Decentralized and Integrated Municipal Solid Waste Management

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Global solid waste generation: 2016 to 2050

- 2016 world total: 2.01 billion tonnes per year estimated
- 2030 world total: 2.59 billion tonnes per year projected
- 2050 world total: 3.40 billion tonnes per year projected

The waste figures are only for municipal sources (residences, public institutions and commercial establishments); the figures do not include construction and demolition waste, hazardous waste, industrial waste, and medical waste.
Aspects of solid waste generation

- As we become more affluent, we not only consume more resources, but also produce more waste.
- As our societies urbanize, we produce more waste.
- As our world becomes more industrialized and urbanized, more and more of our waste is non-biodegradable.
- We produce about 300 million tonnes of plastic every year, equivalent to the weight of the humans on the planet. ²
- Municipal solid waste alone produces 5 percent of global emissions or 1.6 billion tons of CO₂-equivalent. This will be 2.6 billion tonnes of CO₂-equivalent by 2050. ¹
- Open dumping, landfilling, and incineration, are the main methods of waste management globally. In several low-income countries, less than half of municipal solid waste is collected.
- Our global oceans are now becoming the largest unmanaged waste dump. It is estimated that by 2050, there will be more plastic in oceans than fish (by weight). ³
Waste and urbanization regional distribution (2016)
South Asia: solid waste generation (kilogram/person/day) and waste composition (2016)
Solid waste disposal/management methods by region (2016)
Solid waste collection rates by region (2016)

- North America: 100%
- Europe and Central Asia: 90%
- Latin America and the Caribbean: 84%
- Middle East and North Africa: 82%
- East Asia and Pacific: 71%
- South Asia: 44%
- Sub-Saharan Africa: 44%
Urban solid waste management challenges

- Inefficient use of material resources; low resource recovery
- No segregation of waste at source
- Inefficient collection & unsanitary disposal of waste
- Increased vulnerability to climate change and social risks
- Low local capacity & resources
- Ineffective policies & regulations
- Lack of demonstrated SWM solutions
- Low local awareness of 3R practices
- Lost revenue and low quality of urban waste management services
- High financial burden for local government
- Inefficient use of local capacities & resources
- Environmental & public health consequences

Inefficient Urban Waste Management
Political issues related to waste management

- SWM is seen as difficult/untenable, with unclear entry points
- Lack of skilled personnel in governments with knowledge of developing useful policies and regulations, and multi-stakeholder partnerships
- No clear analysis of potential economic gains from improving waste recovery and mitigation, and of long term societal costs from not sustainably managing waste
- No clear information of locally appropriate solutions for waste management (low cost, low technology, decentralized)
- Lack of financial resources and technical or managerial capacity (in low income and lower middle income countries)
- Lack of private interest in investing in waste recovery due to no enabling policy and regulatory environment

The waste problem cannot be solved 'at the last minute' or by 'business-as-usual' approach; it requires integrated planning, with a multi-stakeholder approach, capacity building activities, and clear short and long term goals.
Social-economic issues related to waste management

- Grave ongoing health impacts from air, water, and soil pollution due to unsustainably managed waste
- Poor people are most affected – they live close to or work on open dumpsites
- Significant ecological and economic resources being lost in unrecovered waste (especially in the organic fraction of waste)
- High present and future costs to society – waste collection and disposal, health treatment, environmental remediation, strengthening of social-ecological resilience, climate change mitigation and adaptation
- Lack of public awareness of and participation in 3R (Reduce, reuse, recover/recycle; in addition refuse & redesign products)
- Private sector investment is low due to unfavorable policy environment
- Unsustainable waste management inhibits local and national efforts to develop sustainably (SDGs, NDCs, NUA)

*People are the consumers of resources, designers of products, and the producers of waste. Their awareness building and participation is essential to SWM.*
Technological issues related to waste management

- Applied technologies are often not locally appropriate and result in large trade-offs
- Focus is on large end-of-pipe solutions – collect and dump or burn – not on decentralized solutions that recover value and reduce waste at source
- No focus on building awareness among waste generators to reduce waste at source or participate in 3R practices
- Technology transfer (North-South-South) can be costly and entail outdated or unsustainable solutions
- No local capacity building of waste managers to efficiently manage/operate the technology, which increases dependency on solutions providers and increases costs/failure rates
- Planning for technological applications does not focus on enhancing local circular economy and social-ecological resilience

Waste management technologies should be locally appropriate and generate local employment and revenue; the local government should have the capacity to assess and efficiently use technologies to recover ecological and economic value.
Paradigm shift in solid waste management

Hierarchy of Preferred Solid Waste Management Strategies

Paradigm Shift for the 21st Century
Solid Waste Management - an integrated and multi-stakeholder approach

- Improved resource use and waste-to-resources recovery
- Good sanitation and resilience to climate change & environmental risks
- Improved collection & disposal of waste
- Financial sustainability, green enterprises and efficient use of municipal resources
- Enhanced local capacity for SWM
- Effective policies and regulations
- Low cost and locally appropriate SWM solution
- Waste segregation at source
- Awareness & use of 3R practices
- Improved public participation in minimizing waste and SWM
- Improved revenue from SWM and better SWM services
- Integrated implementation of SDGs, NJA & NDCs
IRRC and SDGs

IRRC Approach

- Improved public participation in minimizing waste and SWM
- Improved resource use and waste-to-resources recovery
- Improved collection & disposal of waste
- Good sanitation and resilience to climate change & environmental risks
- Low cost and locally appropriate SWM solution
- Enhanced local capacity for SWM
- Financial sustainability; green enterprises and efficient use of municipal resources
- Integrated implementation of SDGs, NUA & NDCs
- Effective policies and regulations
- Waste segregation at source
- Awareness & use of 3R practices
- Improved revenue from SWM and better SWM services

IRRC

SDGs

1. No poverty
2. Zero hunger
3. Good health and well-being
4. Quality education
5. Gender equality
6. Clean water and sanitation
7. Affordable and clean energy
8. Decent work and economic growth
9. Industry innovation and infrastructure
10. Reduced inequalities
11. Sustainable cities and communities
12. Responsible consumption and production
13. Climate action
14. Life below water
15. Life on land
16. Peaceful societies and strong institutions
17. Partnerships for the goals
## Different partners – Different resources

<table>
<thead>
<tr>
<th>Community</th>
<th>Municipal/Provincial</th>
<th>National/International</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Households</strong></td>
<td>Municipal government</td>
<td>National government</td>
</tr>
<tr>
<td>- Separated waste</td>
<td>• Regulatory power</td>
<td>• Regulatory power</td>
</tr>
<tr>
<td><strong>Civil society organization</strong></td>
<td>• Public funds, resources</td>
<td>• Market intervention</td>
</tr>
<tr>
<td>- Community access</td>
<td>• Waste collection</td>
<td>• Public funds, resources</td>
</tr>
<tr>
<td><strong>Ward governments</strong></td>
<td>Waste company</td>
<td><strong>Multilateral and bilateral development agencies</strong></td>
</tr>
<tr>
<td>- Community trust</td>
<td>• Facility operations</td>
<td>• Networking</td>
</tr>
<tr>
<td><strong>Waste pickers</strong></td>
<td>Provincial government</td>
<td>• Technical knowledge</td>
</tr>
<tr>
<td>- Access to waste</td>
<td>• Regulatory power</td>
<td>• Climate financing</td>
</tr>
<tr>
<td>- Market knowledge</td>
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</tbody>
</table>

Different partners – Different resources
IRRC: A pioneering solution

- An Integrated Resource Recovery Center (IRRC) is a recycling facility where a significant portion (80-90%) of waste can be processed in proximity to the source of generation, and in a decentralized manner. The IRRC concept is based on the reduce, reuse and recycle (3R) principles.

- The Integrated Resource Recovery Center model was developed by Waste Concern, an NGO based in Dhaka.

- The model is cost-effective, affordable, low-tech and community-based, and allows transforming waste into various types of resources.
IRRC: Turning Waste into Resources

Segregated Waste
- Organic Waste
- Inorganic Waste
- Used Cooking Oil
- Others

Processes
- Aerobic Composting
- Anaerobic Digestion
- Faecal Sludge Management
- Separation of recyclables

IRRC

Resources
- Compost
- Biogas
- Recyclables
- Refuse Derived Fuel
- Biodiesel
- Emission Reductions
- Plant nursery

Cost and Liability

90%

10%

Rejects
IRRC: Aerial view

- **Aerobic Composting Shed**
- **Biogas to Electricity Generator room**
- **(Faecal) Sludge Management Shed**
- **Cocopeat Filter**
- **Anaerobic Biodigester (Biogas)**
IRRC: Aerial view

(Faecal) Sludge Management

Anaerobic Biodigester (Biogas)
IRRC: Aerial view

Aerobic Composting Shed

Anaerobic Biodigester

Anaerobic Biodigester
Economic benefits from IRRCs

- Reduced landfilling costs
- Extended landfill life
- Reduced subsidy for chemical fertiliser
- Improved crop yields
Social benefits from IRRCs

1. No Poverty
   - Better job opportunities

2. Good Health and Well-being
   - Reduced disease

3. Affordable and Clean Energy
   - Improved living conditions

4. Climate Action
   - Improved ecological awareness
Environmental benefits from IRRCs

- Reduced greenhouse gas emissions
- Improved soil quality
- Reduced pollution
- Low-carbon fuel
### Capital and Operational Estimates for IRRCs

<table>
<thead>
<tr>
<th>Activity</th>
<th>IRRC with composting and recyclables</th>
<th>IRRC with Anaerobic Digestion (biogas)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land requirement</td>
<td>150-200 m² per ton of waste</td>
<td>400-500 m² per ton of waste</td>
</tr>
<tr>
<td>Waste required</td>
<td>High quality organic waste required; cost of segregation</td>
<td>High quality organic waste required; cost of segregation</td>
</tr>
<tr>
<td>Technical training &amp; capacity building for establishing policies and programs</td>
<td>USD 5,000 to USD 10,000 per 1 to 2 tons of waste</td>
<td>USD 5,000 to USD 10,000 per 1 to 2 tons of waste</td>
</tr>
<tr>
<td>Community awareness building, &amp; waste separation advocacy programs</td>
<td>USD 5,000 to USD 10,000 per 1 to 2 tons of waste</td>
<td>USD 5,000 to USD 10,000 per 1 to 2 tons of waste</td>
</tr>
<tr>
<td>Permits, surveys, assessments</td>
<td>USD 10,000 to USD 15,000</td>
<td>USD 10,000 to USD 15,000</td>
</tr>
<tr>
<td>Establishment of IRRC (CAPEX)</td>
<td>USD 20,000 to USD 30,000 per ton of waste</td>
<td>USD 30,000 to USD 40,000 per ton of waste</td>
</tr>
<tr>
<td>Operation of IRRC (electricity, waste, staff, maintenance) (OPEX)</td>
<td>USD 2,000 to USD 3,000 /ton/year (about 10% of CAPEX)</td>
<td>USD 3,000 to USD 4,000 /ton/year (about 10% of CAPEX)</td>
</tr>
</tbody>
</table>
# Economic Benefits of IRRCs (composting only)

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Type</th>
<th>Value (US$)</th>
<th>Bangladesh</th>
<th>Sri Lanka</th>
<th>Viet Nam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Job creation: additional income for waste-pickers employed</td>
<td>Social/Economic – Public &amp; Private</td>
<td>3.76</td>
<td>3.00</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Cost savings for the municipality for avoided landfilling of waste</td>
<td>Economic – Public</td>
<td>11.68</td>
<td>28.75</td>
<td>34.85</td>
<td></td>
</tr>
<tr>
<td>Savings in chemical fertilizer use (25% reduction)</td>
<td>Economic/Environmental – Private &amp; Public</td>
<td>4.85</td>
<td>1.13</td>
<td>10.54</td>
<td></td>
</tr>
<tr>
<td>Savings in subsidy to chemical fertilizers</td>
<td>Economic – Public</td>
<td>2.07</td>
<td>2.74</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Increase in crop yields</td>
<td>Economic – Private &amp; Public</td>
<td>24.55</td>
<td>21.52</td>
<td>46.71</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>46.91</strong></td>
<td><strong>57.14</strong></td>
<td><strong>92.10</strong></td>
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</tr>
</tbody>
</table>

All values are in USD, for composting of 1 ton of organic waste; *Source:* ESCAP and Waste Concern
Sources of information


6. Waste Concern, Bangladesh. See: www.wasteconcern.org