

# **COOLING AGENTS**

AN ANALYSIS OF CLIMATE CHANGE MITIGATION  
BY THE INFORMAL RECYCLING SECTOR IN INDIA

2009

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## PREFACE

Intuition and common sense suggest that recycling waste mitigates greenhouse gases. Now, data from all over the developed world shows this to be true.

Almost 2% of the population in cities of the developing world is made up of recyclers, mostly informal and largely poor. Most of them are scarcely acknowledged legally. If, as common sense suggests, they save greenhouse gases by recycling, then it is unfair to ignore their mitigation work in cities. It is also unwise to ignore this work because it is a valuable resource in the fight against climate change. Thus, the aim of this report is twofold: to establish the relationship between municipal solid waste and greenhouse gases, and to undertake a first attempt at quantifying the emissions reductions attributable to the informal recycling sector in Delhi, India.

Arriving at numbers for recycling rates, waste composition, and other key determinants of greenhouse gas mitigation from waste management is a tall order in many areas of the developing world. Recycling in countries like India, the Philippines, Brazil, Columbia and Thailand is based on the efforts and innovation of millions of informal sector workers. The challenge here is to be able to quantify the many tasks that such workers undertake, and to tease out the wide array of implications for climate change data. For example, informal sector innovation frequently results in a change in travel distances, the mode of transport, and even in what type of recyclable waste is picked up. In much of India, wastepickers use non-motorized transportation for picking up and transporting waste. Sometimes, they travel as far as 20 kilometers from their home on a simple cycle-rickshaw in search for valuable waste. The energy savings implications are obvious. But if a slum demolition drives them to live outside the city, their efforts are often supplemented by motorized transport. Accounting for these shifts is not easy, if at all possible.

The fundamental question Chintan faced was this: how to put numbers to the greenhouse gas savings the informal recycling sector brings to the table? We decided to look only at the materials that were most frequently recycled – leaving out several other additional savings, such as use of non-mechanized transport and informal sector contributions to composting. Yet there were no currently available methodologies for calculating emissions reductions from recycling specifically developed for the Indian context. Therefore, we used material-specific emissions factors developed by the United States Environmental Protection Agency. Though we are ultimately unable to overcome the non-transferability of those emissions factors outside of the U.S. context, close scrutiny reveals that they likely *underestimate* the greenhouse gas savings achieved by recycling in India. In other words, we arrived at a very conservative estimate; it is likely that the savings from recycling are much higher than those we project. Given that numbers all over India are far from accurate, we decided not to calculate savings for the entire country, because the margin of error was likely to be significant. Instead, we decided to restrict our calculations to Delhi alone. Should any other city need help, we are happy to help them think through the process of generating similar estimates for their own informal recyclers.

Among the many findings and recommendations in this report, two are particularly eye-opening:

First, by recycling glass, metals, plastics and paper alone, the informal sector in Delhi reduces emissions by an estimated **962,133 TCO<sub>2</sub>e each year**. This is roughly equivalent to **removing 176,215 passenger vehicles from the roads** annually or **providing electricity to about 133,444 homes** for one year (US estimates). It also compares favorably to the yearly emissions reductions of other projects in Delhi that have been approved for carbon credits under the Kyoto Protocol's Clean Development Mechanism (CDM). For example, the annual contribution of the informal recycling sector to emissions reductions is **more than three times greater than the projected annual emissions reductions from the proposed Timarpur-Okhla Integrated Waste-to-Energy Project**. This plant would include an RDF power plant, a biomethanation plant, and wastewater treatment system in one facility. This massive and capital-intensive project would reduce emissions by an average of 262,791 TCO<sub>2</sub>e per year over the ten-year crediting period, far less than the current GHG mitigation efforts of the informal recycling sector.

The second important conclusion is that structural inadequacies of the CDM are creating climate injustice by forcing the institutional sidetracking of wastepickers and other smaller recyclers. We don't see it because they are informal and operate under our radar screens. The bigger truth is that there are likely millions of informal poor, apart from recyclers, whose work contributes to emissions reductions, but who remain unaccounted for, and unrewarded for protecting our global commons.

As beneficiaries of their services, the onus to advocate for a shift in this paradigm lies on all of us.

**Bharati Chaturvedi**  
**Director**

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## I. EXECUTIVE SUMMARY AND INTRODUCTION

Rising levels of gases in the Earth's atmosphere are affecting the stability of the climate. Warming of the climate system is now unequivocal, evidenced by increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea levels. Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the increase in anthropogenic (human-induced) concentrations of six greenhouse gases (GHGs).<sup>1</sup>

Emissions of some GHGs can be traced directly to Municipal Solid Waste (MSW). Emissions result from virtually every step in the life cycle of materials that end up as waste, from resource extraction, product manufacture, and distribution, to landfill maintenance and solid waste management.<sup>2</sup> Recycling and waste prevention are thus valuable tools in the battle against climate change.

In many countries of the developing world, the urban poor form the backbone of recycling programs. Informal wastepickers, waste recyclers, and small junk dealers, collectively known as the “informal recycling sector,” make up as much as 2% of the urban population in Asia and Latin America.<sup>3</sup> These are men, women, and children who forage through trash heaps and depend on the revenues derived from selling recovered materials for all or part of their livelihood. Their work provides sanitation services to the municipalities where they live and results in reductions in greenhouse gases. The aim of this study is to critically examine the role that the informal recycling sector plays in climate change mitigation in developing countries, with a particular focus on India.

Rapid growth in population, urbanization, and the economy in India during the previous decade have resulted in an intensifying waste burden in urban areas and rising emissions from waste. Formal waste management systems in Indian municipalities are almost universally in non-compliance with national waste management laws, and formal recycling programs are extremely rare. Most emissions reductions from recycling in India are attributable to the informal sector.

The key finding of this study is that the informal recycling sector in Delhi alone accounts for estimated net GHG reductions of 962,133 metric tones of carbon dioxide equivalent (TCO<sub>2</sub>e)

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<sup>1</sup> IPCC, *Climate Change 2007: Synthesis Report, Summary for Policymakers*.

<sup>2</sup> US EPA, *Climate Change and Waste: Reducing Waste Can Make a Difference*.

<sup>3</sup> Wilson et al., “Building Recycling Rates Through the Informal Sector,” 629.

each year. This equates roughly to removing 176,215 passenger vehicles from the roads annually or providing electricity to about 133,444 homes for one year (US estimates). It also compares favorably with the average annual emissions reductions from several formal waste management projects in the city that have received carbon finance through international mechanisms.

The study first reviews the current waste management challenge faced by Indian cities and the ways in which formal and informal actors work to meet this challenge. The study then provides a snapshot of India's aggregate GHG emissions scenario and international climate policy priorities. Next, the study turns to India's emissions from the waste sector and describes the relationship between MSW, GHGs, and waste management technologies and processes. Finally, the quantitative estimate of net GHG reductions from citywide informal sector recycling in Delhi is derived using life cycle analysis tools.

In the 2008 National Action Plan on Climate Change, the Indian government lauded the informal sector as the backbone of India's recycling system and affirmed its role in emissions abatement. Going forward, municipal and national authorities can build upon this gesture to engage seriously with the informal recycling sector and harness their climate entrepreneurship for sustainable development. This report concludes with specific recommendations for how civic agencies might form a more solid partnership with the informal sector.

The companion piece to this study, *Wastepickers and Carbon Markets*, picks up where this one leaves off, exploring the challenges and opportunities to bringing informal recycling sector emissions reductions to market.

## II. MSW MANAGEMENT AND THE INFORMAL SECTOR IN INDIA

### 2.1 Aggregate Trends

Demographic and macroeconomic currents in modern India have significant bearing on the volume of municipal solid waste (MSW) generated each year. With roughly 1.2 billion people, India boasts the second largest population in the world and continues to grow at about 1.4 percent per year.<sup>4</sup> The government of India also remains keenly focused on economic growth. The economy has posted an average growth rate of more than 7 percent in the decade since 1997, and in 2006 and 2007 GDP growth topped 9 percent.<sup>5</sup> Such rapid growth in GDP spurs the consumption of materials and the production of waste.<sup>6</sup> At the same time, urban centers in India are absorbing an increasing share of the country's inhabitants. The urban population already accounts for nearly 30% of all Indians, and every year the urbanization rate grows by 2.4 percent.<sup>7</sup> Following this trajectory, by 2020 India will have more than 400 million urban dwellers.<sup>8</sup> In short, with concurrent growth in population, urbanization, and the economy, the considerable environmental, atmospheric, and public health burdens of waste are already being felt across India's cities.

Urban solid waste generated in India has increased from 6 million tones per year in 1947 to 48 million tones per year in 1997, and currently stands at almost 70 million tones annually.<sup>9</sup> This volume is likely to double by 2015, and double again by 2025.<sup>10</sup> Waste volumes in Delhi and the surrounding National Capital Region (NCR) are particularly high, exceeding even those of most other major Indian cities in both aggregate and per capita terms. A survey of 59 Indian cities in 2004-05 conducted by the Central Pollution Control Board (CPCB) and the National Environmental Engineering Research Institute (NEERI) revealed that Delhi was the largest

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<sup>4</sup> United Nations Population Division, "India: Country Profile."

<sup>5</sup> CIA, "India."

<sup>6</sup> Bogner et al., "Waste Management," 609.

<sup>7</sup> CIA, "India."

<sup>8</sup> Chintan, *Informal-Formal: Creating Opportunities for the Informal Waste Recycling Sector in Asia*, 28.

<sup>9</sup> Prime Minister's Council on Climate Change, *National Action Plan on Climate Change*, 28.

<sup>10</sup> Hanrahan, Srivastava, and Ramakrishna, *Improving Management of Municipal Solid Waste in India: Overview and Challenges*, 8.

producer of MSW in India, generating 5,922 metric tones per day.<sup>11</sup> According to the Municipal Corporation of Delhi (MCD), current daily generation is roughly 8,500 metric tones.<sup>12</sup> Independent analysis by Chintan Environmental Research and Action Group revises this figure upward, in the range of 9,000 to 10,000 metric tones per day, and Chintan projects that by 2020 MSW in Delhi will swell to 23,000 metric tones per day.<sup>13</sup> On a per capita basis, individual residents in Delhi generate nearly .6 kg of waste per person per day.<sup>14</sup>

<b>MSW Volumes and Generation Rates In Ten Major Indian Cities (2005)</b>				
<b>City</b>	<b>Population (2001)</b>	<b>City Area (Sq. Km)</b>	<b>Waste Quantity (Tones Per Day)</b>	<b>Waste Generation Rate (KG / Capita / Day)</b>
Delhi	10,306,452	1483	5922	0.57
Greater Mumbai	11,978,450	437	5320	0.45
Chennai	4,343,645	174	3036	0.62
Kolkata	4,572,876	187	2653	0.58
Hyderabad	3,843,585	169	2187	0.57
Bangalore	4,301,326	226	1669	0.39
Ahmedabad	3,520,085	191	1302	0.37
Pune	2,538,473	244	1175	0.46
Kanpur	2,551,337	267	1100	0.43
Surat	2,433,835	112	1000	0.41

Source: Indian Central Pollution Control Board (CPCB) and the National Environmental Engineering Research Institute (NEERI), 2004-05.

Most of the urban waste (50% – 90%) generated in India each year is disposed of in landfills and open dumps.<sup>15</sup> Delhi is no exception to this trend. Since 1975, twenty landfills and dumps have been created in the city, of which 15 are exhausted and 2 suspended. Only three dumps are still active, in Bhalaswa, Ghazipur, and Okhla.<sup>16</sup> Bhalaswa and Ghazipur are nearing exhaustion, and although Okhla is officially closed it continues to receive waste daily.

## 2.2 Formal Waste Management Practices in Delhi

<sup>11</sup> Central Pollution Control Board (CPCB) and National Environmental Engineering Research Institute (NEERI), *Waste Generation and Composition*.

<sup>12</sup> Hindustan Times, "Time to "Bale" Out ."

<sup>13</sup> Chintan, *Space for Waste: Planning for the Informal Recycling Sector*.

<sup>14</sup> Central Pollution Control Board (CPCB) and National Environmental Engineering Research Institute (NEERI), *Waste Generation and Composition*.

<sup>15</sup> IEA, *Turning a Liability into an Asset: Landfill Methane Utilisation Potential in India*, 5.

<sup>16</sup> Chintan, *Space for Waste: Planning for the Informal Recycling Sector*.

Managing MSW is usually the single biggest activity that a municipality undertakes, often accounting for up to half of total expenditures and sometimes more than all the other functions combined.<sup>17</sup> Thus a municipality's ability to manage waste might be thought of as a proxy measure of the city's overall effectiveness in providing services to its citizens.

Prior to 2000, most state legislation in India lacked clarity about the requirements and responsibilities incumbent upon municipalities for the collection, transport, and disposal of MSW. In response, the Supreme Court directed the Government of India, state governments, and municipal authorities to improve MSW management. Ultimately, the Ministry of Environment and Forests (MoEF) issued the Municipal Solid Waste (Management and Handling) Rules 2000. This comprehensive piece of legislation identifies the specific infrastructure and services that municipalities must provide within their territorial jurisdiction with regard to collection, storage, segregation, transport, treatment, and disposal of waste.<sup>18</sup>

Compliance with the rules has been dismal; by and large, Indian cities receive poor marks in ensuring environmentally sound and sustainable management of waste.<sup>19</sup> A performance audit on the management of waste in India undertaken by the Comptroller and Auditor General of India in 2007 paints a sobering picture. The audit revealed that MoEF and the states do not have complete and comprehensive data about waste volumes and composition; the risks posed by improper MSW management to public health and the environment have not been adequately assessed; the stated priorities of reducing, recycling and reusing waste have been largely ignored while municipalities focus instead on disposal; MoEF has failed to adequately promote the use of recycled and environmentally friendly products; collection of waste by the municipalities was not taking place regularly and effectively; there is negligible segregation of waste after collection; waste processing facilities and sanitary, scientific landfills were virtually non-existent; and open dumping abounds.<sup>20</sup> To date, not a single municipality in India has fully complied with the provisions of the Rules.<sup>21</sup>

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<sup>17</sup> Hanrahan, Srivastava, and Ramakrishna, *Improving Management of Municipal Solid Waste in India: Overview and Challenges*, 16.

<sup>18</sup> Zhu et al., *Improving Municipal Solid Waste Management in India*, 11-12.

<sup>19</sup> *Ibid.*, 9.

<sup>20</sup> Comptroller and Auditor General of India, *Performance Audit: Management of Waste in India*.

<sup>21</sup> The Energy and Resources Institute (TERI), *Looking Back to Change Track: GREEN India 2047*, 83.

In Delhi and the NCR the situation is much the same. There are three formal civic agencies with the responsibility of managing the city's waste – the Municipal Corporation of Delhi (MCD), the New Delhi Municipal Council (NDMC), and the Delhi Cantonment Board (DCB), each with jurisdiction over a portion of Delhi's territory.<sup>22</sup> The MCD is the largest of the three, accounting for 95% of the region.<sup>23</sup> The MCD spends upwards of \$80 million USD per year on sanitation and cleanliness activities,<sup>24</sup> but the city is still swimming in waste. MCD has 540 tipper trucks, but only half are on duty at any time and none have capacity for handling segregated waste.<sup>25</sup> In 1996 the MCD was collecting roughly 68% of the city's waste, but this figure has dropped below 50% over the years,<sup>26</sup> partially due to a wave of waste sector privatization. There is one major composting unit in the city, run by private firm through a concession with public authorities, which handles 200 tones of waste per day. In sum, though it is widely recognized that management of MSW is an integrated process that includes source reduction, maximizing reuse and recycling, promoting safe and sound disposal, and providing services to a broad constituency of citizens, MCD remains focused primarily on transportation in trucks and dumping at the three remaining landfills.

To accommodate the growing volumes of waste in this system, the NCR Planning Board is now faced with the task of finding 28 sq. km of additional space for landfills in the next decade, and another 100 sq. km by 2050.<sup>27</sup> Several attempts to outsource waste to other Indian states have been met with defiance, and because of the premium on space in Delhi, authorities now acknowledge the importance of recycling, reuse, and source reduction.

The composition of Delhi's waste is suitable for composting and recycling. Compostable organic material comprises 54.42% of Delhi's overall waste stream. Recyclable content makes up 15.52% of the overall waste stream, but accounts for nearly 40% of residential waste.<sup>28,29</sup> Delhi's waste is also getting dryer; growth of recyclable content in the waste stream tends to

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<sup>22</sup> Chintan, "Fact Sheet: Wastepickers."

<sup>23</sup> Chintan, *Space for Waste: Planning for the Informal Recycling Sector*, 2.

<sup>24</sup> *Ibid.*

<sup>25</sup> *Ibid.*, 3.

<sup>26</sup> *Ibid.*, 6.

<sup>27</sup> *Ibid.*, 2.

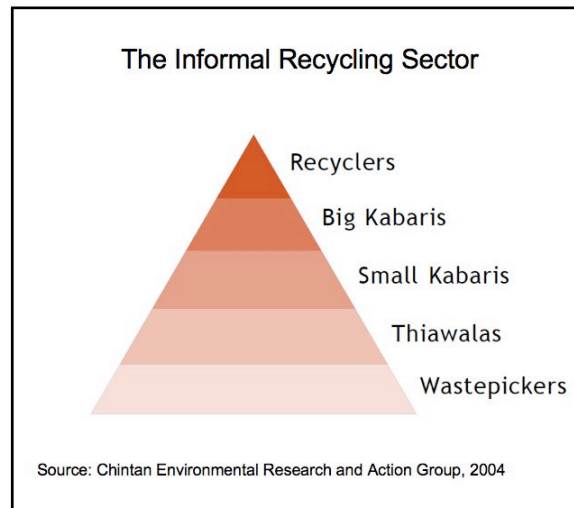
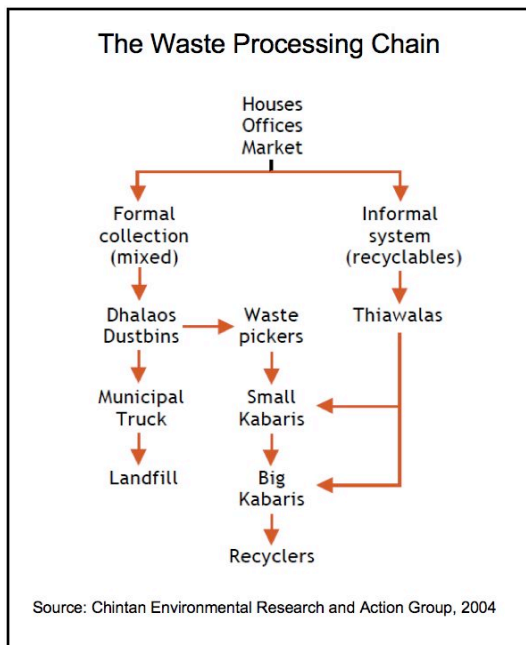
<sup>28</sup> Central Pollution Control Board (CPCB) and National Environmental Engineering Research Institute (NEERI), *Waste Generation and Composition*.

<sup>29</sup> Chintan, *Space for Waste: Planning for the Informal Recycling Sector*.

accompany economic growth, and recyclables are now double what they were in the period from 1982 – 1990. The growth in dry, recyclable content has led to a renewed interest in combustion disposal technologies as well as waste-to-energy projects. Finally, MCD has also recently explored more arcane waste disposal solutions like compacting waste into bales, wrapping it in plastic, and stacking it in large cubes in selected areas of the city’s periphery.<sup>30</sup>

### 2.3 Informal Sector Waste Management in Delhi

Alongside the formal waste management system in Delhi is a large and thriving informal recycling economy. The workforce in this sector numbers roughly 100,000 people and consists of wastepickers, small *kabaris* (small middlemen), *thiawalas* (collectors), and big *kabaris* (big middlemen).<sup>31</sup> The relationship of the informal sector to overall MSW management in Delhi is best understood through the following figures:



The figure on the left illustrates that most waste collected by formal actors goes directly to landfills. Mixed waste from residences, offices, and markets is brought to exterior dustbins and *dhalaos*, which are open-sided neighborhood disposal units resembling large concrete sheds.

<sup>30</sup> Hindustan Times, “Time to “Bale” Out .”

<sup>31</sup> Chintan, *Space for Waste: Planning for the Informal Recycling Sector*, 4.

From here municipal trucks transport mixed waste to landfills without undertaking segregation into recyclable and non-recyclable streams. However, wastepickers work in many *dhalaos*, segregating the waste into recyclables and compostable organic streams and collecting the recyclables. Wastepickers also collect recyclables from public bins and streets, conduct door-to-door collection, and occasionally scavenge directly from landfills.

The figure on the right illustrates the relative size of the groups involved in the informal recycling sector as well as how recyclables move up the value chain. The first layer is made up of wastepickers – men, women, and children who are some of the poorest in Indian society. Wastepicking is considered the most menial of all activities, and it is generally people with few alternatives who are driven to this work. Although wastepickers form the backbone of the recycling process in Delhi, small dealers are an important link. Often poor themselves, they purchase mixed recyclables directly from wastepickers and sell them to big dealers. The big dealers frequently own large warehouses or storage areas and generally deal in a single type of material. These big dealers then sell to recycling centers outside of Delhi. Augmenting these efforts are *thiawalas*, who operate aggregation spots near markets and shops, buying recyclables directly from businesses as well as from wastepickers, then delivering them to small dealers. Finally, there are itinerant buyers who move through residential neighborhoods on cycle rickshaws (*cycle kabaris*) and purchase recyclable goods directly from residents to sell to dealers. Most of the populace in Delhi interacts with bottom three layers of the pyramid, whose labor actually propels recycling in the city.<sup>32</sup>

Through various interventions in the waste management system, the informal sector recycles an impressive amount of the city's waste. According to Chintan estimates, wastepickers collect 15% – 20% of Delhi's total waste by weight and recycle virtually all possible recyclable materials they touch.<sup>33,34</sup> This sector drives the city's recycling efforts, keeps the streets clean, and saves civic agencies huge sums of money.<sup>35</sup> If the municipality paid minimum wage to an equal number of employees for this work, it would cost Delhi at least 15 million rupees per day (\$307,000 USD / day).

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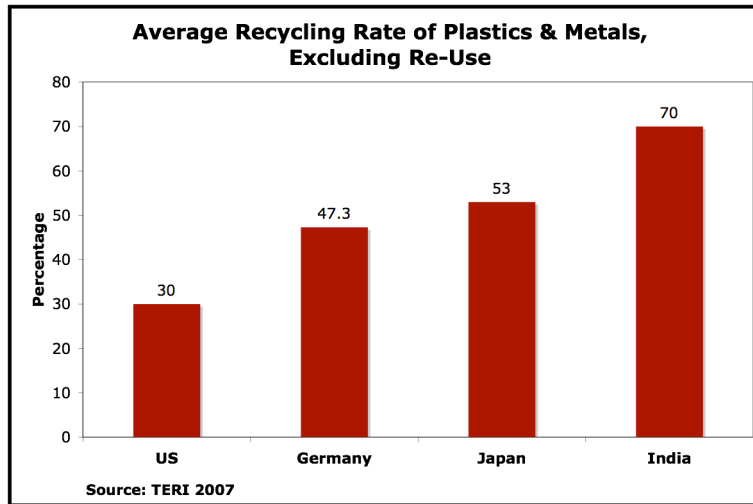
<sup>32</sup> Ibid., 1-5

<sup>33</sup> Chintan, *Space for Waste: Planning for the Informal Recycling Sector*.

<sup>34</sup> Chintan, "Fact Sheet: Wastepickers."

<sup>35</sup> Chintan, *Space for Waste: Planning for the Informal Recycling Sector*, 1.

Delhi exemplifies a trend widespread throughout the country. Local recycling markets in India are growing at a rate of 12% to 15% annually, a trend widely attributed to wastepickers' efforts.<sup>36</sup> The informal sector has also given India one of the highest rates of recycling in the world.



#### 2.4 Summary

The volume of MSW produced each year in India is large and growing rapidly. In both aggregate and per capita terms, Delhi's waste volumes exceed those of most other major Indian cities. Because of the scarcity of landfills in Delhi and tight space constraints for the construction of new landfills, the city is desperately looking for ways to reduce waste volumes at the same time as it improves MSW management. Thus far, formal MSW management systems in Delhi and most other major Indian cities have failed to comply with the goals and provisions of the Municipal Solid Waste (Management and Handling) Rules 2000. Formal MSW management in Delhi has thus far focused on end-of-pipe solutions and has few avenues of support for source reduction, recycling, or composting. On the other hand, the informal sector in Delhi is thriving, recycling most of the city's recyclables and subsidizing the work of the civic agencies responsible for MSW management. The informal sector is highly organized and efficient, intervening in the management process at many levels.

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<sup>36</sup> The Energy and Resources Institute (TERI), *Looking Back to Change Track: GREEN India 2047*, 88.

Ultimately, to meet the challenges posed by rising waste volumes in Indian cities, municipalities should seek greater harmonization and coordination between formal and informal actors. Greater cooperation between actors and increased support for wastepickers would improve overall waste management as well as provide side benefits in terms of GHG reductions. As the following sections of this report show, reducing emissions is now a government priority and there is significant emissions abatement potential to be found in India's waste sector.

### III. INDIA AND CLIMATE CHANGE: A SNAPSHOT

#### *3.1 Greenhouse Gas Emissions in India*

India is the third largest aggregate emitter of greenhouse gases (GHGs) in the world, after China and the United States.<sup>42</sup> According to the World Resources Institute, in 2005 India's emissions from the six major GHGs amounted to 1,853 million TCO<sub>2</sub>e, which represents nearly 5% of the global total. By way of comparison, China and the United States account for roughly 19% and 18% of global emissions, respectively. Because of India's large population and development path, per capita emissions remain relatively small; whereas developed countries such as the United States, Canada, and Australia all emit over 20 TCO<sub>2</sub>e per capita per year, Indians emit 1.7 TCO<sub>2</sub>e per person per year.<sup>43</sup>

#### *3.2 India's Participation in the Global Climate Regime*

India acceded to the Kyoto Protocol of the United Nations Framework Convention on Climate Change (UNFCCC) in 2002.<sup>50</sup> As a non-Annex I country, India is neither legally bound to emissions reductions nor required to file annual national greenhouse gas inventories with the UNFCCC Secretariat. To date, the Indian government has undertaken one national inventory of all GHG emissions. The inventory was based on data from 1994 and the results were communicated to the UNFCCC in 2004. In May 2007 the government began preparing its second GHG inventory, an ongoing process.<sup>51</sup> India's engagement with the Kyoto Protocol has taken place predominantly through the Protocol's Clean Development Mechanism (CDM), an environmental investment and credit scheme. The CDM provides opportunities for industrialized

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<sup>42</sup> Government of India, *The Road to Copenhagen: India's Position on Climate Change Issues*, 3.

<sup>43</sup> World Resources Institute, Climate Analysis Indicators Tool (CAIT) version 6.0

<sup>50</sup> UNFCCC, "Kyoto Protocol Status of Ratification."

<sup>51</sup> Ministry of Environment and Forests, Government of India, "India's Second National Communication (SNC)."

countries with emission-reduction commitments to finance and implement emission-reducing projects in developing countries. Such projects earn saleable Certified Emission Reduction (CER) credits, which industrialized countries can count towards meeting Kyoto targets. India has hosted 440 registered projects, making the country the site of over 25% of all CDM activity and second only to China in terms of volume.<sup>52</sup>

On June 30, 2008, Prime Minister Manmohan Singh unveiled India's first comprehensive National Action Plan on Climate Change (NAPCC), which delineates current and future priorities for climate change mitigation and adaptation. The NAPCC consists of eight "national missions" for the coming decade, including provisions for solar energy production, climate adaptation in the agriculture sector, enhanced energy efficiency, and climate friendly urban planning and waste management.<sup>54</sup> The plan is firm in its commitment to maintaining high economic growth rates, so each of the proposed measures is intended to stimulate development as well as yield complementary climate benefits.<sup>55</sup>

Invoking the principle of climate equality, the government of India has argued that each inhabitant of the earth is entitled to an equal share of the "global atmospheric resource."<sup>56</sup> In this context, India pledges that its *per capita* greenhouse gas emissions will at no point in the future exceed those of developed countries. The international community has responded to this commitment with ambivalence, and whether India should account for emissions on a national or per capita basis is a bone of contention among international climate negotiators.

As parties to the UNFCCC enter the final stretch of negotiating a successor agreement to the Kyoto Protocol, the contours of India's participation in a new regime are uncertain. In advance of the 15<sup>th</sup> Conference of the Parties, to be held in Copenhagen in December 2009, India has released a position paper that adheres to four basic principles:

- Climate change is primarily a problem of cumulative historical emissions from developed countries, not from emerging economies like India.

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<sup>52</sup> UNFCCC, "CDM Statistics."

<sup>54</sup> Ibid.

<sup>55</sup> "Summary: India's National Action Plan on Climate Change."

<sup>56</sup> Prime Minister's Council on Climate Change, *National Action Plan on Climate Change*, 2.

<sup>59</sup> Government of India, *The Road to Copenhagen: India's Position on Climate Change Issues*.

- Although the UNFCCC does not require action from developing countries, India has pledged to keep per capita emissions at or below industrialized country levels.
- India is indeed the third largest emitter in the world, but it is not a “major emitter” on a per capita basis.
- The gap in total emissions volume between India and the first and second-ranking countries – China and the United States – is very large.<sup>59</sup>

While these principles inform India’s climate position, there is lingering disagreement among Indian climate negotiators about how the principles should drive actual policy. At the Major Economies Forum on Energy and Climate in Italy in July 2009, India’s chief climate change negotiator joined his counterparts in signing a pledge to restrict overall climate change from anthropogenic causes to 2 degrees Celsius.<sup>60</sup> Though the pledge is non-binding, Indian mid-level negotiators were furious, fearing that other countries would capitalize on this public gesture to lock India into hard emissions caps and jeopardize economic development. During the subsequent visit to India by U.S. Secretary of State Hillary Clinton, Indian Environment Minister Jairam Ramesh retrenched, asserting that India would never take legally binding commitments to reduce emissions.<sup>61</sup>

### 3.3 Summary

India is one of the largest aggregate emitters of greenhouse gases in the world, but per capita emissions remain relatively low. The government of India has signaled an awareness of the importance of climate change mitigation and adaptation while resisting national emissions reduction targets. The government has campaigned instead for per capita GHG accounting and the right to pursue economic growth. The NAPCC thus seeks to identify ways in which India can pursue economic gains while also achieving climate side benefits. The Plan identifies waste management as one sector in which emissions reductions might be found. The following section elaborates the relationship between MSW and GHGs and explores the emissions implications of various waste management techniques.

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<sup>60</sup> The White House Office of the Press Secretary, “Declaration of the Leaders; The Major Economies Forum on Energy and Climate.”

<sup>61</sup> Transnational News Navigator (TNN), “India Will Not Take on Emission Cut Targets, Jairam Tells Hillary.”

## IV. MSW & GHGS: UNDERSTANDING EMISSIONS FROM WASTE

### *4.1 Sources of Emissions from MSW*

Municipal solid waste is responsible for emissions of three key greenhouse gases: carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), and nitrous oxide (N<sub>2</sub>O). Each item in a city's waste stream that ends up in a landfill or incinerator represents the culmination of a long process which includes energy-intensive extraction and processing of raw materials; manufacture of products; transportation of materials and products to markets; use by consumers; and eventually waste management. At virtually every step in this life cycle, one or several of the aforementioned gases is released.<sup>62</sup>

First, landfills emit GHGs. The decomposition of mixed organic wastes, such as food and paper, under anaerobic conditions typically found in uncovered landfills and dumps generates landfill gas (LFG).<sup>63</sup> Once a landfill is closed, it continues to emit LFG for several decades. LFG consists of about 50% methane, 50% carbon dioxide, and a trace amount of non-methane organic compounds.<sup>64</sup> Methane is second only to CO<sub>2</sub> as a GHG resulting from human activities. It is a short-lived GHG, with an atmospheric lifetime of approximately 12 years.<sup>65</sup> It is also relatively potent; over a 20-year time horizon CH<sub>4</sub> is 72 times more effective at trapping heat in the atmosphere as CO<sub>2</sub>, and over a 100-year period it is 25 times more effective.<sup>66</sup> Because of the relative ease with which it can be captured, as well as its heat-trapping properties, short atmospheric life, and significant volume, methane is often considered the “low-hanging fruit” for short-term mitigation.

Second, the disposal or combustion of MSW materials at end-of-life suggests their replacement by new products. For every item discarded or burned instead of recycled, a new one must be extracted, processed, and manufactured from raw or virgin resources. This creates large volumes of waste byproducts. For example, every ton of discarded products and materials in the

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<sup>62</sup> US EPA, *Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks*, ES-4.

<sup>63</sup> Methane to Markets Partnership, *Global Methane Emissions and Mitigation Opportunities*, 2.

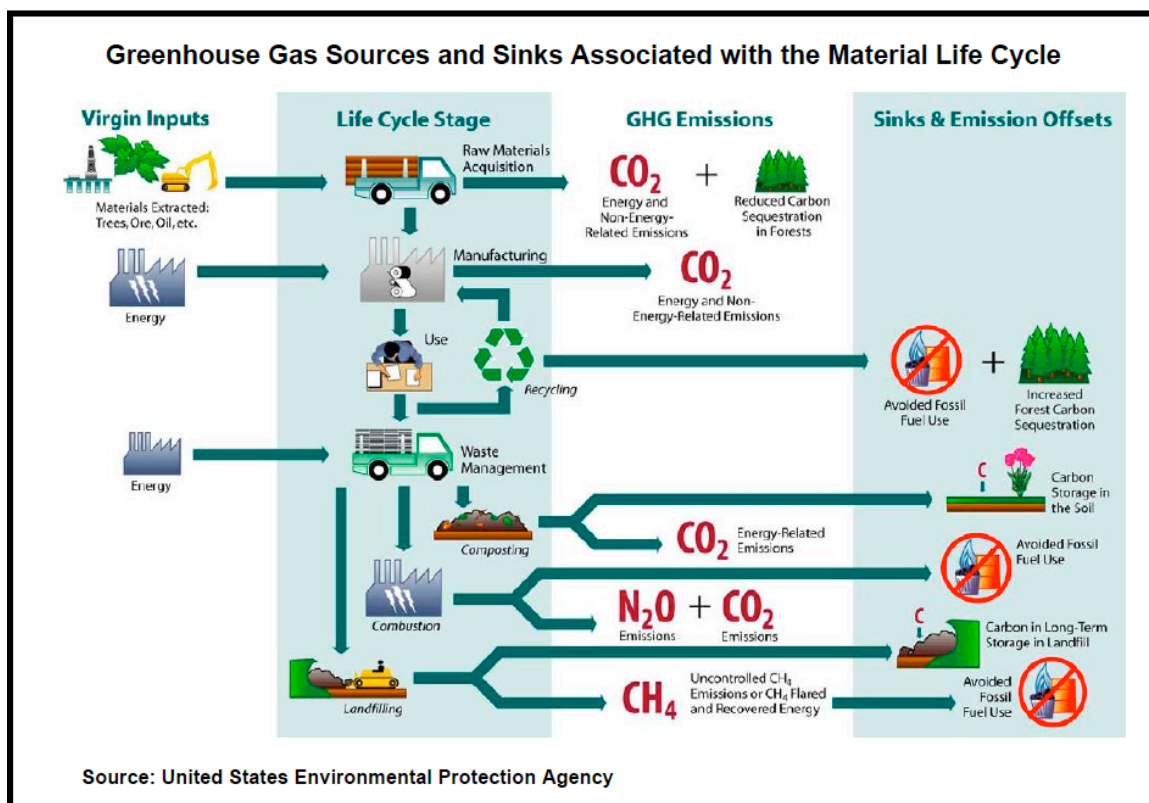
<sup>64</sup> Methane to Markets Partnership, *Landfill Methane Recovery and Use Opportunities*, 1.

<sup>65</sup> Methane to Markets Partnership, *The Significance of Methane and Activities to Reduce Methane Emissions*, 1.

<sup>66</sup> IPCC, “Changes in Atmospheric Constituents and in Radiative Forcing.”

<sup>68</sup> Platt et al., *Stop Trashing the Climate: Executive Summary*, 5.

United States generates about 71 tons of manufacturing, mining, oil and gas exploration, agricultural, coal combustion, and other discards.<sup>68</sup> This process of making, transporting, using, and disposing of materials also requires energy consumption at each step along the way, primarily in the form of fossil fuel combustion.<sup>69</sup> Conventional greenhouse gas inventories generally do not account for the climate change impact caused during the product life cycle, but the magnitude of life-cycle emissions is striking. Making new paper requires harvesting more trees. Making new metals requires mining additional ore. Making new plastic requires processing petroleum. In short, the status quo linear materials economy is intimately linked to most of the major drivers of climate change: virgin materials extraction, transportation, industrial energy use, and deforestation.



Once a product or material is no longer useful to producers or consumers and becomes “waste,” the manner in which a community deals with it affects emissions both upstream and downstream. Waste management affects upstream emissions by influencing demand for new

<sup>69</sup> US EPA, *Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks*, 4.

products and industrial processes, and affects downstream emissions by controlling the volume and kind of waste that reaches landfills and incinerators. Common waste management options at the municipal level include source reduction, recycling, composting, incineration, and landfilling. The GHG impacts of these approaches are weighed in the following section and their usefulness to Indian municipalities is considered.

#### *4.2 A Survey of MSW Management Technologies & Their GHG Potentials*

In weighing MSW management options in India, municipalities face the dual challenges of reducing waste volumes and reducing emissions. The most common practice of dumping garbage in open landfills fails to achieve both goals. Waste combustion and waste reduction (which includes source reduction, recycling, re-use, and composting) can both reduce overall waste volumes, but they have differing implications for GHG emissions.

##### *Waste Reduction Technologies*

Because various MSW management options intervene in the material life cycle of products at different points, quantifying the GHG-emission balances of these practices requires the application of life cycle assessment tools.<sup>70</sup> Waste reduction practices such as point source waste minimization, recycling, re-use, and composting generally reduce overall emissions, but the magnitude of avoided GHG-emissions is highly dependent on the specific materials involved, the recovery rates for those materials, local management options, climactic conditions, and (in the case of energy offsets) the specific fossil fuel avoided. This specificity poses difficulties for the creation of comparable and transferable studies.<sup>71</sup>

Despite these methodological barriers, a clear picture is beginning to emerge from research concerning the impact of MSW management on GHG emissions. Independent studies undertaken by the United States Environmental Protection Agency (EPA) and the Institute for Local Self-Reliance (ILSR) concur that source reduction and recycling (including composting

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<sup>70</sup> Bogner et al., “Waste Management,” 602.

<sup>71</sup> Ibid.

and reuse) provide strong GHG-reduction opportunities.<sup>72,73</sup> These processes reduce emissions in three ways:

- They save energy. Manufacturing goods from recycled materials typically requires less energy than producing goods from virgin materials. Likewise, when people reuse materials or when products are manufactured with less material, less energy is required to extract, transport, and process the raw inputs. The reduction in energy demand translates into less fossil fuel combustion required in power plants.
- They keep organic waste out of landfills. Composting organic waste reduces methane emissions. Composting has the added benefits of producing an organic fertilizer byproduct that reduces energy demand from synthetic fertilizer, irrigation, and tilling while also improving soil fertility, plant growth, and carbon sequestration.<sup>74</sup>
- They increase carbon stocks. In the case of paper products, waste prevention and recycling save trees, thereby increasing the long-term carbon sequestration function of standing forests.<sup>75</sup>

### Mass Combustion Technology

Incineration is a waste management strategy often practiced in countries with space constraints and advanced technological infrastructure. The general process involves feeding MSW into a furnace, where it is burned at high temperatures. The waste is converted to bottom ash, particulates, flue gases, and heat. Sometimes this heat is captured and put to other applications, and many modern combustion units couple waste disposal with electricity production. Greenhouse gas emissions from combustion include CO<sub>2</sub> and N<sub>2</sub>O. For some wastes mass combustion compares favorably with landfilling terms of net emissions, but for other materials landfilling produces fewer emissions. Mass combustion is rare in India.

### Waste-to-Energy Combustion Technologies

The thermal waste-to-energy (WTE) plants that have been built or proposed in India thus far – in Hyderabad, Vijayawara, Pune, Delhi, and elsewhere – operate on “fluff,” a form of RDF

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<sup>72</sup> US EPA, *Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks*.

<sup>73</sup> Platt et al., *Stop Trashing the Climate: Executive Summary*.

<sup>74</sup> GAIA, *Zero Waste for Zero Warming*, 2.

<sup>75</sup> US EPA, *Climate Change and Waste: Reducing Waste Can Make a Difference*.

based on waste that has been sorted, dried and pulverized.<sup>76</sup> Several biomethanation plants have also been constructed. Biomethanation, an alternative form of WTE, relies on gas produced from a slurry of organic waste.<sup>77</sup> Although thermal power generation from MSW can reduce citywide volumes and exploit the energy value of post-consumer waste, deploying WTE safely is very capital-intensive. The Intergovernmental Panel on Climate Change (IPCC) notes that the high cost of incineration with safety and emission controls restricts its sustainable application in many developing countries.<sup>78</sup> Where it can be safely deployed, WTE offers the potential to reduce GHG emissions because the electricity produced by WTE plants ostensibly replaces an equal amount that would have been generated by a standard fossil fuel-based power plant.

Understanding emissions reductions from WTE requires knowledge of how the electricity they displace was produced. For example, if a WTE plant displaces hydropower, the emissions gains are generally less than if the plant displaces electricity from coal. In addition, scholars disagree about the “carbon neutrality” of burning organic wastes. Biomass feedstocks such as wood, paper, and food scraps are sometimes considered carbon neutral because, unlike fossil fuels, the carbon released when they are combusted was already a part of the active carbon cycle. However, feedstocks such as wood, paper, and agricultural materials are sometimes produced from unsustainable forestry and land practices that threaten the overall amount of carbon stored in forests and soil over time. Destroying them squanders the possibility for their reuse as compost feedstock or as recycled inputs into the manufacturing system. Electing to burn these materials instead of recycling or composting them may effectively increase emissions. Once biogenic carbon is included explicitly in the analysis and the temporal nature of carbon storage is accounted for, incinerators have been shown to emit more CO<sub>2</sub> per megawatt-hour than coal-fired, natural-gas-fired, or oil-fired power plants.<sup>79,80</sup>

#### *4.3 Calculating and Comparing Emissions Across Waste Management Technologies*

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<sup>76</sup> Hanrahan, Srivastava, and Ramakrishna, *Improving Management of Municipal Solid Waste in India: Overview and Challenges*, 54.

<sup>77</sup> *Ibid.*, 55.

<sup>78</sup> Bogner et al., “Waste Management,” 608.

<sup>79</sup> Platt et al., *Stop Trashing the Climate: Executive Summary*, 10.

<sup>80</sup> Hogg, *A Changing Climate for Energy from Waste?: Final Report for Friends of the Earth*, ES-i.

The primary result of the aforementioned EPA study, “Solid Waste Management and Greenhouse Gases: A Life Cycle Assessment of Sources and Sinks,” was the development of material-specific GHG emission factors that can be used to account for the emissions of various waste management practices.<sup>81</sup> Emissions factors were developed for 26 material types and six categories of mixed materials based on national average conditions in the United States.<sup>82</sup> The computer model associated with this study, known as the “Waste Reduction Model,” or WARM, uses the emissions factors to help waste managers calculate and compare the net emissions and energy balances associated with landfilling, recycling, combustion, source reduction, and composting.

Net GHG Emissions of MSW Management Options Compared to Landfilling <sup>3</sup> (MTCE/Ton)						
Material	Source Reduction Net Emissions		Recycling Net Emissions	Composting Net Emissions	Combustion <sup>b</sup> Net Emissions	
	Minus Landfilling Net Emissions		Minus Landfilling	Minus Landfilling	Minus Landfilling	
	Current Mix of Inputs	100% Virgin Inputs	Net Emissions	Net Emissions	Net Emissions	
Aluminum Cans	-2.26	-4.28	-3.71	NA	0.01	
Steel Cans	-0.88	-1.02	-0.50	NA	-0.43	
Copper Wire	-2.01	-2.03	-1.35	NA	0.00	
Glass	-0.17	-0.19	-0.09	NA	0.00	
HDPE	-0.50	-0.55	-0.39	NA	0.24	
LDPE	-0.63	-0.65	-0.47	NA	0.24	
PET	-0.58	-0.60	-0.43	NA	0.28	
Corrugated Cardboard	-1.63	-2.32	-0.96	NA	-0.29	
Magazines/Third-class Mail	-2.28	-2.36	-0.76	NA	-0.05	
Newspaper	-1.09	-1.39	-0.52	NA	0.03	
Office Paper	-2.71	-2.79	-1.31	NA	-0.70	
Phonebooks	-1.49	-1.49	-0.49	NA	0.03	
Textbooks	-3.03	-3.11	-1.38	NA	-0.70	
Dimensional Lumber	-0.42	-0.42	-0.54	NA	-0.08	
Medium-density Fiberboard	-0.47	-0.47	-0.54	NA	-0.08	
Food Discards	NA	NA	NA	-0.25	-0.25	
Yard Trimmings	NA	NA	NA	0.01	0.00	
Mixed Paper						
Broad Definition	NA	NA	-1.06	NA	-0.27	
Residential Definition	NA	NA	-1.03	NA	-0.25	
Office Paper Definition	NA	NA	-1.06	NA	-0.29	
Mixed Metals	NA	NA	-1.44	NA	-0.30	
Mixed Plastics	NA	NA	-0.42	NA	0.26	
Mixed Recyclables	NA	NA	-0.83	NA	-0.20	
Mixed Organics	NA	NA	NA	-0.12	-0.12	
Mixed MSW (as disposed)	NA	NA	NA	NA	-0.15	
Carpet	-1.10	-1.10	-1.97	NA	0.10	
Personal Computers	-15.14	-15.14	-0.63	NA	-0.06	
Clay Bricks	-0.09	-0.09	-0.01	NA	-0.01	
Concrete	-0.01	-0.01	-0.01	NA	-0.01	
Fly Ash	-0.01	-0.01	-0.25	NA	-0.01	
Tires	-1.10	-1.10	-0.51 <sup>c</sup>	NA	0.04	

Note that totals may not add due to rounding, and more digits may be displayed than are significant.  
 NA: Not applicable, or in the case of composting of paper, not analyzed.  
<sup>a</sup> Values for landfilling reflect national average CH<sub>4</sub> recovery in year 2004.  
<sup>b</sup> Values are for mass burn facilities with national average rate of ferrous recovery.  
<sup>c</sup> Recycling of tires, as modeled in this analysis, consists only of retreading the tires.

**Source: US EPA, Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks, 2006**

<sup>81</sup> US EPA, *Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks*, 12.

<sup>82</sup> Brady, “Recycling and the Waste Reduction Model .”

The table above, derived from WARM, illustrates the net life-cycle GHG emissions that would result from recycling, composting, combusting, or source reducing one U.S. “short ton” of waste material compared to the status quo practice of landfilling. For example, suppose a company chose to institute an office-paper recycling program instead of throwing all of their office paper in mixed trash bins destined for the landfill. For each ton of recycled office paper, the company would be responsible for a net reduction of 1.31 metric tones of carbon equivalent (MTCE) under average U.S. conditions. Calculated into CO<sub>2</sub> equivalents, this amount represents roughly 4.80 TCO<sub>2</sub>e in emissions reductions. Suppose instead that this same ton of office paper were collected and sent to a mass combustion incinerator. The resulting net carbon emissions (- .70 MTCE, or -2.56 TCO<sub>2</sub>e) would still compare favorably to landfilling, but would be an effective increase in net emissions when compared to recycling. The greatest emissions savings would come if the company chose not to use this ton of paper in the first place, perhaps by transferring some paper-intensive tasks to computer-based programs. In this case, the company could reduce emissions by 2.71 MTCE, or 9.94 TCO<sub>2</sub>e, per ton of office paper.

The example of PET plastic in the table above is illustrative of a second important trend: for several materials, mass combustion has *negative* emissions benefits even compared to landfilling. For newspapers, glass, and all three major plastics (HDPE, LDPE, and PET) combustion is equal to or worse than landfilling in terms of net greenhouse gas emissions. Conversely, for nearly every category of waste material, source reduction and recycling offer greater climate benefits than either combustion or landfilling.

The EPA study and the WARM model identify source reduction as the most effective practice in reducing overall emissions from MSW. Source reduction reduces net emissions by avoiding energy-intensive raw material acquisition and manufacturing, as well as the absence of emissions from waste management. Recycling represents the second best opportunity, since it reduces energy-related emissions in the manufacturing process but not as dramatically as source reduction. Recycling similarly avoids emissions from waste management, and in the case of paper, it increases forest sinks. Like source reduction and recycling, composting generally compares favorably to landfilling, with a few exceptions in the area of horticultural waste. Finally, in terms of net GHG emissions on a life-cycle basis, mass combustion and landfilling

exhibit the highest emissions for most materials.<sup>83</sup> It should be noted that waste-to-energy plants were not included in this analysis.

Building upon these findings, the ILSR study, “Stop Trashing the Climate,” utilizes the WARM model to calculate the climate benefits that could be achieved by modest source reduction and the expansion of recycling, reuse, and composting.<sup>84</sup> By reducing waste generation 1% each year and diverting 90% of discards away from landfills and incinerators through recycling, reuse, and composting, the United States could lower emissions by 406 million TCO<sub>2</sub> annually. This is equivalent to closing one-fifth of all coal-fired power plants in the country.<sup>85</sup>

Though the empirical analyses undertaken in these studies are specific to the United States, the general findings are valuable for municipalities in India. As the MSW problem escalates across Indian cities and emissions from waste continue to climb, it is clear that municipal waste management decisions can play a role in fighting climate change. It is also apparent that an mitigation hierarchy exists among traditional management options, with source reduction and recycling at the top and landfilling at the bottom.<sup>86</sup>

#### 4.4 Summary

Municipal solid waste contributes significantly to anthropogenic emissions of key greenhouse gases, including CO<sub>2</sub> and CH<sub>4</sub>. Landfill gas is rich in methane, which seeps into the atmosphere for decades after a landfill is closed. Waste and “wasting” also generate CO<sub>2</sub> emissions from energy use by encouraging the linear materials economy and necessitating the continual production of new consumer goods. Greenhouse gases are released at virtually every step during the life cycle of new products and materials, from virgin mineral extraction and processing to manufacturing and transportation. Waste management decisions are crucial for climate change because they sit at the hinge between downstream landfill emissions and upstream product life-cycle emissions. The best climate and waste models and studies available agree that non-disposal waste management technologies such as source reduction and recycling

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<sup>83</sup> US EPA, *Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks*, 13.

<sup>84</sup> Platt et al., *Stop Trashing the Climate: Executive Summary*.

<sup>85</sup> *Ibid.*

<sup>86</sup> Masters and Ela, “Chapter 9: Solid Waste Management and Resource Recovery.”

(including reuse and composting) offer climate benefits when analyzed on a life-cycle basis and compared to disposal technologies such as landfilling and many forms of waste combustion.

## V. INDIA'S EMISSIONS FROM THE WASTE SECTOR AND FORMAL MITIGATION EFFORTS

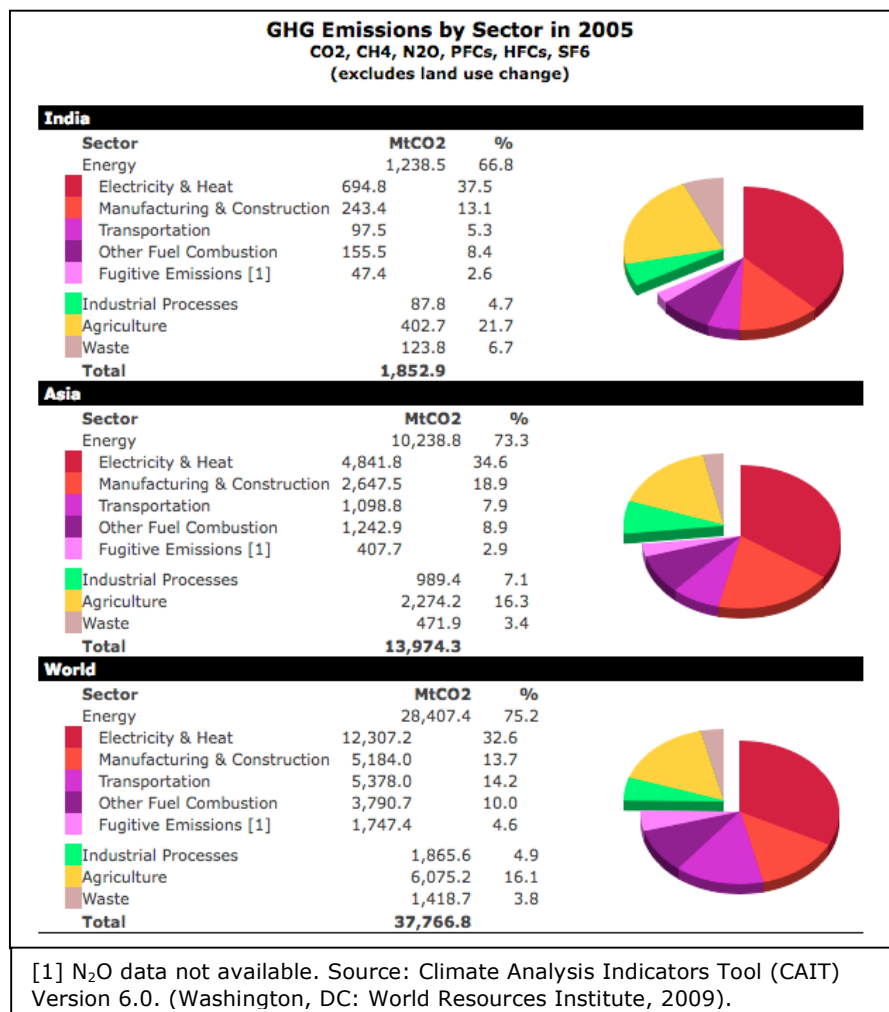
### 5.1 India's Emissions from Waste

Emissions from the waste sector in India have grown steadily over time, and the proportional contribution of waste to total emissions in India now exceeds both regional and global averages. The waste sector – which includes solid waste disposal, biological treatment of solid waste, incineration and open burning of waste, and wastewater treatment and discharge – was responsible for roughly 124 million TCO<sub>2</sub>e of emissions in 2005, or 6.7% of total Indian emissions.<sup>87</sup> This is *nearly double* the average contribution of the waste sector of other countries in Asia and is also higher than the world average, implying that emissions from the waste sector pose a relatively greater climate risk in India than elsewhere. The Government of India has noted, however, that Indian emissions from waste are lower than many industrialized countries when considered per unit of GDP.<sup>88</sup>

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<sup>87</sup> World Resources Institute, Climate Analysis Indicators Tool (CAIT) version 6.0

<sup>88</sup> Prime Minister's Council on Climate Change, *National Action Plan on Climate Change* .



From 1990 to 2005, emissions from the waste sector in India increased every year, and in recent years they have continued to climb. The average annual compound growth rate in waste emissions over the period was 1.8%, resulting in 31% overall growth in emissions from the waste sector.<sup>89</sup> Much of the increase can be attributed to ballooning volumes of waste that resulted from the large influx of population from villages to cities over this period, as well as systematic waste disposal practices that channeled the brunt of the waste into unsanitary landfills incapable of capturing methane generated during anaerobic decomposition.<sup>90</sup> In contrast, during the same period, many developed countries greatly reduced emissions from waste, largely due to improved landfill gas recovery technologies, recycling programs, and integrated waste

<sup>89</sup> Ibid.

<sup>90</sup> Sharma, Bhattacharya, and Garg, "Greenhouse Gas Emissions from India: A Perspective," 328.

management practices at the municipal level.<sup>91</sup> For example, the U.S. reduced emissions from the waste sector by 0.9% annually, for an overall reduction of 13.1%. European nations saw even greater reductions; in Germany emissions from waste decreased by an average of 6.7% per year, resulting in an overall reduction of 64.4% from the waste sector.<sup>92</sup>

<b>Growth in GHG Emissions from Waste, 1990-2005 CH4, N2O (MtCO2e)</b>					
<b>Country</b>	<b>1990</b>	<b>2005</b>	<b>Change</b>	<b>Avg. Annual Growth</b>	<b>Total Growth</b>
Canada	20.2	27.2	7	2.00%	34.60%
<b>India</b>	<b>94.4</b>	<b>123.8</b>	<b>29.4</b>	<b>1.80%</b>	<b>31.10%</b>
Indonesia	27.9	34.5	6.6	1.40%	23.50%
Brazil	34.6	42.8	8.1	1.40%	23.40%
Australia	10.3	12	1.7	1.00%	16.70%
Japan	8.3	9.6	1.3	1.00%	15.60%
China	152.3	174.2	21.8	0.90%	14.30%
Russian Federation	51.7	47	-4.7	-0.60%	-9.10%
United States	214.8	186.7	-28.1	-0.90%	-13.10%
France	13.6	11.7	-1.9	-1.00%	-14.20%
United Kingdom	25.6	10.5	-15.1	-5.80%	-59.10%
Germany	37.8	13.5	-24.4	-6.70%	-64.40%

Source: Climate Analysis Indicators Tool (CAIT) Version 6.0. (Washington, DC: World Resources Institute, 2009).

## 5.2 Formal Efforts to Mitigate Emissions from Waste in India

Because of India's active involvement in the CDM and the financing available through this mechanism, most formal efforts to reduce emissions from waste in India have taken the form of CDM projects. Twenty-two of India's CDM projects fall under the broad category of waste management and disposal, including landfill methane capture and flaring, waste-to-energy plants, and several small composting initiatives.<sup>93</sup>

The NAPCC does recognize the crucial role that recycling and composting can play in reducing emissions from municipal solid waste and explicitly identifies the informal sector as the "backbone of India's highly effective recycling system."<sup>94</sup> The NAPCC further admits that a host of municipal regulations impede the operations of wastepickers and informal recyclers, leaving them at a tiny scale and with little access to finance or advanced recycling technologies. Thus, while the informal sector's significant contribution to climate mitigation is acknowledged at the

<sup>91</sup> Bogner et al., "Waste Management," 587.

<sup>92</sup> World Resources Institute, Climate Analysis Indicators Tool (CAIT) version 6.0

<sup>93</sup> UNFCCC, "CDM Statistics."

<sup>94</sup> Prime Minister's Council on Climate Change, *National Action Plan on Climate Change*, 30.

highest levels of the Indian government, little has been done at the municipal level to facilitate their, quantify their contribution to emissions reductions, or include them in climate initiatives.

### *5.3 Summary*

India has experienced rapid growth in population, urbanization, the economy in the last decade, resulting in an intensifying waste burden in urban areas and rising emissions from waste. The proportional contribution of the waste sector to total emissions in India now exceeds both regional and global averages, and there is thus significant abatement potential in this sector. While the government has affirmed the importance of the informal sector, little has been done to support the sector or incorporate wastepickers and informal recyclers into official emissions reduction activities. Efforts to reduce emissions from waste have largely taken the form of landfill methane capture and waste-to-energy plants funded through the CDM. In the following section, actual emissions reductions by the informal sector in Delhi are quantified in order to show the potential that this sector holds for helping India achieve its climate and sustainable development goals.

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<sup>142</sup> US EPA, “Greenhouse Gas Equivalencies Calculator.”

## VI. THE CONTRIBUTION OF THE INFORMAL SECTOR TO CLIMATE CHANGE MITIGATION

### *6.1 Informal Sector Emissions Reductions from Recycling*

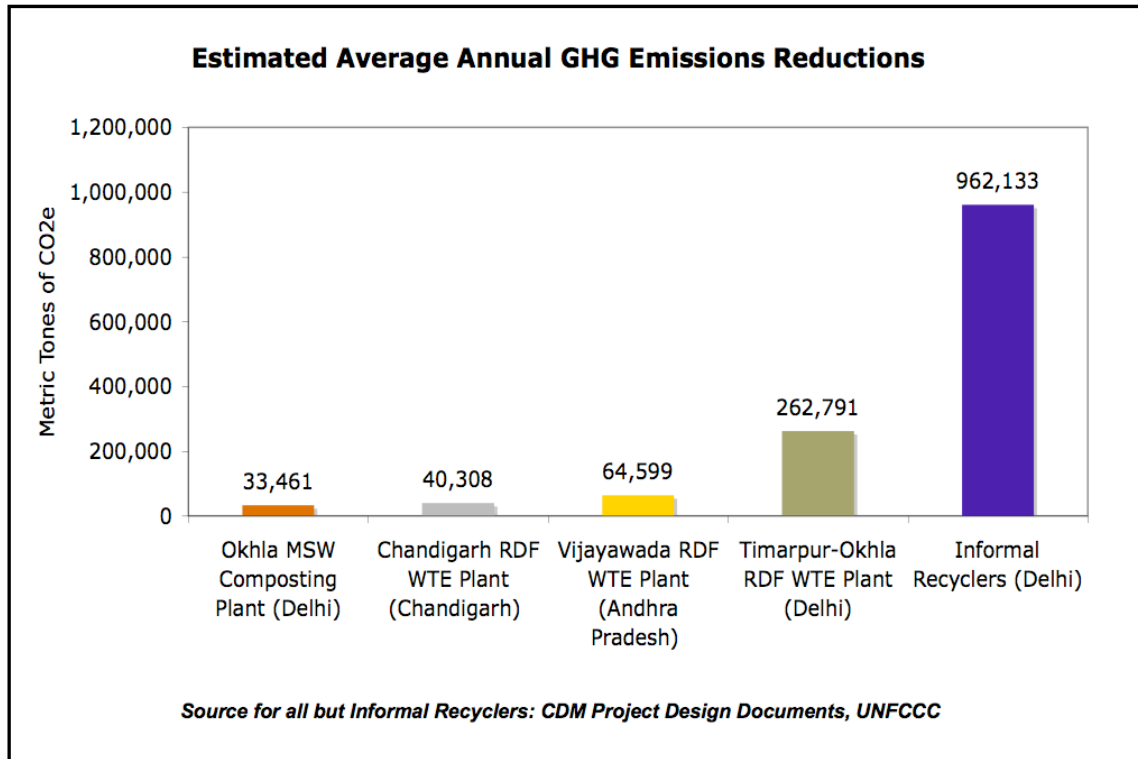
Accurately quantifying the contribution of Delhi's informal waste recyclers to emissions reductions is currently hindered by the availability of comprehensive data on waste volumes and waste composition in the city, as well as accessible and India-specific life-cycle models for calculating emissions from recycling, such as WARM does for MSW managers in the United States. In addition, while approved methodologies exist under the CDM for calculating emissions reductions from landfill gas capture, composting, and waste-to-energy projects, no such methodologies exist for establishing baseline and alternative scenarios from improvements in recycling rates.

Unfortunately, because the approved methodologies are all pegged against avoided methane emissions from landfills, they reify the current focus on end-of-life emissions in the MSW stream at the expense of technologies and processes like source reduction and recycling that operate farther back in the life of products. This is a structural problem with the CDM that can only be overcome with an innovative shift in thinking about emissions in general and the materials economy in particular. When emissions "reductions" from disposal technologies are only compared to emissions from disposal itself, instead of weighed against alternative MSW management scenarios, the CDM may be encouraging technologies and processes that do not provide for the greatest GHG savings.

Despite these institutional impediments and the lack of an approved methodology, we might arrive at a highly speculative estimate of the informal recycling sector's emissions reductions by employing the material specific emissions factors developed for the WARM model. Since virtually all waste in Delhi that is not recycled by wastepickers is sent to the three dumps, it is reasonable to compare the net GHG emissions reductions that would result from recycling one ton of a material against a baseline of landfilling that ton of waste. Using the material-specific net reductions listed previously in this report, the following table illustrates the contribution of wastepickers to emissions reductions from recycling:



The following table compares the contribution of the informal sector with this and several other WTE and composting initiatives in India that are currently registered with the CDM Executive Board.



The validity of the informal sector emissions reductions rests on a raft of assumptions. First, we assume that the daily volume of MSW generated in Delhi is 8,500 metric tones. This is a modest and reasonable estimate, lower than those used by Chintan and a figure that has been cited by the MCD itself. Second, the studies of the physical makeup of MSW in Delhi upon which our recyclable content percentages are based likely underestimate the actual portion of some recyclables in the waste stream. Because these studies generally derive their samples at the level of the *dhalao*, they miss the recyclable content that is removed by maids and servants and then sold to *cycle kabaris* and junk dealers before household waste is brought to *dhalao*s. This practice is particularly common in the case of metals and cardboard cartons, because they are very lucrative. Third, there are few studies of informal sector recycling rates for specific material types. The percentage of a particular waste stream recycled may vary across both space and time, depending on specific neighborhood demographics, wastepicker specialization and relationships

with buyers, season of the year, current commodity prices, and so on. This report thus errs heavily toward conservative side, using only published accounts of recycling rates. The percentage for metals and plastics is a nationwide average and is generally attributed to the efforts of the informal sector. Rates for paper and glass are cited in a press release by a consortium of NGOs that support wastepickers. Anecdotal evidence suggests that in both cases the rates used here are lower than the actual coverage of informal sector recyclers. Taken together, these three assumptions suggest that the informal sector contribution to GHG reductions may be even higher than this study's estimate.

Any shortcomings in the assumptions listed above are primarily due to insufficient data and might be overcome with better performance by the Central Pollution Control Board and local agencies responsible for tracking municipal waste in Delhi. An even greater methodological hurdle is the non-transferability of the material-specific emissions factors used to calculate the informal recycling sector's contribution to emissions reductions. These emissions factors were developed by the US EPA for domestic waste managers and are thus based on national average conditions in the U.S. (e.g., average fuel mix for raw material acquisition and manufacturing using recycled inputs; typical efficiency of a mass burn combustion unit; national average landfill gas collection rates; average mix of plastic types in the mixed plastics waste stream, etc).<sup>144</sup> These conditions are certainly different in India.

However, in addition to conservative estimates of overall waste volume, recyclable content in the waste stream, and wastepickers' recycling rates, the emissions factors themselves may underestimate the GHG savings from recycling in Delhi. For example, none of Delhi's dumps have methane collection technologies, so diverting materials away from them is likely to have a greater landfill gas avoidance impact than in the U.S., where emissions factors include a national average landfill gas collection rate. In addition, India's Northern Grid, which feeds Delhi, relies more heavily on coal-fired power plants than the U.S. national average used in the EPA's emissions factors. In both situations, hydroelectric and nuclear energy production together account for roughly 25% of the mix, and fossil fuels account for about 72%.<sup>145,146</sup> However, the percentage of Indian Northern Grid energy coming from coal, the dirtiest of all fossil fuels, is

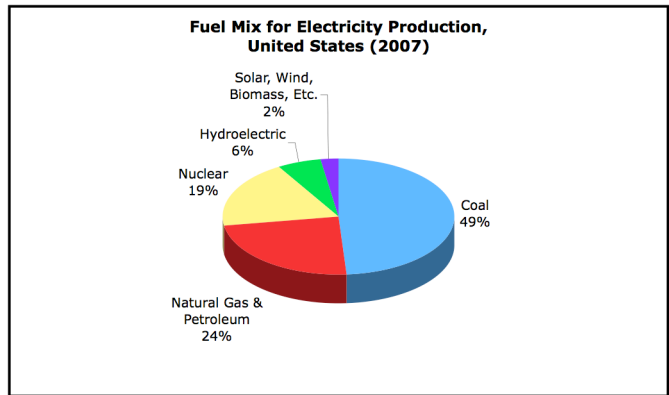
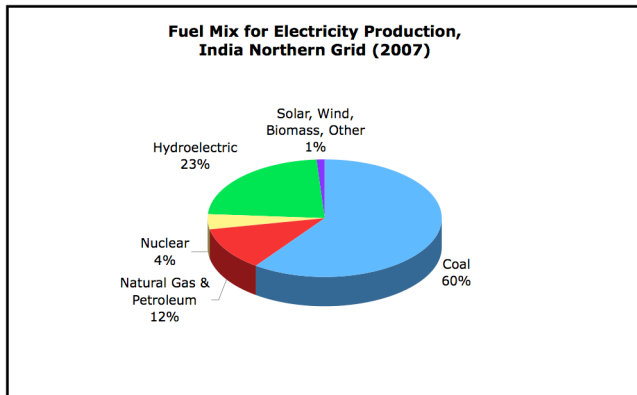
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<sup>144</sup> US EPA, *Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks*, ES-12.

<sup>145</sup> India CDM Designated National Authority (CDM DNA), *The Timarpur-Okhla Waste Management Company Pvt. Ltd's (TOWMCL) Integrated Waste to Energy Project at Delhi*, Appendix 1.

<sup>146</sup> EIA, *Electric Power Annual 2007*, 2.

much higher. Thus, using an emissions factor tailored to the US energy mix is likely to underestimate the benefits provided by displacing energy through recycling in India.



Ultimately, in order to more accurately assess the climate change mitigation potential of the informal sector as outlined in the National Action Plan on Climate Change, the Indian government would need to develop its own set of material-specific life-cycle emissions factors tailored to the Indian context. This is not without precedent. The international community has shown great interest in using adapted versions of the EPA’s emission factors to develop GHG inventories of their waste streams. For example, Environment Canada and Natural Resources Canada recently built upon the EPA’s life-cycle methodology to develop a set of Canada-specific GHG emission factors.<sup>147</sup> Without a similar effort, Indian policymakers will remain hindered by insufficient data on the true climate impact of waste and the magnitude of the informal sector’s emissions reductions.

### 6.2 Informal Sector Emissions Reductions from Composting

The informal sector’s contribution to GHG emissions reductions in Delhi may be even higher once their role in the city’s composting efforts is reflected in the analysis. Wastepickers are active in small-scale community composting efforts in the Defense Colony neighborhood, where they collect waste from 1000 households in a door-to-door program and deposit the

<sup>147</sup> US EPA, *Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks*, ES-6.

organic waste in neighborhood composting pits once they have removed the recyclables.<sup>148</sup> They are also contributing to composting on a much grander scale; their segregation work at city *dhalaos* effectively subsidizes major composting units such as the Okhla MSW Composting Project by providing them with nearly pure organic waste.

The Okhla project is one of the few large-scale composting facilities in Delhi. The plant was built by the MCD in 1981 and operated until 2000, at which time it ceased to be commercially viable and shut down, primarily due to high operation costs and problems with marketing the final organic fertilizer product. In May 2007 the MCD signed a concession agreement with a private firm, IL&FS Waste Management and Urban Services Limited (IL&FS), to revive the Okhla plant with carbon finance support from the CDM. The agreement gives IL&FS concession over the plant for 25 years, with all investment and operation costs borne by IL&FS and all revenues reverting to the firm. The plant operates by the windrow composting method and diverts roughly 200 tones of waste per day away from the nearby Okhla Landfill.<sup>149</sup> Nearly 90% of the incoming waste is organic. Half of this waste consists of horticultural clippings from Delhi's parks that are delivered to the plant by the NDMC and MCD, and half is organic waste from city *dhalaos* delivered to Okhla by civic agencies and private waste contractors, including Ramky Group and Delhi Waste Management (DWM). Because wastepickers operate out of nearly all *dhalaos*, the waste is finely segregated and the recyclables removed by the time the city trucks and contractor trucks arrive. Accepting nearly pure organic waste makes the composting plant run smoothly by relieving the burdens on the sieving and screening machines and increasing the overall volume of organic waste fed into the facility.<sup>150</sup>

### 6.3 Summary

While razor sharp calculations of the informal sector's emissions reductions citywide remain elusive, there is undeniable evidence that wastepickers' combined recycling and composting efforts account for major reductions in greenhouse gases. The sector accounts for estimated GHG emissions reductions of 962,133 TCO<sub>2</sub>e per year from recycling alone. Even as a conservative estimate, these reductions exceed those of most other major emissions reductions

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<sup>148</sup> Toxics Link, *An Initiative Towards Decentralised Solid Waste Management*.

<sup>149</sup> India CDM Designated National Authority (CDM DNA), *Upgradation, Operation and Maintenance of 200 TPD Composting facility at Okhla, Delhi*.

<sup>150</sup> Valsan, "Site Visit and Interview: Okhla MSW Composting Unit."

<sup>152</sup> BioCycle Magazine, "Regional Roundup," 15.

initiatives in the waste sector, some of which are already earning carbon credits. Many of the complications with the figure are the result of poor data collection by municipal and national authorities and inadequate methodological tools available for life cycle analyses of emissions from waste. To capture the full carbon benefits that wastepickers provide from recycling, the Government of India must develop material-specific emissions factors customized to the Indian context. An official methodology for establishing baseline and additionality scenarios for emissions reductions from recycling in the CDM would also make this project much more manageable. In addition to recycling, wastepickers effectively subsidize the city's composting efforts through their direct involvement in community composting programs and their indirect support of the Okhla facility through *dhalao* segregation. Wastepickers' efficiency and experience with manual segregation make them ideal candidates for formal inclusion in large-scale composting efforts.

Going forward, civic authorities could tap the latent potential of the informal sector for more successful composting and recycling while at the same time meeting their sustainable development and climate change objectives. Some of this cooperation can be achieved through harmonization of policy, but much of it hinges on finance. The issue of carbon credits and carbon financing is taken up in the following section.

## VII. CARBON FINANCE FOR REDUCING EMISSIONS FROM WASTE

### *7.1 Composting and Recycling in Carbon Markets*

Approved methodologies for calculating baselines and emissions reductions from composting exist in both the CDM and the Chicago Climate Exchange (CCX). Baseline emissions are calculated by measuring landfill emissions from the anaerobic decomposition of organic matter in a specific area. By diverting organic matter away from landfills, composting projects can reduce methane emissions and earn credits. For example, the Okhla MSW Composting Plant in Delhi currently earns CERs from the CDM. Similarly, a mixed solid waste composting facility in Nantucket, Massachusetts, USA, is one of the first composting facilities in the country to register emissions reductions for credits through the new composting protocol of the CCX.<sup>152</sup>

Unfortunately, there are currently no approved methodologies in either the compliance or voluntary markets for calculating and rewarding life-cycle emissions reductions from recycling. This is likely due to the difficulties of developing material-specific emissions factors that are transferable across contexts. There is, however, growing consensus that as carbon markets grow and integrate, recycling initiatives could very well earn credits that would both contribute to climate change mitigation and add to the current economic value of recycling, thereby reaping side benefits from improvements in recycling infrastructure.<sup>153,154</sup> Such a development would be particularly welcome in India, where the need to enhance the recycling sector – and the informal recycling sector in particular – is made explicit in the National Action Plan on Climate Change.

Conceptually, to participate in the carbon market a recycling project would need to demonstrate real reductions in emissions through real increases in recycled material volumes that would not have otherwise occurred. The recycling project must also have distinct spatial boundaries and system boundaries. A municipality, group of NGOs, private waste collection firm, recycling center, or some combination of actors could oversee the project, but ownership and clear legal jurisdiction over the project must be demonstrated. All of these requirements could theoretically be met by a community recycling program. The actors involved would first measure the baseline performance of the recycling system and then identify and implement a

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<sup>153</sup> Masters and Ela, “Chapter 9: Solid Waste Management and Resource Recovery,” 653.

<sup>154</sup> NRC, *Climate Change and Recycling White Paper*, 1.

series of measures to increase recycled material volumes. These measures might be investments in new technologies or implementation of enhanced practices. The program would then measure the increases in recycled volumes of each material and apply material-specific life-cycle emissions factors to quantify the climate benefits. At this stage the recycling program would be equipped to bring the emissions reductions to market.<sup>155</sup>

### *7.2 The Informal Sector in Carbon Markets*

A raft of structural barriers currently inhibits informal recyclers in Delhi from entering the carbon market. The first barrier is legal. Wastepickers exist in a legal limbo; while their efforts have been acknowledged and their contribution to MSW management has been encouraged, they have few legal contracts for the collection of waste. Establishing indisputable ownership of the project activity is a prerequisite of any carbon market transaction.

Second, carbon markets generally do not reward previous good behavior. Carbon markets hinge on the concept of additionality, which in the case of recycling implies implementing measures to increase recycling rates against baseline practices. If current informal sector practices are taken as the baseline, the very success of the sector leaves it little room to grow; the informal sector already recycles an exceptionally high portion of Delhi's recyclable materials. On the other hand, since the informal sector is now mature in Delhi and verges on "common practice," it would be very difficult for the informal sector to demonstrate that the baseline against which they are working is a scenario in which no informal sector recycling exists.

Third, the spatial and systems boundaries of the informal sector are fluid. Various communities of wastepickers inhabit diverse pockets around the city. The sector also comprises a whole pyramid of intermediaries that sit between wastepickers and recycling facilities. Wastepicker homes are sometimes demolished or relocated quickly because of city development plans. Some 15,000 of the 150,000 in the informal sector are affiliated with Chintan, but apart from this affiliation, communication between and bridges among communities are the exception rather than the rule. Wastepicker groups in areas such as Seemapuri, Bhopura, and Ghazipur are all highly organized and efficient, but to be eligible for carbon credits a community-based recycling program would need to establish firm spatial and systems boundaries.

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<sup>155</sup> Ibid., 1-3.

Fourth, India's CDM Designated National Authority (DNA), which approves and manages the applications for CDM projects hosted in India, has a history of supporting projects that compete directly with wastepickers for access to waste. These generally take the form of waste-to-energy (WTE) plants. Because electricity produced from a WTE plant is theoretically less carbon-intensive than the same amount of electricity produced from power plants running on the current fuel mix, there are approved CDM methodologies for waste-to-energy plants. If the proposed Timarpur-Okhla integrated WTE plant is actually built in Delhi, it will compete directly with wastepickers for recyclables. India's DNA has already sent this project up the pipeline, and because it has been pre-approved for CDM funding, its financial picture has been enhanced. There is thus a disincentive for the DNA to approve community-based recycling projects launched by the informal sector if they reduce the amount of recyclables available as fuel for the plant, which they are likely to do. This also makes "bundling" informal sector recycling projects with private sector projects increasingly difficult.

Finally, there is no established methodology in either compliance or voluntary markets for quantifying and rewarding emissions reductions from recycling. Even private corporations and municipalities – who do not face the added barriers that inhibit wastepickers – have been unable to overcome this challenge. The World Bank Carbon Finance Unit filed a formal request for the development of such a methodology with the CDM Executive Board in February 2007, but no methodology has been approved to date.<sup>156</sup>

In the case of composting projects, appropriate methodologies exist, but wastepickers in Delhi are directly active in composting only on a small scale. Composting also generally requires ownership of significant plots of land or access to finance that would enable the use of advanced composting technologies. Neither of these are realistic expectations for wastepickers at present. If the informal sector were to scale up composting efforts in the city, wastepickers would again be in competition with private composting projects, such as the Okhla MSW Composting facility, which are already being supported by India's CDM DNA.

Voluntary markets offer no shortcuts for the informal sector. There are many "over-the-counter" carbon exchange platforms, such as the CCX, the Montreal Climate Exchange, The Green Exchange, and the Asia Carbon Exchange, which facilitate voluntary carbon transactions

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<sup>156</sup> World Bank Carbon Finance Unit, "CDM Form F-CDM-SSC-Subm ver 03: Proposal for a New Small Scale Methodology for Recycling of Material Sorted at a Recycling Facility to Replace Material Made of Virgin Inputs."

and also act as futures and derivatives markets where CDM CERs are traded. But the actual carbon assets that are traded on these platforms are developed much in the same way as CDM CERs or European Union Allowances (EUAs). That is, they have similarly demanding baseline, additionality, and certification requirements. Because of the CCX's *ex post* rule, if the informal sector in Delhi were to host a CCX offset project, it must invest and implement a program that raises recycling rates and then hire an independent third party auditor to verify the project *before* trying to sell the emissions reductions into the CCX.

### 7.3 Summary

While there are currently approved methodologies for calculating emissions reductions from composting, landfill methane capture, and waste-to-energy plants in international carbon market mechanisms, no such methodologies exist for recycling. As a result, municipalities are incentivized to pursue CDM projects that utilize a limited set of technologies. Carbon finance through international mechanisms offers opportunities for municipalities to get low-carbon technologies off the ground, but some of these projects paradoxically put the informal and formal sectors in conflict over access to waste. Strategic alliances between formal and informal actors are necessary if India is to solve the dual climate and waste problems in the decades to come. A suite of recommendations for how local, national, and international actors might collaborate to combat these problems is presented in the final section of this report. A fuller account of the challenges and potential for the informal sector to participate in carbon markets is contained in the Chintan publication *Wastepickers and Carbon Markets*.

## VIII. CONCLUSIONS AND RECOMMENDATIONS

### *8.1 Key Findings*

This study has shown that India currently faces a major waste management challenge. Rapid growth in population, urbanization, and the economy in the previous decade has resulted in an intensifying waste burden in urban areas, affecting environmental quality and public health. At the same time that waste volumes are growing, greenhouse gas emissions from waste in India continue to climb and greater international attention is being focused on India's role in dealing with emissions.

Formal responses to the waste problem at the municipal level have been inadequate, and greater collaboration between municipalities and the informal recycling sector is now needed. Recycling as a management option has been shown to provide large emissions reductions benefits compared to alternatives, and the informal sector has established itself as the premier recycling institution in the country. Emissions reductions by the informal sector in Delhi alone are very large, exceeding the reductions achieved by many other waste management projects.

However, official efforts to reduce emissions from waste in India remain focused on landfill methane capture and waste-to-energy plants. The focus on reductions at the disposal stage is likely due to structural deficiencies in the CDM that provide perverse economic incentives for waste emissions reductions from end-of-pipe technologies, and the lack of approved CDM methodologies for calculating baselines and emissions reductions from recycling programs on a life cycle basis. These trends have contributed to a paradoxical situation whereby some of India's most environmentally-active but poorest citizens have been pushed aside in the country's pursuit of sustainable development and its effort to fight climate change.

In the 2008 National Action Plan on Climate Change, the Indian government lauded the informal sector as the backbone of India's recycling system and affirmed its role in emissions abatement. Going forward, municipal and national authorities, as well as international actors, must build upon this gesture to engage seriously with the informal recycling sector and harness their climate entrepreneurship for sustainable development. Below are specific recommendations for doing so.

## 8.2 Recommendations

*For the CDM Executive Board:*

- **Approve recycling methodologies.** The Executive Board should entertain and approve both large-scale and simplified small-scale methodologies for calculating baselines and emissions reductions from local recycling programs. Such methodologies might range from simple quantification of increased rates of material sorted at a recycling facility that will replace virgin manufacturing inputs, to more complex life cycle models at the community level.

*For India's CDM Designated National Authority (DNA) and the MoEF:*

- **Reject WTE projects that compete with the informal sector.** Because the Indian DNA is tasked with harnessing carbon finance only for projects that will provide economic, social, and environmental benefits to its Indian constituents, it should neither approve nor support CDM projects that compete directly with informal recyclers for dry waste.
- **Press for methodologies.** The DNA and MoEF should further use their leverage with UNFCCC actors to press for new recycling methodologies in the CDM and should actively work to expand its CDM projects to include recycling efforts.
- **Expand portfolio for composting.** The DNA should focus greater attention on composting opportunities at the municipal level and include composting in its public campaigns to attract international investment in India's CDM projects.

*For the Central Pollution Control Board (CPCB):*

- **Develop emissions factors.** The CPCB should collaborate with the Climate Change and Waste program of the U.S. Environmental Protection Agency to develop material-specific emissions factors tailored to the Indian context for individual waste items and categories of mixed waste. In addition to improving the availability of aggregate data on the climate benefits of recycling, composting, and source reduction, this measure would enable individual Indian municipalities to compare the GHG emissions that result from various combinations of waste management practices.
- **Improve data.** CPCB should also improve the specificity and public availability of data on the material composition of recyclables (% by weight, for each type of recyclable) in Delhi's MSW.
- **Undertake a formal study on recycling in India.** There are few comprehensive sources of information on recycling rates and materials recycled in India. Because the informal sector accounts for most recycling, such a study might be best carried out in collaboration with local NGOs that work directly with the sector.

*For Delhi's Civic Agencies (MCD & NDMC):*

- **Provide informal sector with in-kind compensation for emissions reductions.** Earning monetary compensation for GHG emissions reductions is highly dependent on the ability to calculate such reductions with a high degree of accuracy. While there are currently structural impediments to arriving at razor sharp calculations for the informal sector, it is certain that their contribution to fighting climate change is real and substantial in magnitude. In the absence of financial compensation, Delhi's civic agencies should support the informal recycling sector by *licensing small junk dealers* so that they can operate legally, *contracting exclusively with the informal sector for door-to-door collection of waste*, and *providing the informal sector with space* for segregation, handling, and storage of waste.
- **Subsidize community composting.** While subsidies for WTE projects are available from the Ministry of New and Renewable Energy, there are currently no subsidies for composting efforts. This is not a technology that produces electricity, but it is a technology that saves emissions. The National Action Plan on Climate Change identifies composting as the “dominant technology choice” for the waste sector and notes that it will require “net fiscal expenditures” on the part of concerned local bodies to deal with the waste and climate problem. As India's capital, Delhi should show leadership in the waste sector by developing financial support structures for community composting.

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