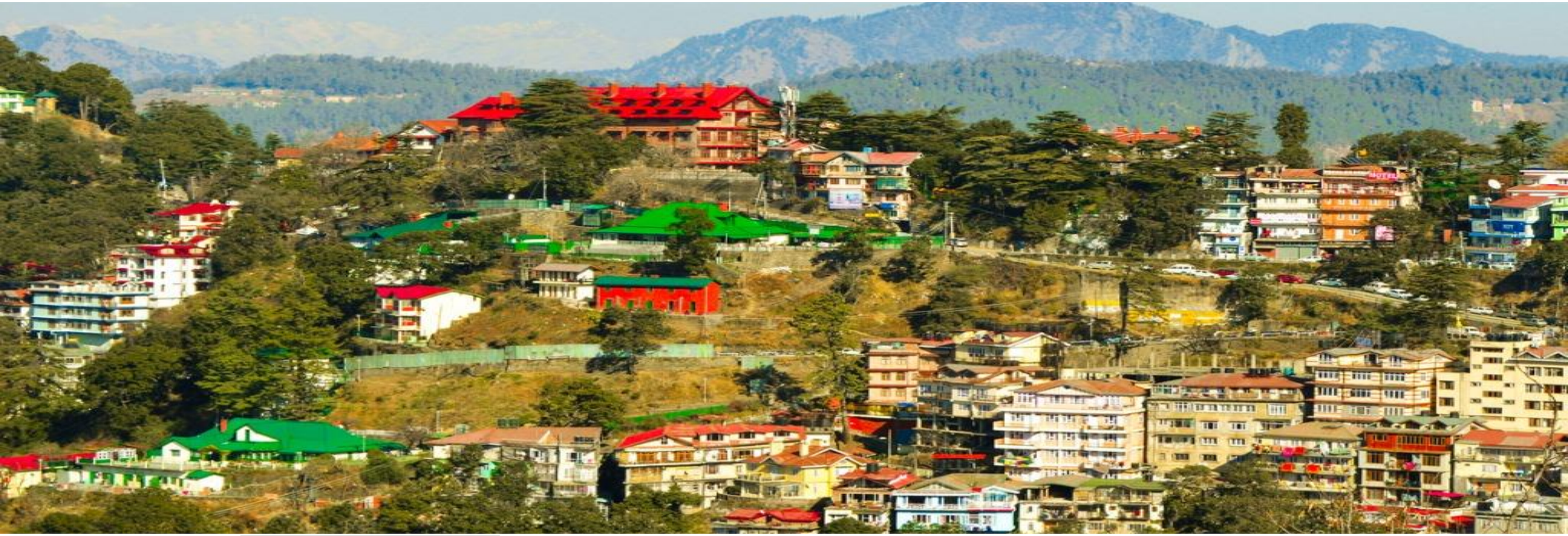
Project – International Urban Cooperation: Sustainable and Innovative Cities and Region

Sub-project – Baseline study for SWM and waste to energy in Shimla

Deliverable – Final Presentation

April 14, 2021



Funded by the European Union

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Agenda

- Assignment background
- Shimla district profile
- Assignment methodology
- Solid waste management in Shimla
- Waste to energy plant in Shimla
- SWM in Wolverhampton, UK
- SWM best practices in other European cities
- Challenges and corresponding solution
- Next steps

Assignment background

Objectives of the assignment

- To prepare a baseline study for solid waste management (SWM) with a focus on waste to energy plant in Shimla
- The project commissioned as part of the Shimla - Wolverhampton strategic collaboration under the IUC – India programme
- Baseline study to provide set of recommendations to Shimla against the challenges being faced by the waste to energy plant
- To conduct as-is analysis of the solid waste management value chain in Shimla including the policies governing the same

Objective of the IUC programme

- Improved international urban policy diplomacy and increased cooperation on sustainable urban development and climate change
- The IUC programme has two components as follows:

  a) City/ sub-national cooperation on sustainable urban development to strengthen EU-India cooperation at both national and city levels

  b) Cooperation on sustainable energy and climate adaptation and mitigation, access to clean energy, through GCoM initiative

Note: EU- European Union; GCoM- Global Covenant of Mayors; IUC – International Urban Cooperation;

Shimla – district profile

Shimla district

- Known as the former summer capital of the British India
- Area of the district: 5,131 sq.km
- Estimated population of district in 2020: 927,971
- Consists of 3,347 villages and divided into 8 sub-divisions
- Administrative authority: Municipal Corporation of Shimla

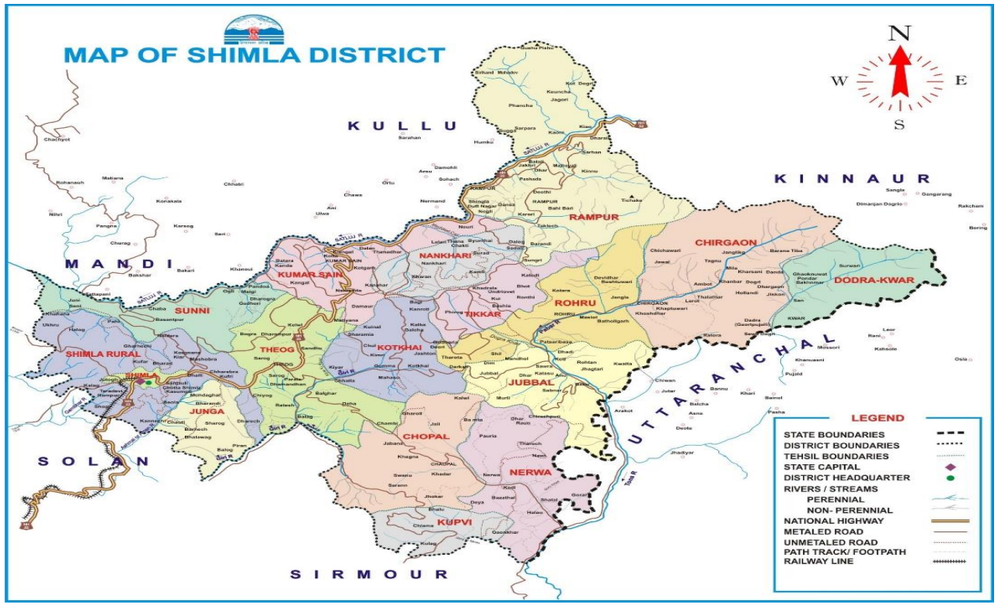
Geographical location

- 116 km from Chandigarh; 350 km from Delhi
- Shimla is built on top of seven hills like summer hill etc.
- Bounded by Mandi, Kullu, Kinnaur and Uttrakhand
- No water body near the main city; closest river is Sutlej
- Other rivers in district – Giri and Pabbar
- Easy connectivity through road, air and rail

Climate

- Climate in Shimla is predominantly cool to moderately warm
- Temperature range from -4 degree to 31 degree across year
- Average precipitation is 1,575 mm, less than other hill stations

Shimla district map



Source: [Brief Geography of District Shimla – Himachal Pradesh General Studies, May 19, 2020, by HP General Studies.]

Assignment methodology

Secondary research and documents shared

- Extensive secondary research carried out during the preparation of this baseline study
- Documents shared by officials of IUC-India and Municipal Corporation of Shimla and City of Wolverhampton Council

Stakeholder consultations

- Multiple rounds of stakeholder consultations were undertaken through video conferencing and conference calls
- Inputs provided by officials of IUC-India, city of Wolverhampton and MC Shimla were of great importance in preparation of baseline study

Limitations of study

- Study is limited to the assessment of the current situation of the SWM value chain in Shimla along with the waste to energy plant
- On account of restrictions laid out due to COVID-19 site visits, face to face interviews, primary data collection, etc. were not feasible

Note: IUC - International Urban Cooperation; MC Shimla - Municipal Corporation of Shimla

Current status of SWM in Shimla

Generation

84.5 tons generated

Amount of waste segregated:
50-60%

Collection

70 tons collected for treatment/ disposal

Waste collection rate:
83%

Transportation

Transportation of waste through

42 vehicles owned by MC Shimla

Segregation at plant

Recyclable waste of

~4 tonnes is segregated through manual and mechanical process at the WTE plant

WTE

Segregated waste converted to

~40 TPD of RDF at WTE plant

Disposal

Disposal of

6-8 TPD of waste adjacent to WTE plant

Note: TPD - Tonne per day
W2E - Waste to energy
RDF – Refuse derived fuel

Waste generation and segregation in Shimla

Waste generation

- Total solid waste generated from 34 wards in the city is 84.5 TPD
- Generated waste consists of metals, glass, food, paper, textile, plastic, rubber, inert material and miscellaneous substances.
- Moisture content in the waste collected from residential, commercial and mixed zones varies between 40-60%

Waste collection

- SWM for the city of Shimla is under the administrative control of the Health Officer of the Municipal Corporation of Shimla
- 100% households covered under door-to-door collection by Shimla Environment, Heritage Conservation and Beautification Society
- Of 84.5 TPD of waste generated, ~70 TPD is collected (83%) and is sent to the waste to energy plant

Segregation of waste

- SEHB has provided coloured bins, yellow and green, to households, commercial est., etc. for collection and segregation of garbage
- The yellow bin is for non-biodegradable waste and green bin is for biodegradable waste collections within the establishments
- The waste segregation initiative has not met with the intended success and only 50-60% waste is segregated in the city

Note: TPD- Tonne per day

Waste collection, transportation and treatment in Shimla

Waste transportation

- Transportation of waste from the city to the waste to energy plant is managed by the Municipal Corporation of Shimla
- MC Shimla has procured 42 tippers for transportation of waste with each ward having a minimum of 1 truck at their disposal
- Routing and loading plan for waste transportation is shared with all vehicles and exercised in coherence with door to door garbage collection

Waste treatment and disposal

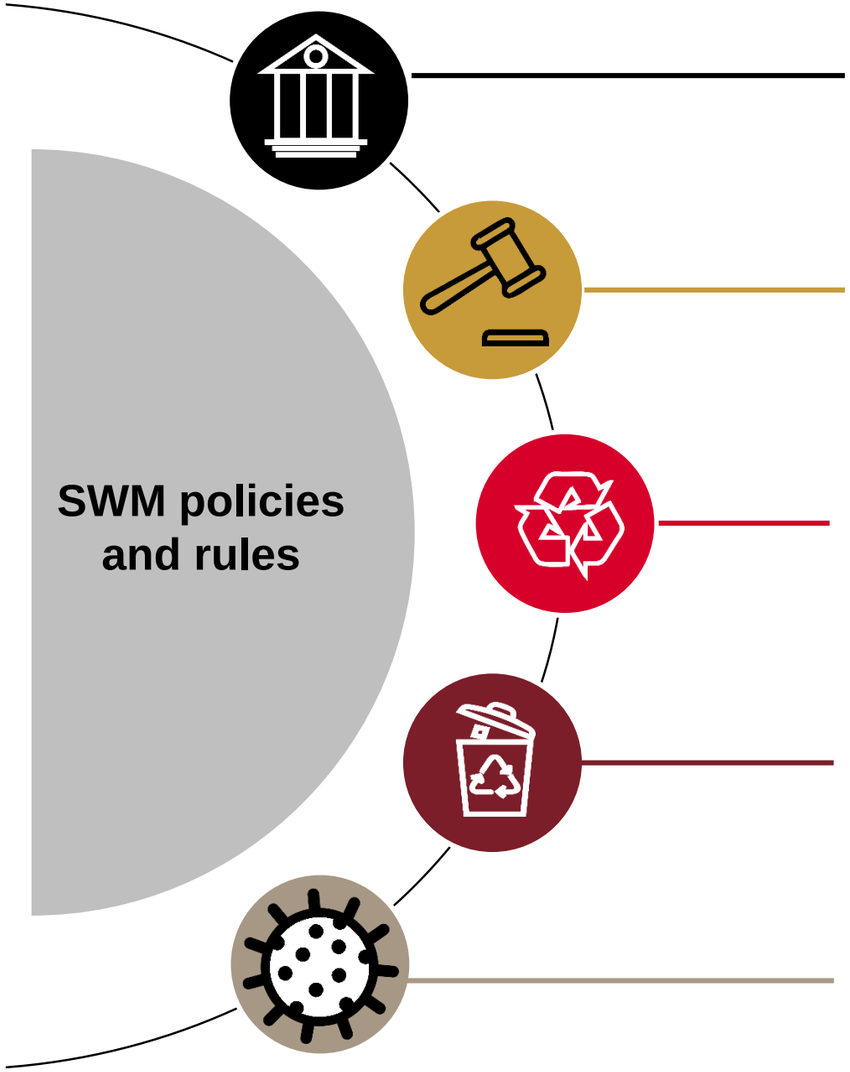
- Waste from Shimla is transported to waste to energy plant for conversion to RDF and subsequent production of electricity
- The plant converts 40 tonnes of waste into RDF which is sold to cement plant, 6-8 tonnes of residue is disposed at site adjacent to the plant
- When fully operational the plant will produce up to 2.5 MWh of electricity using gasification technology and RDF as an input

Composting and biogas plant

- Biogas plant of 1 TPD capacity has been commissioned. Biogas produced is used for domestic purposed by labourers working at the plant
- MC Shimla has floated tenders for establishing a composting plant with a capacity of 5 TPD which will use wet waste as its input
- Establishment of composting plant will help in improving the efficiency of the WTE plant as the WTE will only receive dry waste

Note: NGO – Non governmental organization
Cum- cubic meter
TPD – tonne per day
WTE – waste to energy

Policy and legal framework



Himachal Pradesh Non-biodegradable Garbage (Control) Act, 1995

- To prevent non-biodegradable waste being thrown/deposited at public places
- Restriction/prohibition on using things made of non-biodegradable material
- Placement of receptacles for deposit of non-biodegradable garbage

Door to door garbage collection bye-laws (MC Shimla), 2006

- Mandates household to handover garbage to agency authorized by MC Shimla
- Led to the formation of SEHB society in 2009 headed by Commissioner
- Optimisation of routing of each vehicle was established

Solid Waste Management Rules, 2016

- Identifies all stakeholders for efficient SWM system
- Defines responsibilities of members in value chain
- Introduces incentives, penalties and other initiatives

Plastic Waste Management Rules, 2016

- Defines plastic and all types of plastic waste
- Lists roles and responsibilities of stakeholders
- Explains modalities of plastic SWM and challenges

UN Habitat Covid-19 SWM guidelines

- Places generating hazardous waste to be mapped for efficient resource allocation
- Coordination and collaboration with informal workers, NGOs etc.
- Increased waste collection services for identified biomedical waste sources

Waste to energy plant – Introduction

Agreements signed

- Waste concession and land access agreement: March 29, 2016
- EEPL to accept all kinds of municipal solid waste at the plant
- No tipping fees to be paid by MC Shimla to EEPL for waste
- PPA with HPSEB Limited: May 16, 2016
- HPSEB to purchase electricity at Rs 7.90/unit (€ 0.09/unit)
- PPP concession period has been set at 20 years
- Land for the energy plant has been provided by MC Shimla

Overview

- Waste to energy plant commissioned in August 2017
- Built on PPP basis at a cost of Rs 42 crore (€ 4.9 million)
- Capacity to generate up to 2.5 MWh of electricity from waste
- Based on RDF technology using gasification technology
- Trials underway and the plant is producing 2 KWh of electricity

Figure - Waste to energy plant in Shimla

Source: MC Shimla

Figure - Gasifier section of plant

Source: MC Shimla

RDF – Refuse derived fuel
EEPL – Elephant Energy Pvt. Ltd.
PPA – Power purchase agreement
HPSB – Himachal Pradesh State Electricity Board Ltd.

Waste to energy plant – Refuse derived fuel

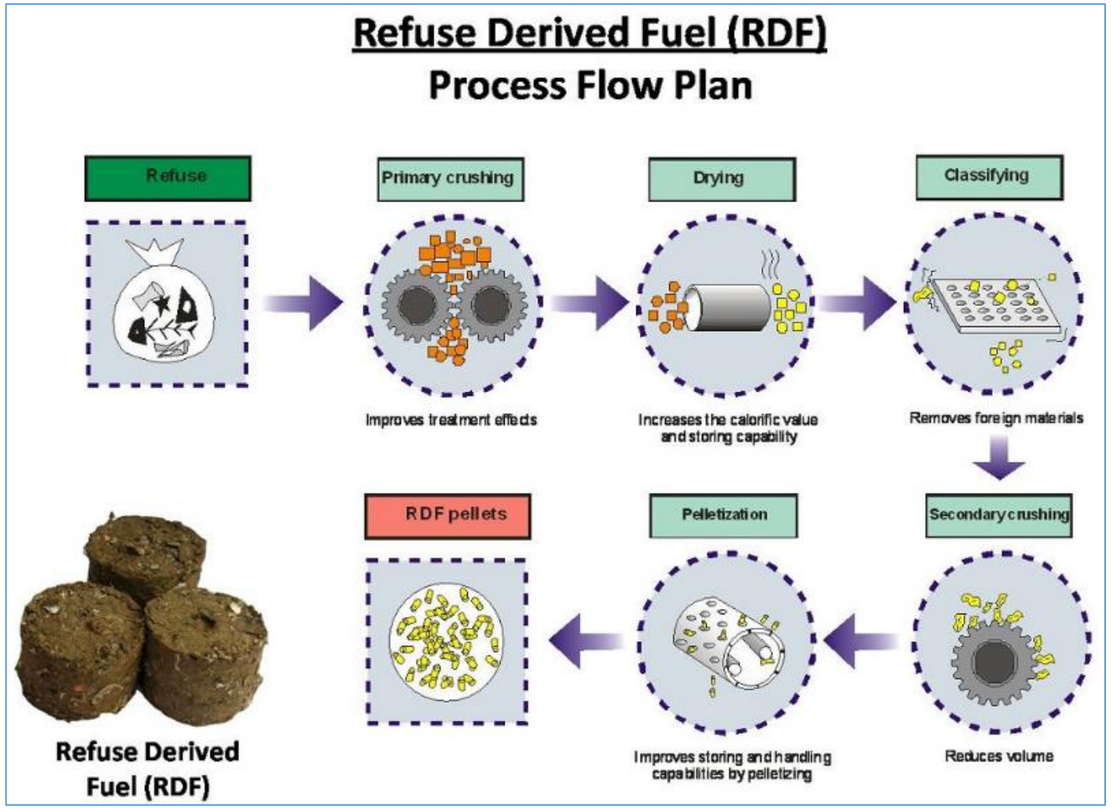
Overview

- MSW contains – paper, cloth, plastic, and other fractions
- These fraction can be processed to produce refuse derived fuel
- RDF has high calorific value and is used as alternate fuel
- RDF is used as feedstock in the gasifier to produce syngas
- Syngas used in engines/turbines to generate electricity
- Processing municipal waste to RDF reduces load on landfill sites

Processing of RDF

- Production of RDF is a four step process:
- Waste is crushed in to appropriate size for drying
- Crushed refuse goes through high temperature blast
- The drying process dries and deodorize the refuse
- Refuse is then separated according to their weight
- Heavy material with low calorific value is discarded
- Light material with high calorific value is used as RDF

Figure - Processing of Refuse Derived Fuel



Source: [Refuse derived fuel]

MSW – Municipal solid waste
RDF – Refuse derived fuel

Waste to energy plant – Gasification technology

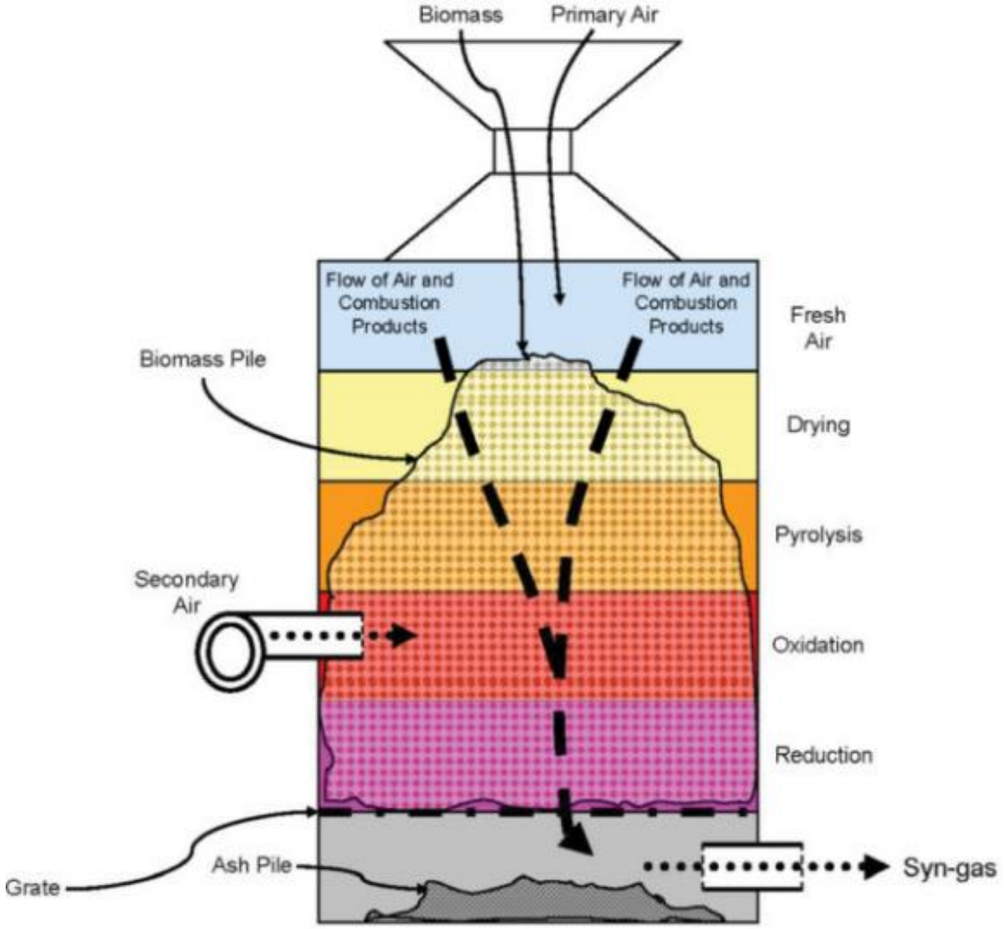
Overview

- Thermal process to convert organic material to combustible gas
- Material is reacted at high temperatures, without fully combusting it
- Resulting gas mixture is know as synthesis gas (Syngas)
- Process is carried out in temperature range of 600 – 1,000°C
- Syngas can be used directly for heating or electricity generation
- Process is similar to combustion but has low moisture acceptability

Process of gasification gasification

- There are 4 stages involved in the gasification process:
- Drying: Moisture in feedstock evaporated by heat from lower zones
- Drying process occur at 150-200°C; Pyrolysis: 200-600°C
- Pyrolysis: Thermal decomposition of biomass in low oxygen
- Combustion: Oxidation occurs in the presence of a reactive gas
- Combustion process occurs at 700-1,000°C
- Reduction: Multiple reactions take place to produced syngas

Figure - Gasification process



Source: [Biomass gasification for large scale electricity generation – EE Publishers, January 30, 2019 by Mike Rycroft, EE Publishers]

MSW – Municipal solid waste
RDF – Refuse derived fuel

Waste to energy plant – O&M and data provision

Description of O&M of RDF plant

- Consists of 2 RDF lines, magnetic separators, manual separation, shredders and dryers to produce refuse derived fuel
- After segregating the wet waste, the dry waste is shredded, classified, and pelletized into RDF which is then sold to cement plants
- The plant receives mixed waste, hence much of plant's energy is utilized in segregating waste so that it can be converted into RDF

Description of O&M of gasification plant

- A gasification plant generally consists of reactor, air supply system, feeding system, gas outlet system, ash removal system, grate, etc.
- RDF is dried before undergoing various reaction resulting in formation of syngas which is passed through turbines to generate electricity
- The operator is in the process of upgrading the filtration mechanism to remove excess nitrates and sulphates from the syngas

Challenges being faced by Shimla related to SWM

Solid waste segregation, collection, and transportation

- Low segregation rate: Only 50-60% waste produced is segregated. Waste reaching WTE plant has high moisture and low calorific value
- Difficult terrain and weather: Only 25% of city is connected through road; hilly terrain causes problems in waste collection
- Inefficient use of waste collection trucks: Due to lack of awareness, segregated waste is getting mixed while loading in the trucks

Solid waste treatment

- Difficulty in composting: No composting plant in city; Waste is not segregated creating problem in composting which requires wet waste
- Pollutants in syngas: Due to unsegregated waste, syngas produced at the plant consists of tar restricting efficient production of electricity
- Absence of scientific landfill: No landfills present in Shimla; waste is dumped adjacent to WTE plant and covered with soil and debris
- Others: lack of enabling policies at state and city level, inadequate funds to implement projects, lack of awareness and technical know-how

About Wolverhampton, UK

Wolverhampton city

- Population: 249,470 (2011, Census)
- Population density: 3,595/ sq km
- Number of households: 110,750
- Area: 69.4 sq km
- Administrative body: City of Wolverhampton Council

Economy

- Major employer of the city's population is the service sector
- Important sub-sectors: Public administration, education, health
- Largest non-service industry is that of manufacturing
- Industrial hub – factories of Land Rover and Goodyear
- Football club Wolverhampton Wanderers contribute to economy
- Indian diaspora forms the largest proportion of ethnic minority

Figure- Map of Wolverhampton

Source: [City of Wolverhampton location map]

Waste management in Wolverhampton, UK (1/2)

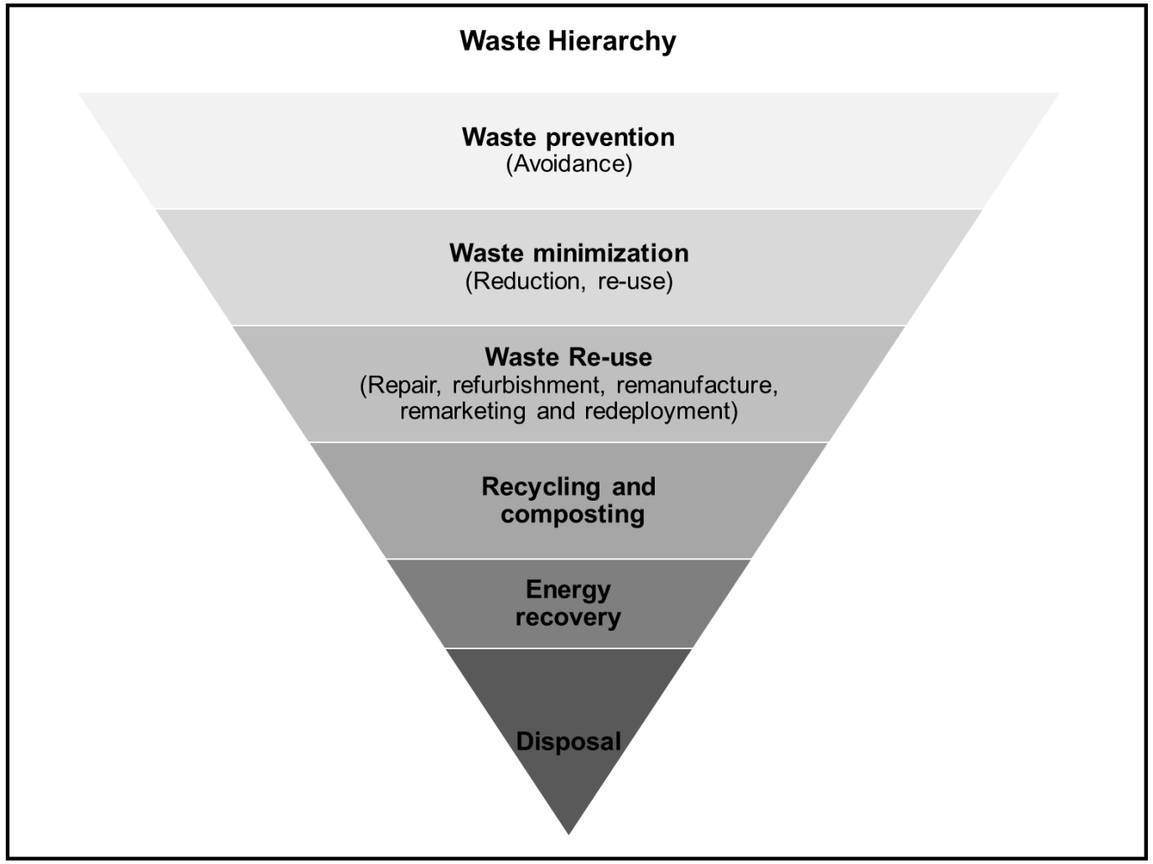
Waste generation

- Amount of general waste produced: 330 TPD
- Amount of recyclable waste generated: 85 TPD
- Total 415 TPD tonnes of waste is generated in the city
- General waste: Food waste, textile, nappies, miscellaneous, etc.
- Recyclable waste: Glass, plastic, paper, ferrous material etc.
- Recycling rate in city: 38% (2019-20)

Waste collection and segregation

- 240l coloured bins for segregation of waste provided
- Council employs 140 people to undertake waste management
- Once a week collection for general and recyclable waste
- Waste collection cycle of 15 days is followed by council
- Council also collects garden waste at fee of GBP 40 per month
- The garden waste collected is used to generate biogas

Figure – Hierarchy of waste collection in Wolverhampton



Source:https://wolverhampton.moderngov.co.uk/documents/s75571/Appendix%201%20for%20Waste%20Strategy%202018-2028.pdf

TPD – Tonnes per day
L - Litres

Waste management in Wolverhampton, UK (2/2)

Waste transportation

- Council directly delivers collected general waste to WTE plant
- Council has a fleet of 17 refuse collection vehicles
- Each truck typically tips off 2-3 times per day
- City is divided into 14 curbside routes for waste collection
- Operate 4 daily rounds collecting both kind of wastes
- Operate 4 rounds daily for the paid garden waste service

Waste treatment and disposal

- All general waste collected is disposed off at the WTE plant
- 19% of incinerated waste becomes residue of bottom/ fly ash
- WTE produces 36,500 MWh gross electricity per month
- Council has a disposal contract for composting garden waste
- Garden waste collected fortnightly on chargeable basis
- 11,000 tonnes of green waste is collected from the residents
- Composting of green waste is undertaken using open windrows

Figure – Kerbside collection in Wolverhampton

Source:https://wolverhampton.moderngov.co.uk/documents/s75571/Appendix%201%20for%20Waste%20Strategy%202018-2028.pdf

WTE – Waste to energy

Waste to energy plant in Wolverhampton, UK

Overview

- Constructed in 1998 by MES Environmental Limited
- Facility can process maximum of 110,000 tonnes of waste/year
- Plant uses combustion technology to produce electricity
- When operating at full load, plant generates 8 MW of electricity
- Plant exports 7.1 MW of electricity to grid

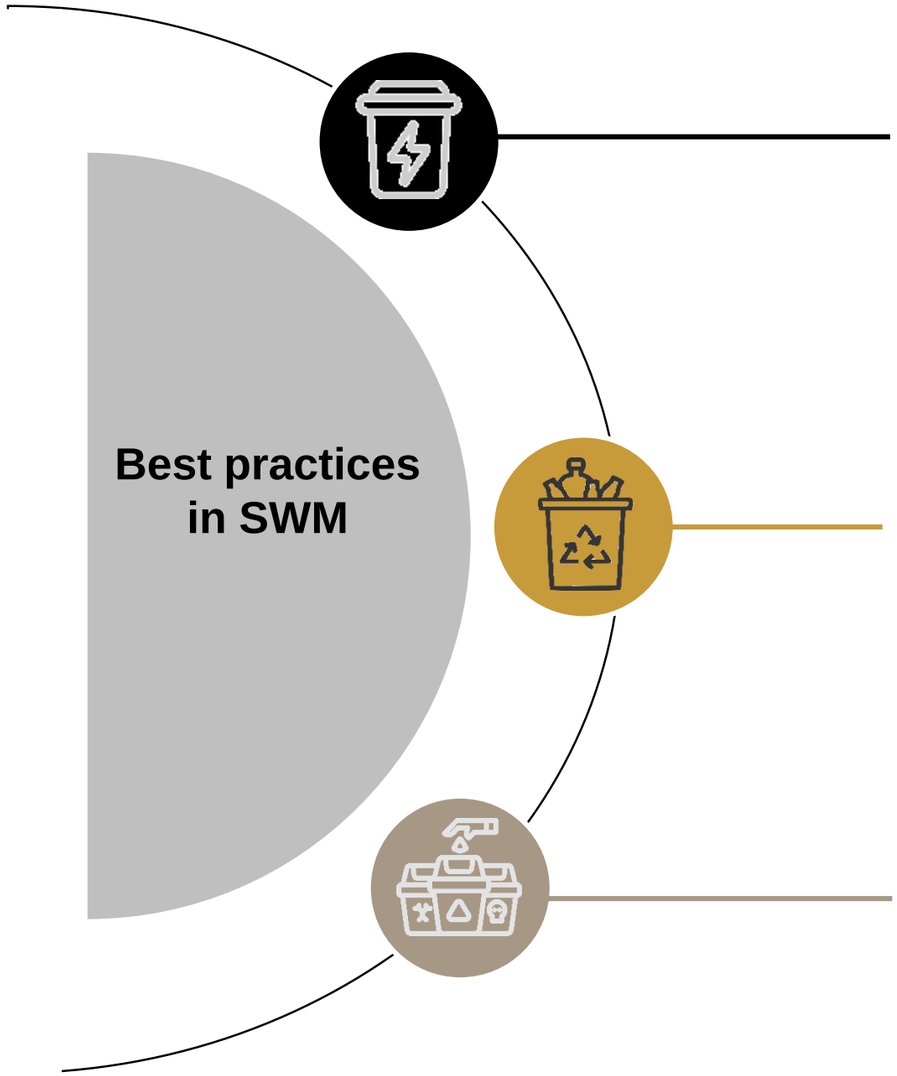
Summary of operations

- Plant has two combustion lines with total capacity of 14 tonnes/hr
- Each line has separate furnace, boiler, flue gas treatment equipment
- Plant uses incineration process to convert waste to electricity
- Steam is generated in high-pressure boilers using incineration
- Electricity is produced by expanding steam through a steam turbine
- Operations undertaken at negative pressure to prevent odour & dust
- Multi-stage high efficiency flue gas cleaning system implemented

Figure - Waste to energy plant at Wolverhampton

Source: Wolverhampton EFW – MES Environmental Limited

SWM best practices from other European cities



Vienna, Austria

- Landfilling of waste with TOC content over 5% is banned in Austria
- Packaging waste handled by ARA AG, an NPO, established by pvt. stakeholders
- Treatment of packaging waste by recycling and energy recovery (incineration)

Ljubljana, Slovenia

- Separate collection of biodegradable and recyclable waste on door to door basis
- Reuse centres to encourage reuse of old, redundant but reusable items
- Rise in number of packaging-free vending machines and zero plastic waste stores

Copenhagen, Denmark

- Source separation of recyclable waste fractions is a major part of city's SWM
- Waste collected by municipalities from households and sent to recycling centres
- Deposit and return system for PET bottles used for storing water, beverages etc.

ARA – Alstoff Rescycling Austria
PET – Polyethylene terephthalate
TOC – Total organic carbon
NFO – Not for profit organisation

Key challenges and solutions

Key challenges	Solutions
Waste segregation, collection and transportation	
• Low segregation rate • Difficult terrain and weather • Inefficient use of waste collection truck	• Fines and incentives for waste generators to ensure segregation • Awareness programs to promote waste segregation • Setting-up transfer station at outskirts of the city • Decentralized waste segregation at local community level • Separate days for collection of dry and wet waste
Waste disposal and treatment	
• Difficulty in composting • Presence of pollutants in syngas at WTE plant • Absence of sanitary landfill and legacy waste	• Maintaining ambient temperature inside composting facility • Encouraging residents to practice home composting • Using only dry waste at the WTE plant to improve efficiency • Identify an alternate site with higher capacity for landfill

Next steps

Next steps

- MC Shimla should divide the above recommendations in to short term goals and medium term goal to identify priority projects
- Once identified, project reports should be prepared to define broad goals and objectives of the project
- Projects will require adequate funding for successful completion which can be arranged from earmarked state funds or national schemes

Thank you