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Urban waste management in Himachal Pradesh

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1. Background of the sector

The reported generation of Municipal Solid Waste (MSW) in the State of Himachal Pradesh was estimated to be 304.3 TPD in 2011 (CPCB, 2012). The per capita waste generation rate in Himachal Pradesh is around 0.413 kg/day. It is also estimated that 60% of the waste generated ends up in landfills. Dumping of waste in unscientific manner creates anaerobic condition at the disposal site which leads to uncontrolled emission of methane which is a greenhouse gas (GHG) like methane. The total GHG emissions from waste sector in Himachal Pradesh is estimated at 6.129 tonnes of equivalent CO2 (Department of Science and Technology, GoHP, 2012). The sewage treatment capacity in Class I cities of Himachal Pradesh is 35.63 MLD and the actual sewage generation rate is of 28.94 MLD (CPCB, 2009). The state generates 42147 MTA of hazardous waste out of which 84.27% is landfillable, 5.33% is incinerable and 10.39% is recyclable (CPCB, 2009). This paper, however, majorly focuses on the issues related to municipal waste management.

The population of Himachal Pradesh is expected to rise in the years to come and so is the generation of MSW. The urban population in 2011 and the waste generation rate in that year were used to derive the per capita waste generation in H.P. Based on current annual MSW increase rate of 1-1.33% annually (Pappu et a., 2007) and estimates for the urban population projections in the year 2011, 2021, 2031 and 2041 for the State, total amount of MSW generated is presented in Table 1 below.

Table 1: Estimated waste generation in Himachal Pradesh

Himachal Pradesh			
Year	**Per capita waste generated(kg/day**	**Urban Population (x1000)**	**Waste generated (T/day)**
2011	0.413	736.3369	**304.3**
2021	0.472	883.3212	**416.6**
2031	0.538	1023.429	**550.9**
2041	0.614	1155.249	**709.6**

The daily waste generated in the state of Himachal Pradesh is expected to rise by almost 133% by 2041. Even today the state is struggling with waste management and in the coming years the

quantum of waste generated is only expected to increase, which will assume a crisis for the urban local bodies in the State.

Historically, the urban local bodies (ULBs) in Himachal Pradesh have worked in isolation without much coordination resulting in little or no treatment of the collected MSW and unscientific disposal of waste at dumpsites. This led to resistance from public and the state government came up with a waste management plan.

2. Institutional framework for waste management

2.1 State policies

The H.P government has also specified the responsibility of different authorities in municipal waste management:

- Municipal Authority: The implementation of MSW (Management and Handling) Rules, 2000, with in the territorial area of the municipality is the responsibility of the Municipal Authority. They are also responsible for infrastructure development for collection, storage, segregation, transportation and disposal of MSW. Recent initiative in door-to-door waste collection in Shimla is presently working successfully unlike other Indian cities largely due to the reason that the municipal authority could pass a by-law necessitating waste segregation, mandatory user fee collection and formed a society represented by different stakeholders, headed by Municipal Commissioner to look into issues associated with waste segregation at source.

- State government:

    - The overall responsibility of provision of these rules is on the Secretary-in charge of the Department of Urban Development of the state.

    - The District Magistrate or the Deputy Commissioner of the concerned district has the same responsibility with in the territorial limits.

- State Pollution Control Board:

    - Monitor the compliance of the standards.

    - Grant of authorization of Waste processing and Disposal facility.

    - Prepare and submit annual report to CPCB. (Department of Environment, 2012)

The important legislative development in waste management in H.P. is the ban on use of plastic bags. A proposal to ban 26 items which use plastic as packaging is also pending in the Supreme Court. The Recycled Plastic Manufacturer and usage Rules (1999/2003) designate SPCB as the

authority responsible for the implementation of rules related to the manufacture and recycling whereas the enforcement of the rules related to use, collection, segregation, transportation and disposal is the responsibility of District Collector/ Deputy Commissioner.

The National Urban Sanitation Policy of 2008 stipulates that the municipal waste management strategies must be reflected at the state level in the State Sanitation Strategy (SSS) and the City Sanitation Plan (CSP). This will ensure that the regional variation in the amount and type of MSW is duly acknowledged and appropriate steps are taken to handle it. Also, issues like land acquisitions for waste management purposes and engagement with local stake holders can be addressed more efficiently if the decision makers have region specific know-how and understanding.

According to the draft MSW Rules, 2015, the following are the responsibilities of state governments:

- Enforcement of these rules in cities.
- Forming guidelines for the ULBs to manage municipal solid waste.
- Reporting on the Service Level Benchmarks (SLBs) for solid waste management service by ULBs to the Ministry of Urban Development (MoUD).
- Allocating land to private players for construction of solid waste management facilities.
- Facilitate a regional sanitary landfill facility for a cluster of cities and to ensure professional and optimal management of such facility.
- Provide guidance to cities in managing grants for SWM activities.

Draft manual released by the central public health and environmental engineering organization (CPHEEO) suggest that a Solid Waste Management Cell (SWM Cell) must be constituted by the state government within the Department of Urban Development at the state level. Besides developing the state level solid waste management policies, the cell must also act as a nodal agency to all the ULBs in the state, collect data from them on annual basis and then forward that data to the respective SPCBs (CPHEEO, 2014).

2.2 Institutional framework for implementation

Himachal Pradesh has 50 ULBs and 6 Cantonment Boards and the government envisions development in a sustainable manner. Except the Municipal Corporation of Shimla all the ULBs are managed by the State Department of Urban Development. Figure 1 shows the institutional arrangement followed in the state to manage municipal solid waste.

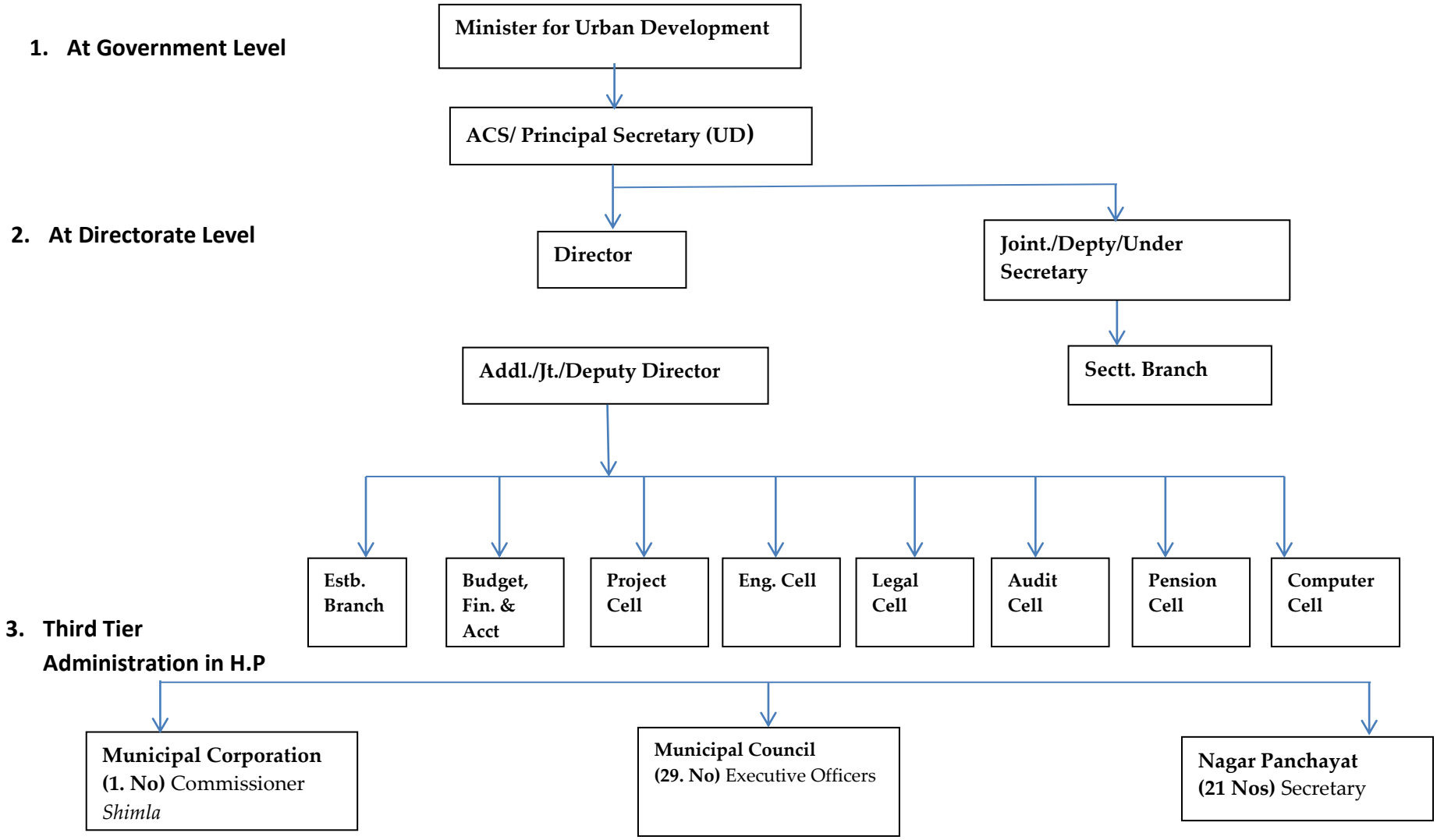

Figure 1 Institutional arrangement for MSW in H. P.

3. Case of Municipal Corporation of Shimla

Municipal Corporation of Shimla is divided into three tiers: Coordinators → Supervisors → Waste Collectors. Shimla had a very serious issue of waste littering and low waste collection efficiency. To improve this situation the Municipal Corporation of Shimla collaborated with the Shimla Environment Heritage conservation and Beautification (SEHB) society. This resulted in improvement in waste collection. The collected waste was proposed to be transported at processing site to produce RDF.

After tendering process the tender was finally awarded to Hunger Pvt Ltd. The plant successfully operated for some time but soon the operation stopped and consequently the waste was being dumped unscientifically. The possible reasons for failure of plant could be unsegregated waste. A court case was filed by the residents residing around the dumping sites against MC Shimla. MC Shimla stopped paying tipping fee to the private operators as the plant stopped functioning. At present the plant is not operating.

As an attempt to collect segregated waste from source itself, MC Shimla distributed two types of bins – yellow (for non-biodegradable waste) and green (for bio degradable waste) to each household but it was realized that the bins were not used for their intended purpose. It was observed that the bins could be designed in a better manner to encourage users to segregate waste and there was a need to properly educate the users. Moreover, the corporation also lacked the capacity to transport segregated waste. Thus, currently, even though the collection efficiency is high the waste collected is unsegregated.

Another challenge in the collection system is the attrition of the tier three employees (waste collectors) into other professions according to seasonal demands. To address this, MC Shimla holds regular capacity building programs wherein the waste collectors are informed about the value of recyclable waste and they are also suggested ways in which they can earn profit out of it. This is an added incentive for waste collectors. Financially, the waste collection system is self-sustaining as users are charged fee according their category.

The Department of Urban Development in H.P has initiated a pilot project in two clusters – Mandi and Dharamshala. Cluster approach in case of waste management is followed to make waste processing projects economically feasible and to address the issue of unavailability of land. H.P has been in careful in identifying the clusters considering manageable distance for waste transportation. The distance between ULBs and the waste processing and disposal sites has been kept as low as possible. Peri- urban areas are also planned to be included in the clusters.

The new plan for waste management is based on four principles:

- Segregation of waste at source
- Community involvement
- Extracting value out of waste by converting it into compost, biogas and/or electricity
- Involvement of the informal sector

Learning from the shortcomings of the Shimla model for waste management indicates that door to door waste collection does not ensure its source segregation but it also revealed that community is willing to participate in the door to door waste collection. Thus, the new model for waste management in H.P lays more emphasis on community participation. The government has prepared an elaborate plan to ensure this. The plan is to conduct workshops with the community leaders, MC officials and employees, kabariwalas etc., and disseminate information about the strategies on waste management. The community leaders along with hired campaigners are expected to reach each household of the community to spread awareness and mobilization of waste management plan. Underground bins will be set up in such a way that no person has to walk more than 100 m to dispose the waste.

GoHP aims at establishing high-end technology intensive plants to process waste and generate compost, biogas, refuse derived fuel (RDF) and/or electricity. A feasibility study is being carried out with the help of the Embassy of Netherland. Also, NEERI Nagpur is engaged in carrying out physio-chemical characterization of waste at dumpsites in Shimla, Mandi and Dharamshala. This will help in decision making while determining the appropriate waste treatment plant for that area. Private companies in Netherland will then be given the task to establish waste treatment plants and landfills.

Informal sector – kabariwalas are an integral part of waste collection system. GoHP has acknowledged this and the new waste management plan has a special focus on this sector. The kabaris will be encouraged to collect the non-biodegradable waste and yard will be dedicated to them in each ULB where they can store and segregate the collected waste. This will ensure that all kinds of non-biodegradable waste is collected, the recyclable waste will sold and the remaining waste can be passed on to the RDF plants.

Sensors are planned to be installed at the waste collection points to estimate the quantity of waste and this information will be connected to the GPS installed in the tipping trucks. This will guarantee that routes followed by the trucks are economically most feasible.

4. Key Challenges

The key challenges in achieving efficiency in waste management sector include non-segregation of waste at the source; the ULBs lack funds and they are inadequate to address the existing acknowledged problems in waste management. The waste inventory data required to make informed decisions while planning for waste management is lacking. It is also seen that compost plants are usually a failure on account of processing mixed with non bio-degradaeable MSW. There is no community participation towards management of waste and sanitation. The ULBs in the State are also unable to recover user charges from residents for solid waste service provision.

The proposed Municipal Solid Waste Management Plan by the State Government has provisions to address these challenges. The H.P. government has recognized the criticality of data collection in waste management and waste audits are planned to acquire this data. In addition, the government has also approached CSIR – NEERI for physical-chemical waste characterization of municipal solid waste at three sites – Shimla, Mandi/Sunder Nagar and

Dharamashala. All of this will help in making an informed decision while framing the policies related to waste management.

Another positive feature in the plan proposed by GoHP is recognition and involvement of the informal sector in the collection of non – biodegradable waste. Special spaces will be allocated to these waste collectors to store and further segregate the waste. This will not only improve collection efficiency and segregation of waste but will also mainstream the much ignored informal sector. There are also plans to involve community at various levels of solid waste management through workshops, mobilization etc.

It has also been acknowledged by the government the ULBs cannot work in silos. A cluster approach has been proposed to make the projects technically and financially more feasible. The two identified clusters are: Dharamsala cluster - Dharamsala, Kangra, Palampur, Nagrota Bagwan, Jawala ji and Dehra, and Sunder Nagar/ Mandi cluster - Sunder Nagar, Ner Chowk, Mandi and Riwalsar. (Directorate of Urban Develeopment, GoHP, 2015).

Public agitations and protests are often seen when a new plan is introduced. This happens due to plans being formulated without proper consultation of the relevant stakeholders. Thus, it is advisable that before the actual planning of municipal waste management plan the ULBs must identify stakeholders in the regions which might get affected by the plan or have an important say e.g., CBOs, rag picker associations, financing agencies etc. and form a steering committee with representation of all the relevant stakeholders for formulating a waste management plan.

5. Learning from international good practices

5.1 Brazil

The specific objectives of Brazilian national policy for solid waste management and the Law include:

- Adherence to waste hierarchy - a) reduce b) reuse c) recycle d) disposal of treated solid waste in an ecological manner must be promoted.
- The industries must be incentivized to use recycled products.
- Environmental impacts must be minimized by adopting, developing and improving clean technologies.
- Integrating reusable and recyclable material collectors in actions that involve joint liability for product life cycle.
- Preference to green procurement i.e. purchase of recycled and recyclable products, goods, services and so on, such that it promotes social and environmental sustainability. (al, 2013)

The Brazilian government, in 2014, decided that all the unregulated landfills must be shut down. Moreover, individual or entities not complying with policies and are responsible for damage to environment are required to compensate the government for remedial action.

The government of Himachal Pradesh can also incorporate such strong policy measures at state level. This will ensure that waste management gets the attention it needs and adequate action can be taken at the instances of non-compliance.

5.2 Europe

Many initiatives have also been taken by the European governments to ensure the safe disposal of solid waste to promote sustainability. Improvement in the efficiency of waste treatment and disposal facilities, diversion of bio waste from landfills to reduce greenhouse gas (GHG) emissions, replacement of mineral fertilizers with organic fertilizers (compost) and an improvement in the output from recycling units to reduce natural resource consumptions are some of the steps taken.

The bio-degradable waste management (BMW) systems[1], in Netherlands, Austria and United Kingdom, focus on building separate collection systems like specific bins which would eventually lead to BMW treatment systems. In addition, some economic instruments like Pay-As-You-Throw (PAYT)[2] and organic waste tax have been used as an incentive so that the residents' themselves divert BMW from the regular waste. Landfill Allowance Trading System (LATS), another such initiative by the United Kingdom government, provided the local authorities the flexibility to manage waste more efficiently.

In 1990 another waste management system – 'Duales (Dual) System Deutschland DSD', was introduced in Germany and then later replicated all over Europe. The main idea behind this was to transfer the responsibility of collection and recycling of main packaging on the producer itself. The packaging is typically marked with a 'green dot' to identify that it belongs to the DSD system. However, in Denmark, it was observed that there was no responsibility of producers in handling the packaging waste; this increased the uncertainty in the estimation of waste and then consequently resulting in higher waste management cost for the local bodies. In the Danish waste management system, all types' wastes, irrespective of the type and origin, are to be handled by the local bodies. The segregation of the waste is done at source itself. The financing of the system is through the polluter-pays-policy. (Pires, Martinhi, & Chang, 2010)

6. Opportunities in Waste Management

6.1 Public Private Partnerships

Due to unavailability of adequate funds, land and/or technical expertise, it is more practical to invest in processing plants/dumping sites which can handle waste from a number of

[1] Bio-degradable waste management system (BWMS) refers to the systems in place which are designed to separate Bio-degradable waste from the municipal waste stream
[2] PAYT is very similar to user fee charges. The only difference is that PAYT is levied according to quantity of waste generated

municipalities. Himachal Pradesh is exploring this approach by issuing pilot projects under PPP in Dharamshala and Sundar Nagar Clusters. (Directorate of Urban Develeopment, GoHP, 2015)

Moreover, the GoHP is gradually adopting 'polluter pays principle'. This is being done by charging user fee from the waste generators. User charges are already being implemented by the Municipal Corporations of Shimla and Mandi, and these experiences have established that citizens are not reluctant in paying the user fee charges if they realize that the waste is managed properly. Thus the government is encouraging other ULBs to charge user fee. Post JNNURM, with the advent of new Government at the National level, the new schemes like SMART cities and AMRUT[3] are likely to bring in more funding for tourism towns and towns in hill areas.

6.2 Recycling and Waste-to-Energy

Shimla, capital of Himachal Pradesh contains almost 43% of compostable waste and 37% of recyclable waste (CPCB,2005). GoHP is yet to conduct a detailed analysis of MSW composition with the help of NEERI.

This waste composition indicates that the waste generated has a high potential to be treated and re-utilized. The organic waste can be composted and recyclable waste can be used for material recovery. This implies that only 20% of the waste generated must be disposed in landfills. However, as mentioned earlier, the actual situation is opposite. Municipal Corporation of Shimla has been working with technology options like – composting and or biogas and production of RDF from residual waste and this seems to be preferred technology option package for rest of the ULBs as these are robust technologies and work well in Indian conditions with segregated waste. In order to improvise the collection system across the state underground bins are proposed to be installed for the convenience of general public.

Box 1: Waste recycling

The amount of paper waste generated in India is increasing as the country is economically progressing. Production of paper has huge direct implication on forest and wildlife. Thus, recycling paper waste is the most logical option. 'Waste to Wealth' was an initiative started by the ITC in 2011. The focus area is south of India, particularly, Hyderabad, Bangalore, Coimbatore and Chennai. IT companies like Infosys, IBM and Wipro have agreed to sell their waste to ITC for recycling. They also plan to tie up with RWAs, NGOs and local bodies.

Source: (CPHEEO, 2014)

[3] AMRUT – Atal Mission for Rejuvenation and Urban Transformation

Box 2: Biogas from waste

The Nisarguna Technology developed by the Babha Atomic Research Centre (BARC) is an improvement over the traditional Gobar Gas plants to generate methane for energy purposes. The improvement in the design prevents choking and allows the plant to treat a variety of waste feed. In 1998, the Municipal Corporation of Greater Mumbai, Stree Mukti Sanghatana, Bhabha Atomic Research Centre, Waste pickers cooperatives and Navi Mumbai Municipal Corporation collaborated together to manage the municipal waste by incorporating The Nasirguna Biogas Technology.

Source: (CPHEEO, 2014)

6.3 Deployment of information technology

Smart Waste Management System: SM-WMS is providing logistic solutions and constantly developing the mechanism according to needs and previous learning. These solutions are usually a combination of hardware and software developed by IT professionals. The basic objective is to minimize time consumption and investment, and maximize the quality of the service provided. For instance, the collection system can be improvised if the quantity and quality of the waste collected is regularly monitored. This knowledge will eventually help in better planning of collection routes, types of vehicles to be used and identification of critical areas which, probably, need special attention. Technologies like optical sensors could be used for high quality segregation of waste which will minimize the economic losses and provide a better input for specialized processing units.

The municipal corporation of Coimbatore is using an using an online waste truck monitoring system using radio frequency identification linked with waste transfer stations and processing units. The Bhopal Municipal Corporation saved up to 2000-3000 liters of diesel per day only by installing GPS devices in about 50 waste trucks.

Information Communication Technology: Integrating the information technology with the existing waste management system can have a huge impact on the condition of the waste sector in India. Technologies like GPS, GIS, remote sensing, online web services and cloud computing can find some real time application in waste management. For example, trucks and bins can be installed with remote optical sensors which can constantly record the data of type and amount of waste collected at various locations and create a database. This database can be instrumental in understanding, analyzing and predicting the waste production patterns, and eventually manage waste more efficiently. (Ion & Gheorghe, 2014) (Planning Commission , 2014)

Himachal Pradesh at present needs to fill knowledge gaps regarding the quantum and types of waste generated. With the help of integration of these technologies it will be easier to monitor activities and record data on regular basis. The strategies to improvise the waste management can then be developed after analyzing and understanding this data.

7. Ways forward

The situation of solid waste management in the State has certainly improved over the years. However, there is still a long way to go. Instead of following the usual end of pipe approach, waste management must be looked at holistically and preference must be given to reduction of waste at the source. The waste management system is faces a huge challenge at collection stage, which is inefficient and consumes most of the funds and time. Municipal Corporation of Shimla has established an extra-ordinary self-sustaining waste collection system with help of SEHB society. The bottle neck of lack of source segregation is, however, yet to overcome. Instead of working against the informal sector, it is important to recognize the importance of informal sector and incorporate it into the formal waste collection system. Waste processing and disposal deserve more strategic and financial importance. The new waste management plan, to an extent, has strategies to address these issues. There is need to maximize resource recovery from waste and waste recycling to reduce the land requirement for waste disposal.

As regards to municipal solid waste and other urban waste streams like e-waste, construction and demolition debris, partnership of various stakeholders viz. ULBs, private formal and informal waste managers, waste generators, and regulatory agencies need to evolve to ensure that waste management is carried out in most efficient manner. The ULBs are running low on funds. The current mechanisms to raise funds for waste management must be improvised. Also, it must be realized that municipalities can no longer 'provide' all the waste management services in isolation. The aspects of waste management which the municipalities can handle efficiently must be identified and private players must be given a chance to manage the remaining aspects. The government must alter policies in such a way that private sector is encouraged to invest, establish and operate facilities in the waste management sector. The key strategies for efficient management of waste as part of greening the waste sector would include:

- **Waste reduction strategies**: Waste reduction strategies involve lesser generation of waste at source and using alternative material which generate waste of lesser hazard as compared to traditionally used ones. It is necessary to decouple the waste generation process from the growth of economy and population. Various ways in which this can be achieved are:

  a. Alternative packaging – use of fabric or jute packaging instead of traditionally used polythene bags which are difficult to collect and recycle (reviving of jute sector)

  b. Designing products like cell phones and other electronic goods for longer shelf life so that they enter the waste stream a little later

  c. Designing products for disassembly so that majority of their components can be recycled at the end-of-life

  d. Developing re-manufacturable products to increase their life cycle

- **Waste inventory**: As evident in the case Himachal Pradesh, getting the most credible waste inventory data is a problem. In absence of dynamic waste inventory, long term

planning for waste management becomes difficult. Each municipality should maintain a complete database for its waste management activities, particularly generation of waste (daily data), characteristics of waste (monthly data), processing facilities actually installed and operated and their performance (monthly data) and final disposal in a sanitary landfill (monthly data).

- **MSW to composting**: Excessive use of chemical fertilizers and resulting run off is resulting in pollution of soil and water bodies and is key non-point source of pollution. The top soil as a result of over irrigation is also getting depleted in organic carbon which affects soil fertility. As stated earlier, MSW in India comprises of around 50% organic or food waste with high moisture content. This waste (food waste, agricultural residues, etc.) can be composted either aerobically or anaerobically. This process not only treats the waste, diverting it from landfill (thus saving on cost of disposal) but also the compost produced can enrich the top soil with organic carbon which is key to soil fertility. The process is net GHG saver as compared to open dumping of waste which results in uncontrolled emission of methane. Decentralized, community composting options should be explored wherever feasible (away from residential areas to avoid community conflicts)

- **MSW to energy**: Viability of producing energy from MSW (woody waste, agricultural residues, food waste, waste papers, plastics, etc.) and extraction of landfill gas from 'open but soon to be closed waste dumps' can not only treat the waste but also provide renewable source of energy to 'energy starved' cities. Technologies like anaerobic digestion (producing power as well as compost), use of refuse derives fuel and landfill gas will be explored for processing such waste. These processes also would be net GHG saver as compared to open dumping of waste which results in uncontrolled emission of methane. Decentralized biomethanation options as implanted in Pune should be explored for other cities as well. The Ministry of New and Renewable Energy (MNRE) estimates that there is potential of generating around 2500 MW of energy from processing of waste in the country.

- **Material recovery and recycling**: India reportedly salvages and recycles around 70% of MSW, though most of it is collected and recycled by informal sector using rudimentary technologies. It is reported that in developing countries around 15-20 million people are engaged in waste recycling activities – in some cities 2% of the population. More than 1 million people are engaged in waste recycling activities in India. It is also reported that informal sector (waste pickers) remove around 10-15% of waste every day from city streets and are key to solid waste management system in any city. There should be efforts to institutionalize informal sector and modernization of recycling technologies. Informal waste recyclers can be trained to collect the waste from households, do decentralized waste processing (composting or biogas) and trade recyclable waste as is demonstrated by Stree Mukti Sangathan in Mumbai.

7.1 Need for funding

The goals of greening the waste sector cannot be achieved without increased investment. Minimizing waste generation requires changes to product design and production processes

upstream. Downstream recovering, remanufacturing, recycling, and final treatment require new facilities or upgrading of existing facilities. Investment is also needed to train the labor force in the sector as well as to formalize the informal sector.

Cities in India typically spend more than half of their waste budget in collection alone (mainly on labour and fuel), although the collection rate remains low and the transport of waste inefficient. Spending on other segments of the waste management chain such as appropriate treatment, recovery and disposal technologies and facilities is generally rather low. Increased investment in basic collection services, the transport of waste and cleaning up dumpsites is a starting point for greening the sector. Investment can be targeted, for example, at techniques such as route optimisation and transfer stations, which can bring down the capital and operational costs of providing waste services.

7.2 Benefits of Greening the Waste Sector

Greening the waste sector is expected to generate substantial economic, environmental and social benefits. They include: 1) natural resource and energy saving; 2) creation of new businesses and jobs; 3) compost production supporting organic agriculture; 4) energy production from waste; 5) reduced GHG emissions; and 6) contributions to equity and poverty eradication. Improved health, avoided health costs, avoided water contamination, and the consequent cost of alternative water supply are also important streams of benefits.

Though the figures for job creation while greening the sector is not available as of now for India; similar experiences in other developing countries show that the activity does create better quality of jobs. Over half a million waste pickers have been reported in Brazil and the country has close to 2,400 companies and cooperatives involved in recycling and scrap trading (UNEP 2008). In Buenos Aires, an estimated 40,000 waste scavengers are estimated to have an economic impact of US$1.78 million per year, close to 0.05 per cent of the city's GDP (Medina 2008). Other estimates put the number of waste scavengers in India at least at a million, while in China up to 10 million workers are reportedly involved in recycling activities (UNEP 2008). Scheinberg et al. (2010) studied informal recyclers in six cities: Cairo, Egypt; Cluj-Napoca, Romania; Lima, Peru; Lusaka, Zambia; Pune, India; and Quezon City (part of Metro Manila), the Philippines, and found that more than 75,000 individuals and their families are engaged in recycling about 3 million tonnes of waste per year with an economic value of more than US$ 120 million.

7.3 Enabling conditions

1. **Finance**: Investing in greening the waste sector requires substantial financial resources for both capital expenditures and operation. Such resources may be found from: 1) private investments; 2) international funding 3) cost recovery from users; and 4) other innovative financing mechanisms.

2. **Incentives and disincentives**: Economic incentives and disincentives serve to motivate consumers and businesses to reduce waste generation and dispose of waste responsibly, thereby contributing to increased demand for greening the waste sector.

The incentives commonly prevalent in the waste sector include: 1) taxes and fees; 2) recycling credit and other forms of subsidies; 3) deposit-refund; and 4) standards and performance bond or environmental guarantee fund. Volumetric landfill taxes can encourage the reduction of waste and are easy to implement. Their effectiveness, however, depends on the tax rate per tonne of waste and on the existence of adequate monitoring and enforcement measures. It is also important to ensure that the tax does not result in increased illegal dumping rather than encouraging 3 Rs.

Pay-as-you-throw (PAYT) is another way of discouraging waste generation. Precaution against illegal waste dumping or misuse of recycling facilities is however needed. Full financing of the waste-management infrastructure has to be assured and sufficient awareness-raising is necessary. PAYT has a positive impact on recycling. For example, PAYT increased the recycling rate from 7 per cent to 35 per cent in Portland, Oregon and from 21 per cent to 50 per cent in Falmouth, Maine in just one year of implementation (Shawnee Kansas 2009).

Waste avoidance can also be achieved by assigning a disincentive for items such as plastic bags. For example, Nagoya city in Japan, after extensive consultation with retailing companies and two years of piloting, assigned a charge for plastic shopping bags in April 2009. The scheme was adopted by 90 per cent of the shopping market. The initiative reduced plastic-bag usage during shopping by 90 per cent as of December 2009. About 320 million bags weighing 2,233 tonnes were estimated to have been saved between October 2007 and October 2009 (Environmental Affairs Bureau 2010).

3. **Institutional arrangement between formal and informal sectors**: It is important to formalise the informal sector enterprises and support them through incentives in order to develop local markets and small and medium formal recycling enterprises. Incentivising formal recycling activities, providing micro-finance and access to the markets could help in shifting the informal sector to formal regime. In addition, raising awareness on the social and health related benefits of formalisation may help in understanding importance of intangible benefits.

4. **Policy and regulatory measures**: The most common types of policy and regulatory measures include:

    - Regulated targets for minimisation, reuse, recycling; and required targets for virgin materials displacement in production inputs;

    - Regulation relevant to the waste management "market", i.e. permitting/licensing requirements for waste handling, storage, treatment and final disposal; and recycled materials standards; facilities standards, including pollution control technologies; and

    - Land-use policies and planning for siting waste processing and disposal infrastructure.

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