leather and leather footwear 1993-2012[20]

[9] Available at http://ibm.nic.in/index.php?c=pages&m=index&id=178
[10] Available at http://steel.gov.in/Annual%20Report%20(200708)/English/Annual%20Report%20(2007-08).pdf
[11] Available at http://www.faidelhi.org/general/Production%20of%20Fertilisers.pdf
[12] Available at http://www.indiansugar.com/PDFS/world_sugar_production-07-13.pdf
[13] Available at http://www.indiacoffee.org/Database/DATABASEJan13_I.pdf
[14] Available at https://rbidocs.rbi.org.in/rdocs/Publications/PDFs/000HSE13120914FL.pdf
[15] Available at http://www.nddb.org/information/stats/milkprodindia
[16] Available at http://dahd.nic.in/documents/reports?page=1
[17] Available at http://planningcommission.gov.in/aboutus/committee/wrkgrp12/wg_paper.pdf
[18] Available at http://psa.gov.in/sites/default/files/Pulp___Paper_-Final.pdf
[19] Available at http://rubberboard.org.in/reports/statisticalhighlights.pdf; and http://rubberboard.org.in/IRS_Vol33.pdf]

Assumptions:

- To ensure consistency with India's National Communication Reports and the Biennial Update Report 2010, the GHG emission inventory is to be prepared on a calendar year basis. For most of the industrial sectors included in this assessment, production data is available on a financial year basis. Production datasets available on financial year basis have been converted to calendar year datasets for a given calendar year by considering $3/4^{th}$ of the value from the previous financial year (corresponding to 9 months from April to December out of 12 months in a year) and $1/4^{th}$ from the next financial year (corresponding to 3 months from January to March out of 12 months in a year). For example $3/4^{th}$ of the production data from the financial year 2006-07 and $1/4^{th}$ of the production data from the financial year 2007-08 has been considered and added together to estimate the production data for the calendar year 2007, and so on.
- Production data for Tannery sector was already reported for the calendar year and thus no further estimation was required to convert this data to calendar year basis.
- Production data for Pig Iron and Sponge Iron was not available for financial year 2006-07. In this case, the value of the production data available for 2007-08 is considered as the production data for year 2007.
- The ASI dataset has been used to obtain the production data for Beer and Soft Drinks. The Soft drinks sector generally covers production of non-alcoholic aerated and non-aerated beverages.
  The average densities of Soft drinks – 1.04 gm/ml and Aerated drinks – 1.02 gm/ml were used to convert the industrial production data available in multiple units to a single unit of tonnes. However, the GHG emission estimates obtained using production data for Aerated drinks from the ASI dataset are observed to be abnormally high, with a variation of +4541% (45 times) and 7076% (70 times) as compared to the Second National Communication (2007) and Biennial Update Report (2010). No alternate reliable data sources have been found to cross verify or plug this information gap on production data for Aerated drinks. Thus, given the resulting high deviation with respect to the official National inventories, only production of non-aerated soft drinks is included under the Soft Drinks Sector and Aerated soft drinks has not been considered under the Soft Drinks Sector in the final emission estimates.

2. Wastewater generated per tonne of product (W_i)

A combination of country specific and default values have been used for this coefficient. The following data sources are used, in the order of preference to prioritize the use of country specific values for this coefficient (based on the availability of information)

1. India's Second National Communication to the UNFCCC

[20] Available at http://www.fao.org/fileadmin/templates/est/COMM_MARKETS_MONITORING/Hides_Skins/Documents/COMPENDIUM2013.pdf

2. related NEERI[21] documentation (indicated in the Table 3 below)
3. 2006 IPCC Guidelines (Chapter 6:Wastewater Treatment and Discharge)

The values for wastewater generation and respective source are indicated in the Table 3 below.

Table 3: Industry-wise Wastewater generation per tonne of Product

Industry	Wastewater generation (m3/tonne of product)	Reference
Iron & Steel	60	India's Second National Communication to the UNFCCC, 2012
Fertilizer	8	India's Second National Communication to the UNFCCC, 2012
Beer	9	India's Second National Communication to the UNFCCC, 2012
Sugar	1	India's Second National Communication to the UNFCCC, 2012
Coffee	5	India's Second National Communication to the UNFCCC, 2012
Soft Drink	3.7	India's Second National Communication to the UNFCCC, 2012
Petroleum	0.7	India's Second National Communication to the UNFCCC, 2012
Dairy	3	India's Second National Communication to the UNFCCC, 2012
Meat	11.7	India's Second National Communication to the UNFCCC, 2012
Pulp & Paper	162	2006 IPCC guidelines for National Greenhouse Gas Inventories, Chapter 6:Wastewater Treatment and Discharge
Rubber	26.3	India's Second National Communication to the UNFCCC, 2012
Tannery	32	Inventorisation of Methane Emissions from Domestic & Key Industries Wastewater – Indian Network for Climate Change Assessment, NEERI, 2010. Available at: http://www.moef.nic.in/sites/default/files/M%20Karthik.pdf

Assumption: Wastewater generation per tonne of product would likely vary over the years, with improvements in production processes and technologies leading to reduction in wastewater generation. However, due to lack of such updated information in the IPCC guidelines, the

[21] NEERI was the lead institution involved in the estimation of GHG emissions from industrial wastewater for the Waste sector. NEERI has been contacted for details on the methodology and information for this assessment and in case of data gaps or limited availability of information in the National Communication reports, preference has been given to relevant NEERI documents.

National Communication, Biennial Updated Reports and in the absence of other documentation on relevant data, constant values of wastewater generated per tonne of product have been used for all the years (2007-2012) in this assessment.

3. Degradable organic component in industrial wastewater (COD_i)

Specific values used for degradable organic concentration in the wastewater (kg COD/m^3) in the India's First and Second National Communication are not indicated in the National Communication reports.

Given this constraint, the following data sources are used, in the order of preference to prioritize the use of country specific values for this coefficient (based on the availability of information)

1. NEERI documentation on the National Inventory (indicated in the Table 4 below)
2. NEERI documentation on Methane Emissions from wastewater in India (indicated in the Table 4 below)
3. 2006 IPCC Guidelines (Chapter 6:Wastewater Treatment and Discharge)

Default and country specific values are used for this coefficient as indicated in the Table 4 below.

Table 4: Industry-wise degradable organic concentration in the Wastewater

Industry	COD (kg COD/m^3)	Reference
Iron & Steel	0.55	NEERI (2010): Status of Methane Emissions from Wastewater and Role of Clean Development Mechanisms in India. Published in the TERI Information Digest on Energy and Environment, [S.l.], p. 155-166, June. 2010. ISSN 0972-6721. Available at: http://www.i-scholar.in/index.php/tidee/article/view/89982
Fertilizer	3.0	NEERI (2010): Status of Methane Emissions from Wastewater and Role of Clean Development Mechanisms in India. TERI Information Digest on Energy and Environment, [S.l.], p. 155-166, June 2010. ISSN 0972-6721. Available at: http://www.i-scholar.in/index.php/tidee/article/view/89982
Beer	2.9	2006 IPCC guidelines for National Greenhouse Gas Inventories, Chapter 6:Wastewater Treatment and Discharge
Sugar	2.5	Inventorisation of Methane Emissions from Domestic & Key Industries Wastewater – Indian Network for Climate Change Assessment, NEERI, 2010. Available at: http://www.moef.nic.in/sites/default/files/M%20Karthik.pdf
Coffee	9	2006 IPCC guidelines for National Greenhouse Gas Inventories, Chapter 6:Wastewater Treatment and Discharge
Soft Drink	9[22]	NEERI (2010): Status of Methane Emissions from Wastewater and Role of Clean Development Mechanisms in

[22] COD value listed for beverages and not for soft drinks specifically

Industry	COD (kg COD/m^3)	Reference
		India. Published in TERI Information Digest on Energy and Environment, [S.l.], p. 155-166, jun. 2010. ISSN 0972-6721. Available at: http://www.i-scholar.in/index.php/tidee/article/view/89982
Petroleum Refineries	1	2006 IPCC guidelines for National Greenhouse Gas Inventories, Chapter 6:Wastewater Treatment and Discharge
Dairy	2.24	Inventorisation of Methane Emissions from Domestic & Key Industries Wastewater – Indian Network for Climate Change Assessment, NEERI, 2010. Available at: http://www.moef.nic.in/sites/default/files/M%20Karthik.pdf
Meat	4.1	2006 IPCC guidelines for National Greenhouse Gas Inventories, Chapter 6:Wastewater Treatment and Discharge
Pulp & Paper	5.9	Inventorisation of Methane Emissions from Domestic & Key Industries Wastewater – Indian Network for Climate Change Assessment, NEERI, 2010. Available at: http://www.moef.nic.in/sites/default/files/M%20Karthik.pdf
Rubber	6.12	NEERI (2010): Status of Methane Emissions from Wastewater and Role of Clean Development Mechanisms in India. Published in TERI Information Digest on Energy and Environment, [S.l.], p. 155-166, jun. 2010. ISSN 0972-6721. Available at: http://www.i-scholar.in/index.php/tidee/article/view/89982
Tannery	3.1	Inventorisation of Methane Emissions from Domestic & Key Industries Wastewater – Indian Network for Climate Change Assessment, NEERI, 2010. Available at: http://www.moef.nic.in/sites/default/files/M%20Karthik.pdf

4. Methane Emission Factor (EF_i) for the industry

The emission factor for the industrial sectors was estimated using the maximum methane producing capacity and the applicable average industry specific methane correction factor. The value of the Methane Correction Factor is based on the prevalent wastewater treatment system used in the respective industrial sector (see **Table** 2).

Specific values used for the Methane Emission Factor and the Methane Correction Factor are indicated in the India's Second National Communication reports for some of the sectors (see Table 5).

The following data sources are used, in the order of preference (based on the availability of information) for consistency with India's National Communication and the IPCC guidelines

1. India's Second National Communication to the UNFCCC
2. 2006 IPCC Guidelines (Chapter 6:Wastewater Treatment and Discharge)
3. Sector-specific documents and studies (used where information is not available from NEERI and IPCC guidelines)

The Methane Correction Factors used and references to identify the prevalent wastewater treatment technologies for the industrial sectors are indicated in Table 5.

Table 5: Industry-wise Methane Correction Factor based on the prevalent treatment system

Industry	Bo (kg CH4/kg COD)[23]	MCF[24]	EF= *Bo x MCF* (kg CH4/kg COD)	Reference for Prevalent Treatment technology
Iron & Steel	0.25	0	0	Sirajuddin, Ahmed, Umesh Chandra, R. K. Rathi, (2010) "Waste water treatment technologies Commonly practiced in Major Steel Industries of India" In 16th Annual International Sustainable Development Research Conference 2010 , 30 May – 1 June, 2010 The University of Hong Kong, Hong Kong. Available at: http://www.kadinst.hku.hk/sdconf10/Papers_PDF/p537.pdf
Fertilizer	0.25	0.2	0.05	India's Second National Communication to the UNFCCC, 2012
Beer	0.25	0.8	0.2	2006 IPCC guidelines for National Greenhouse Gas Inventories, Chapter 6:Wastewater Treatment and Discharge
Sugar	0.25	0.8	0.2	• India's Second National Communication to the UNFCCC, 2012 • Methane extraction from Organic wastewater, at Mandya District, Karnataka< India by M/s Sri Chamundeswari Sugars Ltd https://cdm.unfccc.int/Projects/DB/DNV-CUK1176804855.99/view
Soft Drink	0.25	0.8	0.2	2006 IPCC guidelines for National Greenhouse Gas Inventories, Chapter 6:Wastewater Treatment and Discharge
Coffee	0.25	0.8	0.2	2006 IPCC guidelines for National Greenhouse Gas Inventories, Chapter 6:Wastewater Treatment and Discharge

[23] Bo value is taken as default from IPCC guidelines on Wastewater treatment
[24] MCF value is taken based on treatment systems listed in IPCC Guidelines (see **Table** 2)

Industry	Bo (kg CH4/kg COD)[23]	MCF[24]	EF= *Bo x MCF* (kg CH4/kg COD)	Reference for Prevalent Treatment technology
Petroleum Refineries	0.25	0	0.0	Technical EIA Guidance Manual for Petroleum Refining Industry prepared by IL&FS Ecosmart Limited for MoEF, 2010. Available at: http://envfor.nic.in/sites/default/files/TGM_Petroleum_Refineries_010910.pdf
Dairy	0.25	0.8	0.2	India's Second National Communication to the UNFCCC, 2012
Meat	0.25	0.8	0.2	2006 IPCC guidelines for National Greenhouse Gas Inventories, Chapter 6:Wastewater Treatment and Discharge
Pulp & Paper	0.25	0.8	0.2	• India's Second National Communication to the UNFCCC, 2012 • Methane recovery from wastewater generated at Paper manufacturing unit of Sree Sakthi Paper Mills Ltd., Kerala, India https://cdm.unfccc.int/Projects/DB/SGS-UKL1236761076.31/view
Rubber	0.25	0	0	• Central Pollution Control Board (CPCB), Pollution Control Implementation Division – III report on 'Pollution Control in Natural Rubber Processing Industry'. Available at: http://cpcb.nic.in/divisionsofheadoffice/pci3/pciiiidivrubber.pdf • Woodard, F. (2001). Industrial waste treatment handbook. Available at: http://neerienvis.nic.in/pdf/publications/e-book/Industrial%20Waste%20Treatment%20Handbook.pdf
Tannery	0.25	0.2	0.05	India's Second National Communication to the UNFCCC, 2012

5. Methane Recovery Rates

CH_4 is recovered in some of the industries such as sugar, beer and dairy for energy purposes. In such cases, the methane recovered is to be subtracted from the total CH_4 estimated to be emitted from wastewater treatment in these industries. Methane recovery rates have been taken as per India's Second National Communication for 2007 as follows:

- Sugar: 70% methane recovery rate

- Beer: 75% methane recovery rate
- Dairy: 75% methane recovery rate

Results and Comparison with National Inventory

The GHG emission estimates for time period 2007-2012 along with a comparison with official national reporting (for years 2007 and 2010) are given in Table 6. The estimates for 2007 and 2010 show an over-estimation, with a deviation of 47% and 125% as compared to the national reporting estimates.

Table 6: Results of GHG emission Estimation and Comparison with National Inventory Reporting

GHG Emissions from Industrial Wastewater (Megatonnes of CO_2e)	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
India GHG Platform Estimates	32.51	36.02	49.52	48.76	58.96	54.02
As per Second National Communication (2007) and Biennial Update Report (2010)	22.1	-	-	21.7	-	-
Deviation as compared to official estimates (%)	+47%	-	-	+125%	-	-

This notable deviation in the results can be attributed largely to ambiguity over the values of multiple parameters, assumptions data sources used in official national inventories for 2007 and 2010 across the industrial sectors. The possible reasons for the deviation are discussed further below:

- The methodology for GHG emission estimation from industrial wastewater is dependent on a number of parameters and coefficients such as sector-wise production data, wastewater generation per tonne of product, COD values, and the Methane Correction Factor (based on the prevalent treatment technologies in the industry). Limited clarity and information is provided in the National Communication Reports and the Biennial Update Report on values, assumptions and specific data sources used for these parameters in the preparation of the 2007 and 2010 national inventories. While the data requirements and information gaps were addressed using appropriate data sources such as NEERI reports/documents, however, lack of detail and clarity in the National Communication reports hampered efforts to ensure consistency and comparability with the official National GHG estimates.
- It is not possible to use single source datasets such as the ASI due to issues, namely, the reporting of industrial production data in multiple units of measurement and lack of requisite guidance in the ASI database for normalization/conversion of the data to a single unit (i.e. tonnes). This has necessitated use of multiple data sources for each of the industrial sectors under consideration. While nationally acceptable data sources such as the Indian Bureau of Mines, National Dairy Development Board, Rubber Board, Fertilizers Association of India, and the Department of Industrial Policy & Promotion have been used to access production data, the use of multiple data sources for this key parameter has impacted the reliability of information and the emission estimates.

- The deviation of the emission estimates as compared to the 2010 national emission inventory is higher than that in 2007. It is not known if the 2010 inventory took into consideration the technological and process improvements; likely to impact parameters such as Wi – Wastewater production per tonne of product and Methane correction factor, which in turn would reduce wastewater generation and overall associated GHG emissions. However, due to lack of such updated information in the National Communication and Biennial Updated Reports and in the absence of other documentation with relevant data, constant values of wastewater generated per tonne of product have been used for all the years (2007-2012) in this assessment.
- In this assessment the condition of aerobic treatment systems for Iron & Steel, Petroleum and Rubber industries is assumed to be well managed, and thereby these systems have MCF value as 0 and emission factor of 0 (see Table 2 and Table 5), leading to no CH_4 emissions from wastewater treatment in these sectors. If the aerobic treatment systems for these three industrial sectors are taken to be not well managed and over loaded, these systems will have a MCF value as 0.3 and thereby an emission factor of 0.075. In this case, the subsequent CH_4 emissions due to wastewater treatment in these sectors will lead to overall emission of 37.11 Megatonnes of CO_2e and 54.27 Megatonnes of CO_2e for 2007 and 2010 respectively, with a deviation of 14% and 11% respectively as compared to emissions estimates for 2007 and 2010 under this assessment.
- In the absence of alternate reliable data sources, the ASI dataset has been used to obtain the production data for Beer and Soft Drinks. The average densities of Beer – 1 gm/ml, Soft drinks – 1.04 gm/ml and Aerated drinks – 1.02 gm/ml were used to convert the industrial production data available in multiple units to a single unit of tonnes. However, since the ASI dataset is largely a statistical reporting exercise and the data collected by the ASI is not analyzed further, inconsistencies are observed in the dataset. It is observed that the production data reported in the ASI dataset for Beer, Soft Drinks and Aerated drinks does not follow a particular trend and appears erroneous with high variance over consecutive years. Further, if the production data reported under Aerated drinks in the ASI dataset is used in the GHG emission estimation, the resulting emission estimates are observed to be abnormally high, with a variation of +4541% (45 times) and 7076% (70 times) as compared to the Second National Communication (2007) and Biennial Update Report (2010). Thus, aerated soft drinks have not been included in the final emission estimates as indicated in the section on 'Industrial Production' under 'Data Sources and Assumptions'.

Remarks

Limited information is available in the emission estimation process and datasets used in the in the documentation of official National Inventories for India. Details of the assumptions, values of various parameters/coefficients, data sources and disaggregated results of GHG emission from industrial wastewater for various industrial sectors are not available in these documents as well. Limited updated information on country specific values for parameters exists in the IPCC guideline documents and also in other secondary sources to enable an accurate and updated estimation of GHG emissions from industrial wastewater.

Improved transparency with regards to availability of the underlying datasets and assumptions used for the official National GHG emission estimates in the public domain will greatly help in improving the accuracy of this assessment, enable better comparability, and help identify and address any limitations in the estimates done under this assessment as well as official emission estimates.