GHG Platform INDIA

Status of the Swacch Bharat Mission (Urban) and Implications on India's Solid Waste Emissions

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Introduction

The Government of India (GoI) has launched the nationwide flagship Swacch Bharat Mission, which aims to achieve Swachh Bharat (Clean India) by 2nd of October 2019. The Swachh Bharat Mission - Urban targets universal sanitation coverage in urban areas of India. This brief focuses on the progress of the 'Solid waste management' component under the Swachh Bharat Mission - Urban and analyses impacts of the programme on greenhouse gas (GHG) emissions from the solid waste management sector.

Background

The Waste sector contributed to 3.7% of India's total national-level GHG emission (including land use, land use change and forestry) in year 2013 as per estimates prepared by the GHG Platform India. Emissions from disposal of municipal solid waste (MSW) are estimated to contribute to 16.7% of the total Waste sector emissions in 2013 (Chaturvedula et. al., 2017). MSW is generally defined as waste collected by local municipal governments or other local authorities, typically including residential, commercial, and institutional waste, street sweepings, and garden and park waste in either solid or semi-solid form (excluding industrial, hazardous, bio-medical and e-waste). On disposal of MSW in landfills or in dumpsites in urban areas of the country and in the presence of anaerobic conditions, the methanogenic bacteria break-down the degradable organic component in the waste, releasing methane (CH_4) emissions. Decomposition of the organic content occurs slowly and the CH_4 emissions from a given mass of solid waste deposited continue to be released over a time period spanning a few decades. Waste disposal in the rural areas predominantly occurs in a dispersed manner in India and does not generate significant CH_4 emissions, owing to negligible amount of rural solid waste being piled up in disposal sites in a way that forms anaerobic environments to generate CH_4 emissions).

GHG emission from solid waste disposal depends mainly on the total quantum of solid waste, its composition, the method of disposal, and characteristics related to the disposal site. The rise in solid waste disposal emissions is driven by increasing waste generation rates and growing population, leading to higher quantum of waste going to disposal sites. Changing consumption, land-use patterns and technological advancements have impacted the kind of waste that needs to be managed. Waste composition in Indian cities has undergone a change over the years, leading to an increase in the consumption of paper, paper packaging, plastics and consumer products. The quantum of emissions generated due to MSW disposal over the long term – disposal of a tonne of MSW led to GHG emission of 86 kg of CO_2e during 1954-1960[1], which has increased by 2.7 times to 233 kg of CO_2e for every tonne of MSW disposed during 2005-2013 (Chaturvedula et. al., 2017).

In the absence of adequate waste processing and treatment systems, more than 80% of the MSW generated is dumped at disposal sites without undergoing any treatment or processing.

[1] This analysis and insight into long-term emission related trends for solid waste is a result of the first order decay (FOD) method being followed in the GHG Platform India estimation of emissions from solid waste disposal. The FOD method considers that waste deposited in a disposal site at a point in time decomposes gradually and continues to undergo anaerobic digestion again and generate CH_4 over a long period of time (around 50 years). CH_4 emission will be generated until the waste deposited in the disposal site decomposes completely and reaches its full methane generation potential.Therefore, to fully account for emissions from solid waste disposal in the GHG Platform India estimates starting form year 2005, it is necessary to estimate emissions for a 50-year period before this year i.e. from 1954-2004.

India had only 69 sanitary landfill sites constructed and operational in 2013-14, hence most of the MSW is dumped in open land or in non-scientifically managed unsanitary landfills (open dump sites) (Michealowa, 2015). Driven by growing waste generation and population, urban areas in India are expected to generate 276,342 tonnes per day (TPD) of MSW by 2021, 450,132 TPD by 2031 and 1,195,000 TPD by 2050 (Planning Commission, 2014). GHG emissions from solid waste disposal are estimated to double by 2030 as compared to 2015. Cities housing more than 1 million inhabitants will contribute more than 50% of the total MSW disposal emissions by 2030, with India expected to have 68 such cities by 2030 (Michealowa, 2015). Thus, it is critical that timely interventions are made and appropriate long-term solutions and systems are put in place for Indian cities to address waste management while factoring in impacts on GHG emissions.

The Swachh Bharat Mission - Urban

Municipal solid waste management (SWM) is one of six components covered under the SBM-U, referring to a systematic process that comprises of waste segregation and storage at source, primary collection, secondary storage, transportation, secondary segregation, resource recovery, processing, treatment, and final disposal of solid waste in engineered landfills. SBM-U seeks to cover 4,041 statutory towns/cities that exist in the country as per the 2011 Census for SWM. About 52% (73,658.2 Million INR) of the total SBM-U mission funds have been allocated for SWM (NSSO, 2016). Several campaigns launched to promote cities to engage actively in the SBM include:

- Swacch Survekshan, launched in 2015 introduced healthy competition and ranking system among Cities to improve cleanliness standards, with the cities of New Delhi Municipal Council, Tiruchirappalli, Jamshedpur, Navi Mumbai and Gangtok identified as the cleanest cities across different zones of the country in the Swachh Survekshan 2017
- Segregation at source campaign, launched in 2017 which pushes for segregation at source
- City Compost Policy, 2017 which emphasizes to convert all organic waste in cities into compost or biogas by 2019
- Swachhata Pakhwada, 2017 which focuses to bring behavioral and attitude changes to people in SWM
- Swachhata Hi Seva Campaign, 2017 seeking to mobilize people to directly involve in SBM

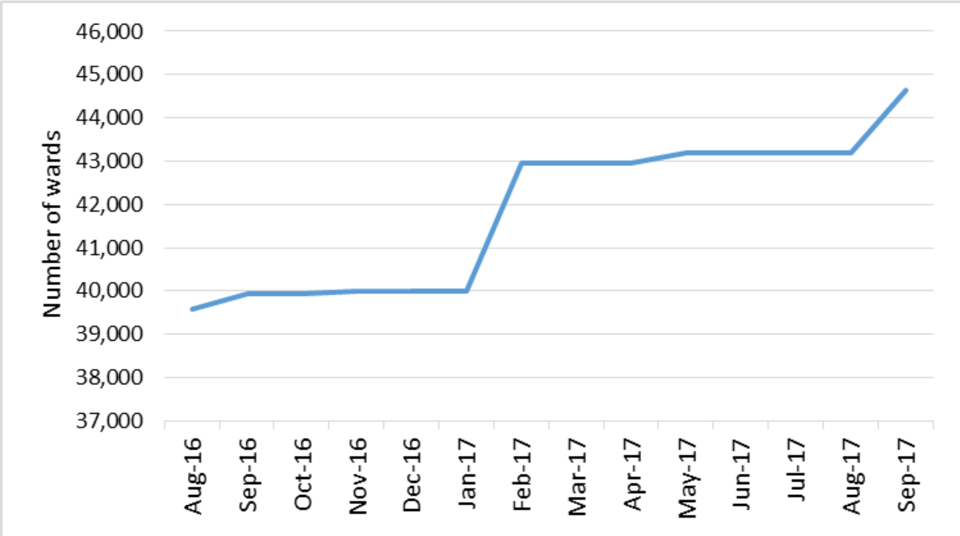
Progress Reported under the Swachh Bharat Mission -Urban

During its initial two years since its rollout, the SBM-U focused on bringing about necessary regulatory and policy changes to facilitate scientific processing of waste. In the third year, the mission shifted its focus towards bringing about behavior change among citizens and encouraging source segregation of waste. The SBM-U aims to achieve 100% door-to-door waste collection between 2014 and 2019. Overall door-to-door collection efficiency has increased from 40.3% to 54% over a two year period from 2015 to 2017. 100% door-to-door collection was achieved in 31,470 of 78,003 target wards[2] in total in 2015 (NIUA, 2015). In 2017, 44,650 wards

[2] Information as of August 2015.

out of 82,725 wards[3] in total achieved 100% door-to-door collection (MoHUA, 2017). The states and union territories of Andaman & Nicobar Islands, Chandigarh, Daman & Diu, Delhi, Goa, Gujarat, Mizoram, and Puducherry have 100% door-to-door collection in all of their wards as of September 2017.

Figure 1: Number of Wards with 100% Door-to-Door Collection Achieved (Aug 2016-Sept 2017)



(Source: Swachh Bharat Urban Website)

Door-to-door collection, however, is only the first step of waste management; adequate infrastructure for waste processing and disposal is critical to ensure that the collected waste is properly managed and treated. **The country's MSW processing capacity was reported to be 15.6% in 2015[2] (NIUA, 2015). Over the subsequent two year period up to 2017[3], the processing capacity has increased to nearly 23% (MoHUA, 2017)** as shown in Table 1, thereby diverting a significant quantum of MSW undergoing processing through composting, bio-methanation, and waste- to-energy routes from disposal sites and avoiding GHG emission resulting from its disposal. Around 20 states have registered an increase in waste processing, to varying degrees, from 2015 to 2017. However, **waste processing remains highly inadequate in a number of states, with less than 10% of the waste being processed in 10 states (Andhra Pradesh, Assam, Chhattisgarh, Haryana, Jammu & Kashmir, Punjab, Mizoram, Odisha, Uttarakhand and West Bengal)**. Only 29% (INR 21,262.4 million) of the funds allocated for SWM under SBM-U have been released as of September 2017. The three states of Tamil Nadu, Rajasthan and Andhra Pradesh account for 48% of all SWM fund disbursements between October, 2014 and 18 January, 2017. Six states and union territories, including Gujarat, Assam and Kerala, did not receive any funds for SWM until January 2017 since the commencement of the programme. Funds allocated for SWM for year 2016-17 were yet to reach 23 states and union territories as of January, 2017 (CPR, 2017).

Issues also exist with regard to the accuracy of reported information. For instance, discrepancies are seen when comparing the reported quantities of solid waste generated in the states for a two year period between 2015 and 2017 in Table 1. Total waste generation of

[3] Information as of September 2017

14,820 TPD is reported for Bihar in 2017 which is about 4 times more than that reported in year 2015. Information reported for two of India's most populous and urbanized states – Maharashtra and Uttar Pradesh, also having the highest contribution to the country's solid waste - indicates no change in waste generation and moreover a decrease in the case of Uttar Pradesh. This trend is also observed for the waste generation data reported for a number of states and union territories including Chandigarh, Chhattisgarh, Dadra & Nagar Haveli, Jharkhand, Madhya Pradesh and West Bengal among others. This is in contrast to the acknowledged annual increase of about 5% in overall quantity of solid waste, which is understood to be a product of 3-3.5% of annual growth in urban population growth allied with rising per capita waste generation (Michealowa, 2015).

Estimates of per capita generation rates based on data reported in 2015 under the SBM have been included for the states in Table 1. Rising income levels and consumption patterns are driving a rise in the per capita generation rate, which is growing at 1.2% annually (Joshi, 2016). Comparing the estimated realistic waste generation quantities in Table 1 (calculated using state-wise population growth rates, per capita waste generated based on 2015 data reported by SBM-U, and factoring in rising per capita generation) with the reported waste generation data for 2017 shows that overall waste generation has been over-reported by 3.4% (i.e. 161,504 TPD of waste generation reported as against 156,141 TPD estimated). While the overall variation may seem low, the variation in the solid waste generation figures is considerable across some of the states that have been indicated above. Further, **with regard to reported information on waste processing, often times reporting of waste treatment rates by cities is largely done based on the installed capacities of the processing plants and does not account for operational status (non-operational/low capacity utilization). Thereby, any impacts due to inadequate functioning of the processing plants are not reliably captured in reported information.**

Table 1: State-wise Waste Generation and Progress of Waste Processing under SBM (2015-2017)

State/Union Territory	Information reported in SBM documents (as of Aug 2015)		Estimated per capita waste generation[4] (kg per day) (2015)	Information reported in SBM documents (as of Sept 2017)		Estimated Total Waste Generation based on per capita generation from 2015 SBM data and population growth[5] (TPD) (2017)
	Total Waste Generation (TPD) (A)	Percentage of Waste Processing (B)	(C)	Total Waste Generation (TPD) (D)	Percentage of Waste Processing (E)	(F)
Andaman & Nicobar	70	30%	0.45	115	23%	75
Andhra Pradesh	5,980	8%	0.33	6,440	8%	6,562
Arunachal Pradesh	110	15%	0.30	181	15%	120
Assam	650	0%	0.13	1,134	7%	699
Bihar	3,703	0%	0.28	14,820	40%	4,029
Chandigarh	340	100%	0.30	340	100%	365
Chhattisgarh	1,896	0%	0.27	1,850	3.0%	2,082
Dadra & Nagar Haveli	35	0%	0.12	35	0%	44
Daman & Diu	85	0%	0.25	23	0%	107
Delhi	8,390	52%	0.46	10,500	52%	9,011
Goa	183	25%	0.18	240	52%	199
Gujarat	9,227	28%	0.31	10,145	28%	10,047
Haryana	3,490	25%	0.33	4,514	1%	3,846
Himachal Pradesh	300	20%	0.41	342	25%	316
Jammu & Kashmir	1,792	2%	0.46	1,792	2%	1,952
Jharkhand	3,750	0%	0.42	2,350	15%	4,062
Karnataka	8,784	34%	0.33	10,000	38%	9,502

[4] Estimates based on the projected state population for 2015 based on annual average growth rate from Census data for year 2001-2011 and the corresponding reported Swacch Bharat data on the quantum of 'total waste generation' as of August 2015 in column A.
[5] Estimates based on the projected state population for 2017 based on annual average growth rate from Census data for year 2001-2011 and projected 'per capita waste generation' for 2017. The projected 'per capita waste generation' for 2017 is calculated by applying a 1.2% annual average growth to the estimated 'per capita waste generation' for 2015 given in column C.

State/Union Territory	Information reported in SBM documents (as of Aug 2015) Total Waste Generation (TPD) (A)	Information reported in SBM documents (as of Aug 2015) Percentage of Waste Processing (B)	Estimated per capita waste generation[4] (kg per day) (2015) (C)	Information reported in SBM documents (as of Sept 2017) Total Waste Generation (TPD) (D)	Information reported in SBM documents (as of Sept 2017) Percentage of Waste Processing (E)	Estimated Total Waste Generation based on per capita generation from 2015 SBM data and population growth[5] (TPD) (2017) (F)
Kerala	1,576	50%	0.07	1,576	50%	1,833
Madhya Pradesh	5,079	12%	0.23	5,079	14%	5,445
Maharashtra	26,820	10%	0.48	26,820	10%	28,661
Manipur	176	50%	0.18	176	50%	194
Meghalaya	268	58%	0.40	268	58%	290
Mizoram	253	4%	0.40	239	4%	273
Nagaland	270	0%	0.37	342	17%	306
Odisha	2,460	2%	0.32	2,460	2%	2,643
Puducherry	495	20%	0.52	495	20%	535
Punjab	3,900	10%	0.34	4,100	10%	4,182
Rajasthan	5,037	15%	0.26	6,400	16%	5,428
Sikkim	49	0%	0.20	89	67%	60
Tamil Nadu	14,532	15%	0.38	15,272	28%	15,613
Telangana	5,520	18%	0.39	7,371	51%	6,057
Tripura	407	0%	0.32	421	45%	466
Uttar Pradesh	19,180	7%	0.39	15,500	13%	20,664
Uttarakhand	1,013	0.5%	0.29	1,400	0.7%	1,109
West Bengal	8,674	0%	0.27	8,675	6%	9,362
Total	**144,494**	**15.6%**	**0.34**	**161,504**	**22.9%**	**156,141**

Impact on GHG Emissions

Improvements in waste processing under SBM have contributed towards a lower rate of increase in the overall GHG emissions from MSW disposal[6]. **Emissions are estimated to have risen at 0.6% per annum over the two year period from 2015 to 2017 (see Box 1)**. This is lower than the compound annual growth rate (CAGR) of 6.1% observed from 2005-2013 for national level emission estimates prepared by the GHG Platform India (Chaturvedula et. al., 2017). **Per capita emissions from MSW disposal are estimated to have fallen from 23.63 kg CO_2e in 2015 to 22.59 kg CO_2e in 2017.**

While the increased quantum of MSW undergoing processing will lead to avoided emissions from disposal, it is important to assess whether the benefits of improvements in processing under SBM-U are being offset by the increase in overall quantity of MSW generated. As seen in Box 1, **for a two year period from 2015 to 2017, GHG emissions are estimated to have increased by an absolute value of 128,000 tonnes of CO_2e despite the waste processing increasing by over 7 percentage points in this same period**. **Thus, it can be deduced that improvements achieved in MSW processing have not kept pace with the cumulative increase in MSW generation. Based on SBM data reported from 2015 to 2017, emissions from MSW disposal are estimated to have risen in 25 states while only 9 states are observed to have a lower absolute value of emissions over this two year period. While overall per capita emissions from MSW disposal have decreased, this trend is reflected in less than half the states, with 18 states witnessing an increase in estimated per capita emissions from 2015 to 2017.**

The progress of the SBM-U for SWM has been slower than anticipated and consequently the considerable mitigation potential of this initiative remains untapped. Improving waste processing infrastructure to the targeted levels under SBM-U across the states can lead to potential reduction of nearly 1.2 million tonnes of CO_2e (owing to avoided emissions from MSW disposal) as compared to year 2015 (see Box 1 and Table 2 in Annexure). This would represent a cumulative decrease of 12% in emissions from MSW disposal in year 2019 from year 2015, with emissions decreasing by 2.9% annually despite the anticipated increase in MSW generation.

Realizing this emission mitigation potential will require significant improvements towards implementing as well as operationalizing waste processing facilities across the states. Among the ten states with the highest contribution to emissions from solid waste disposal (also ranking high in the terms of the size of the resident urban population) emissions are estimated to have decreased only in Tamil Nadu and Telangana, with both states reported to have exceeded the targeted augmentation in waste processing under SBM (see Figure 2). **Only about one-fifth of the MSW generated by the largest states is processed. Key states such as Maharashtra, Andhra Pradesh, Madhya Pradesh and Delhi need to fast-track augmentation of their waste processing capabilities.**

[6] This assessment includes emissions resulting from disposal of solid waste in landfills. It does not account for emissions generated from waste processing/treatment, which are anyway much lower as compared to that from waste disposal, due to limited information available on the operational capacities and technologies of waste processing facilities across states in India under SBM.

Box 1: Impacts of SBM on GHG Emissions from Urban Solid Waste Disposal		
A) Highlights of Trends in Emissions from MSW disposal from 2015 to 2017 as a result of SBM Progress		
Overall India	**2015**	**2017**
Annual GHG emission	10.08 million tonnes of CO_2e	10.21 million tonnes of CO_2e
Absolute change in emissions	-	+0.128 million tonnes of CO_2e
Percent change in emissions	-	+1.3% (rise of 0.6% annually)
Per capita GHG emission	23.63 kg CO_2e	22.59 kg CO_2e
Percent change in per capita emissions	-	- 4.4% (fall of 2.2% annually)
Total MSW generation[7]	144,494 TPD	156,141 TPD
Percent of waste that is processed	15.6%	22.9%
Percent change in per capita waste generation	-	+2.44% (rise of 1.22% annually)
Percent change in population	-	+5.9% (rise of 2.9% annually)
States[8]	**Increase in emissions**	**Decrease in emissions**
Annual GHG emission	25 states (Andaman & Nicobar, Andhra Pradesh, Arunachal Pradesh, Assam, Chhattisgarh, Dadra & Nagar Haveli, Daman & Diu, Delhi, Gujarat, Haryana, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Mizoram, Odisha, Puducherry, Punjab, Rajasthan, Uttarakhand, Uttar Pradesh, West Bengal)	9 states (Bihar, Goa, Himachal Pradesh, Jharkhand, Nagaland, Sikkim, Tamil Nadu, Telangana, Tripura)
Average% change in emissions	+10.5%	-24.5%
Highest change in emissions in% terms	Haryana (+ 45.5%)	Sikkim (- 59.7%)
Per capita GHG emission	18 states (Andaman & Nicobar, Andhra Pradesh, Arunachal Pradesh, Dadra & Nagar Haveli, Daman & Diu, Delhi, Gujarat, Haryana, Jammu & Kashmir, Kerala, Maharashtra, Manipur, Meghalaya, Mizoram, Odisha, Puducherry, Rajasthan, Uttarakhand)	16 states (Assam, Bihar, Chhattisgarh, Goa, Himachal Pradesh, Jharkhand, Karnataka, Madhya Pradesh, Nagaland, Punjab, Sikkim, Tamil Nadu, Telangana, Tripura, Uttar Pradesh, West Bengal)
Average% change in per capita emissions	+4.4%	-20.3%
Highest change in% terms in per capita emissions	Haryana (+ 35.2%)	Sikkim (-66.2%)

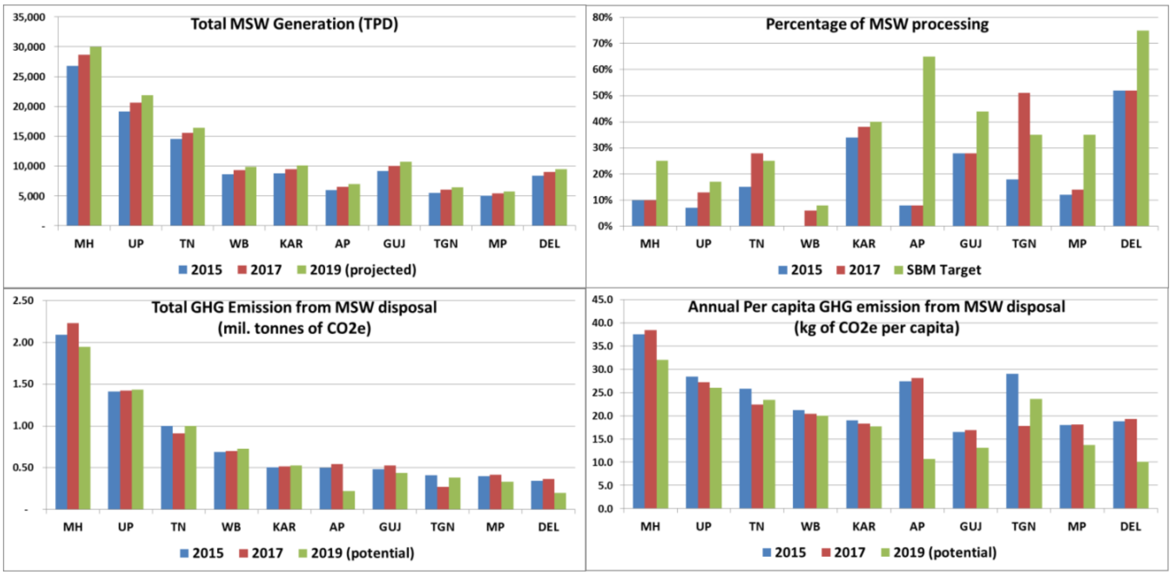
[7] The 'Total MSW generation' for year 2015 is based on data reported under SBM as of August 2017 while MSW generation for year 2017 has been estimated based on the rise in per capita generation rate and population growth due to discrepancies in the data reported under SBM.

[8] No change in Chandigarh which reports 100% processing for 2015 & 2017 and thus has no avoided emissions from disposal; Lakshadweep data not reported

B) Potential Impact on Emissions from MSW disposal on realizing SBM Waste Processing Targets[9]		
Overall India	**2015**	**2019**
Annual GHG emission	10.08 million tonnes of CO_2e	8.89 million tonnes of CO_2e
Absolute change in emissions	-	-1.19 million tonnes of CO_2e
Percent change in emissions	-	-11.8% (fall of 2.9% annually)
Per capita GHG emission	23.63 kg CO_2e	18.41 kg CO_2e
Percent change in per capita emissions	-	• -22.1% (fall of 5.5% annually)
Total MSW generation	144,494 TPD	• 165,766 TPD
Percent of waste that is processed	15.6%	• 32.6%

Note: Further details of the figures and calculation notes available in Table 2 in the Annexure
(Source: ICLEI South Asia analysis based on data from Swacch Bharat Urban website)

Figure 2: Status of Waste Processing and Emissions for Key States



Note: MH – Maharashtra, UP- Uttar Pradesh, TN- Tamil Nadu, WB- West Bengal, KAR- Karnataka, AP- Andhra Pradesh, GUJ- Gujarat, TGN- Telangana, MP- Madhya Pradesh, DEL- Delhi

Mitigation Opportunities through Waste Processing and Disposal Infrastructure

The increased focus on waste segregation makes composting a key opportunity to process organic waste and mitigate GHG emissions which would otherwise result from its unscientific disposal. **T**here are 95 functional/sub-optimal compost plants in the country with a production capacity of 2.36 million tonnes per annum while the total production of city compost from these plants is approximately 330,000 tonnes per annum. Additionally, there are 313 plants under

[9] Based on available information in SBM documents, the State-wise 'Waste processing Targets' under SBM were outlined for March 2016. Since most of the states have not met the Waste processing targets and in the absence of information of any revisions in the targets, these values are assumed to apply till the end of the SBM in 2019 to estimate potential impact if these targets were realized.

construction/up gradation/revival with a capacity of 2.31 million tonnes per annum. Thus cumulatively, taking into consideration both functional and under construction compost plants, the production capacity is set to reach 4.67 million tonnes per annum by March 2018 (MoHUA, 2017).

Bio-methanation technology can help generate methane-rich biogas from organic waste, which can be used for heating, upgrading to natural gas quality or co-generation of electricity and heat, thereby substituting fossil energy. Other waste to energy technologies such as incineration can be adopted to convert inorganic combustible waste into energy. Waste-to-energy is a crucial component of SBM-U and installation of 88.4 MW out of the targeted capacity of 493.7 MW in 2016-17 and 63.4 MW out of targeted 330 MW in 2017-18 has been completed (Henam & Agarwal, 2017). In order to push for sustainable processing, waste-to-energy plants need to be scaled up from the current capacity to 511 MW by 2019 (Sharma, 2017). **Further, the quantum of recyclables such as plastic, metal, glass, construction and demolition waste is also growing across states in the country. Ensuring the availability of the right type and quality of waste through improved waste segregation will help realize the mitigation potential from reuse and recycling of such waste**. It is important to bear in mind that most of the **existing waste processing treatment facilities have encountered significant problems during operation or operate at throughputs far below their capacity. This has led to inadequate processing/treatment/disposal systems for MSW, resulting in larger quantum of waste being sent to dumping/disposal sites**.

Scientific treatment and disposal of MSW and scientific closure of already existing landfill or dump sites will drastically reduce the release of CH_4. Non-scientifically managed disposal sites are prevalent across cities. Dumpsites are characterized by the absence of leachate or methane collection systems absent and exposure of MSW to natural elements such as heavy rain or strong winds. Even the sanitary landfills are not properly managed resulting in CH_4 emissions, landfill fire and leachate problems. Few cities practice leachate collection and treatment and very few projects for landfill gas recovery exist in the country (Michealowa, 2017).

Along with infrastructure development and service delivery enhancement, ensuring sustainable operation of waste processing technologies, particularly waste-to-energy, has become important to improve the overall waste management system and reduce emissions. Estimates suggest that with planned efforts to Reduce, Reuse, Recover, Recycle and Remanufacture (5Rs) and appropriate choice of technology, India can profitably utilize about 65% of MSW in producing energy and/or compost and another 10 to 15% to promote recycling and bring down the quantity of wastes going to landfill or dumpsites to under 20% (Planning Commission, 2014). Given such considerable potential for emission mitigation and the need for improved waste management to tackle ever-increasing MSW volumes, it becomes crucial to ensure that India has a long-term strategy for augmenting waste processing and disposal infrastructure across its cities, beyond the Swacch Bharat targets.

Annexure

Table 2: Estimated Impact of SBM on GHG Emission from Solid Waste Disposal

State/Union Territory	Avg. GHG emission per tonne of MSW disposed based on GHG Platform India state-estimates (kg of CO_2e) (A)	2015			2017				2019		
		Reported Total Waste Generation (TPD) (B)	Reported percentage of Waste Processing (C)	Estimated Annual Total GHG emission from solid waste disposal (tonnes of CO_2e) (D)	Estimated Total Waste Generation (TPD) (E)	Reported percentage of Waste Processing (F)	Estimated Annual Total GHG emission from solid waste disposal (tonnes of CO_2e) (G)	Change in Annual GHG emissions from MSW disposal compared to 2015 (tonnes of CO_2e) (H)	Projected Total Waste Generation (TPD) (I)	Target percentage of Waste Processing under SBM (J)	Potential change in Annual GHG emissions from MSW disposal compared to 2015 (tonnes of CO_2e) (K)
Andaman & Nicobar	246.2	70	30%	4,404	75	23%	5,176	772	78	40%	(182)
Andhra Pradesh	247.8	5,980	8%	497,686	6,562	8%	546,140	48,454	7,030	65%	(275,118)
Arunachal Pradesh	235.3	110	15%	8,029	120	15%	8,783	754	130	25%	330
Assam	245.3	650	0%	58,191	699	7%	58,220	29	738	20%	(5,315)
Bihar	238.0	3,703	0%	321,634	4,029	40%	209,960	(111,675)	4,314	30%	(59,323)
Chandigarh	261.2	340	100%	-	365	100%	-	-	385	100%	-
Chhattisgarh	178.4	1,896	0%	123,432	2,082	3.0%	131,443	8,011	2,256	10%	8,732
Dadra & Nagar Haveli	182.2	35	0%	2,328	44	0%	2,940	612	64	0%	1,896
Daman & Diu	131.2	85	0%	4,070	107	0%	5,143	1,072	154	0%	3,324
Delhi	232.2	8,390	52%	341,367	9,011	52%	366,645	25,278	9,495	75%	(140,158)
Goa	244.2	183	25%	12,234	199	52%	8,516	(3,718)	213	100%	(12,234)
Gujarat	199.9	9,227	28%	484,817	10,047	28%	527,904	43,087	10,770	44%	(44,663)
Haryana	212.6	3,490	25%	203,129	3,846	1%	295,460	92,331	4,189	45%	(24,346)

State/Union Territory	Avg. GHG emission per tonne of MSW disposed based on GHG Platform India state-estimates (kg of CO_2e) (A)	2015 Reported Total Waste Generation (TPD) (B)	2015 Reported percentage of Waste Processing (C)	2015 Estimated Annual Total GHG emission from solid waste disposal (tonnes of CO_2e) (D)	2017 Estimated Total Waste Generation (TPD) (E)	2017 Reported percentage of Waste Processing (F)	2017 Estimated Annual Total GHG emission from solid waste disposal (tonnes of CO_2e) (G)	2017 Change in Annual GHG emissions from MSW disposal compared to 2015 (tonnes of CO_2e) (H)	2019 Projected Total Waste Generation (TPD) (I)	2019 Target percentage of Waste Processing under SBM (J)	2019 Potential change in Annual GHG emissions from MSW disposal compared to 2015 (tonnes of CO_2e) (K)
Himachal Pradesh	329.1	300	20%	28,828	316	25%	28,499	(329)	326	25%	561
Jammu & Kashmir	236.2	1,792	2%	151,402	1,952	2%	164,957	13,555	2,095	40%	(43,051)
Jharkhand	170.2	3,750	0%	232,954	4,062	15%	214,464	(18,490)	4,324	25%	(31,475)
Karnataka	238.8	8,784	34%	505,412	9,502	38%	513,606	8,194	10,102	40%	22,976
Kerala	219.5	1,576	50%	63,141	1,833	50%	73,434	10,293	2,173	70%	(10,907)
Madhya Pradesh	244.8	5,079	12%	399,323	5,445	14%	418,396	19,074	5,725	35%	(66,844)
Maharashtra	237.1	26,820	10%	2,089,128	28,661	10%	2,232,554	143,426	30,017	25%	(140,694)
Manipur	237.9	176	50%	7,641	194	50%	8,422	781	211	60%	(299)
Meghalaya	261.2	268	58%	10,732	290	58%	11,603	870	308	84%	(6,037)
Mizoram	238.9	253	4%	21,180	273	4%	22,847	1,667	289	20%	(1,012)
Nagaland	195.2	270	0%	19,239	306	17%	18,077	(1,161)	346	25%	(729)
Odisha	246.2	2,460	2%	216,645	2,643	2%	232,726	16,081	2,785	50%	(91,509)
Puducherry	239.6	495	20%	34,636	535	20%	37,464	2,829	569	60%	(14,724)
Punjab	239.0	3,900	10%	306,214	4,182	10%	328,389	22,174	4,399	50%	(114,341)
Rajasthan	206.4	5,037	15%	322,605	5,428	16%	343,568	20,963	5,743	65%	(171,145)
Sikkim	191.7	49	0%	3,429	60	67%	1,382	(2,047)	79	20%	971
Tamil Nadu	221.9	14,532	15%	1,000,651	15,613	28%	910,675	(89,976)	16,458	25%	(718)

State/Union Territory	Avg. GHG emission per tonne of MSW disposed based on GHG Platform India state-estimates (kg of CO_2e) (A)	2015			2017				2019		
		Reported Total Waste Generation (TPD) (B)	Reported percentage of Waste Processing (C)	Estimated Annual Total GHG emission from solid waste disposal (tonnes of CO_2e) (D)	Estimated Total Waste Generation (TPD) (E)	Reported percentage of Waste Processing (F)	Estimated Annual Total GHG emission from solid waste disposal (tonnes of CO_2e) (G)	Change in Annual GHG emissions from MSW disposal compared to 2015 (tonnes of CO_2e) (H)	Projected Total Waste Generation (TPD) (I)	Target percentage of Waste Processing under SBM (J)	Potential change in Annual GHG emissions from MSW disposal compared to 2015 (tonnes of CO_2e) (K)
Telangana	247.8	5,520	18%	409,468	6,057	51%	268,504	(140,964)	6,489	35%	(27,922)
Tripura	206.2	407	0%	30,632	466	45%	19,274	(11,358)	537	0%	9,750
Uttar Pradesh	216.6	19,180	7%	1,410,361	20,664	13%	1,421,422	11,061	21,855	17%	23,881
Uttarakhand	186.1	1,013	0.5%	68,458	1,109	0.7%	74,807	6,350	1,198	40%	(19,647)
West Bengal	218.2	8,674	0%	690,744	9,362	6%	700,774	10,031	9,923	8%	36,273
Total	-	**144,494**	**15.6%**	**10,084,143**	**156,141**	**22.9%**	**10,212,176**	**128,033**	**165,766**	**32.6%**	**(1,193,700)**

Notes: 1. Figures in brackets in column G and column K indicate negative values or reduction in GHG emissions

2. State-wise values of 'average GHG emission per tonne of MSW disposed' in column A are based on state-level estimates prepared for 2005-2013 by the GHG Platform India

3. Values of 'Total Waste generation' in column B and 'Percentage of Waste processing' in column C are based on data reported under SBM as of August 2015. Values of 'Percentage of Waste processing' in column F are based on data reported under SBM as of September 2017.

4. Estimates of state-wise 'total waste generation' in column F are based on the projected state population for 2017 based on annual average growth rate from Census data for year 2001-2011 and projected 'per capita waste generation' for 2017. The projected 'per capita waste generation' for 2017 is calculated by applying a 1.2% annual average growth to the estimated 'per capita waste generation' for 2015 provided in Table 1 of this document.

5. The 'Total Annual GHG emission from solid waste disposal' for year 2015 in column D and column G is estimated based on the values of 'average GHG emission per tonne of MSW disposed' in column A and the quantum of waste that is going for disposal. The quantum of waste disposed for year 2015 and 2017 is calculated by estimating the quantum of waste processed based on the values of 'Percentage of waste processing' in column C and column F and deducting this from the corresponding values of 'total waste generation' in column B and column E respectively. Potential emission estimates for year 2019 are calculated similarly based on the values of 'projected total waste generation' in column I and 'Target percentage of Waste processing under SBM' in column J.

6. Based on available information in SBM documents, the State-wise 'Target percentage of Waste processing under SBM' in column J were outlined for March 2016. Since most of the states have not met these Waste processing targets and given the absence of information of any revisions in the targets, these values are assumed to apply till the end of the SBM in 2019.

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