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Environmental Impacts for Setting up a Waste to Energy Landfill Site

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Abstract

Engineered landfills are being proposed for proper waste management in developing countries as well as bio energy generation and recovery from the organic waste. Organic waste is a major emitter of greenhouse gases if left to rot, however proper operation of a landfill will see the realization of products like biogas, bio ethanol and bio pellets. In most developing countries, the landfills did not have the waste to energy recovery facility and must be constructed accordingly. However, there is need to minimize the environmental damage during the construction, operation and closure phases of the landfill. The construction of an engineered landfill has potential to create jobs and also boost the usage of green renewable energy. However there are negative impacts on the air, soil, water and personnel that must be minimized to allow the harnessing. of bio energy from landfills without harming the environment.

Keywords: Bio energy, environment, landfill construction, organic waste, waste to energy

1. Introduction

Resource recovery from landfills is becoming popular as an effective waste management to energy initiative (EPA, 1998). Most of the organic waste that ends up at the landfills is organic waste which can be value added to bio energy. Recent studies have shown that the organic fraction has more than 80% of the total waste discarded at the landfill site (Manyuchi et al., 2017). Biomass related energy products such as biogas, syngas, bio pellets, electricity and bio ethanol have been realized from landfill waste's organic fraction (Alijaradi and Persson, 2012). Bio energy production technologies like anaerobic digestion to produce biogas, combustion to produce direct energy, gasification for syngas production and pyrolysis for carbonized bio pellets production have been employed in developed countries as ways to recover bio energy from landfills (Alternative Resources, 2008). Table 1 shows the bio energy potential from an engineered landfill site.

Table 1. Energy recovery from landfills (Food and Rural Affairs, 2004)

Type of energy generated from a landfill	Amount of waste generated (KWh/ton of waste)
Biogas	41-84
Combustion	470-930
Pyrolysis	450-530
Gasification	400-650

Engineered landfills are therefore important tools for waste to energy recovery and on top of the energy they are also creators of green jobs. The construction of landfills also present an opportunity for the reduction of greenhouse gases emissions effectively reducing climate change effects through the use of the organic waste in the landfill. There is need the economic factors, social aspects, environmental considerations as well as politics and legislation that affects the construction and operation of landfills (Taher et al., 2014). For an engineered landfill to be established, the environmental during the site preparation, construction, operation and post closure must be assesses and ways of implementing them recommended. Figure 1 shows the landfill system process from site preparation to post closure with the potential uses of the organic waste to manufacture bio materials and energy being shown.

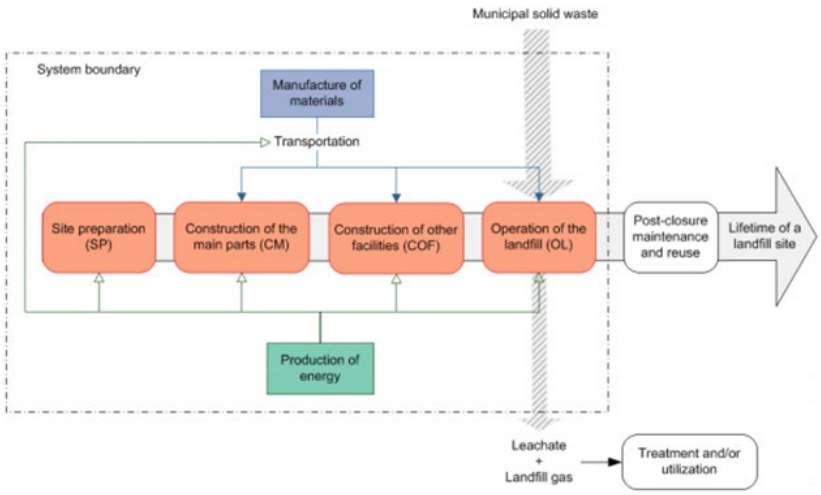

Figure 1. Systems boundary for a landfill for utilization of organic waste (Yang et al., 2014)

This study focused on the environmental impacts for setting up an engineered landfill which can be used as the hub for organic waste to energy recovery from the site preparation to operation. The potential mitigation measures to minimize the environmental impacts were also recommended.

2. Impacts of site preparation and landfill construction

During the landfill site preparation, vegetation will be cleared off and there is potential for disturbance of the existing flora and fauna such as trees and vegetation as well as animals that find natural habitants in them (Alternative Resources, 2008). When the landfill is being constructed the environment will be disturbed by preparing of the site, digging and construction of the landfill cells. The soil excavated in this process must be stock piled for use during the rehabilitation stage. The impact of the site preparation and construction has medium effects to the environment.

3. Impact on topography

Excavation phase

The most visual impact is the land disturbance due to the excavation resulting in the removal of soil and vegetation resulting in a permanent damage of the topography (Food and Rural Affairs, 2004). The moisture content capacity of the soil will also be disturbed due to the digging up of the landfill site resulting in drying up of soils around the landfill site as well as possible localized soil erosion. The soil can also be affected by the heavy excavation equipment causing it to weaken therefore a potential risk in soil runoff is expected. As a mitigation measure the excavated soil must be stockpiled for use in soil rehabilitation through layering of the soil on the landfill site to avoid soil erosion and runoff minimizing the change in topography and the soil type and qualities.

The clearing of the landfill site by removal of vegetation has potential to increase the runoff into the natural draining drainage system which may lead to flooding (Taheri et al., 2014). As the landfill site is being operated it is important to ensure minimal activities that cause damage to the ephemeral drainage are done. Leachate generated from the landfill site must be properly managed to reduce increase in run off which gets to the drainage system. Leachate generated from the landfill can be diverted to ponds where it is treated and allowed to evaporate. In addition, upslope drainage must be constructed so that run off is diverted from the landfill site.

4. Impacts associated with geology and soil

Landfill construction results in the excavation of the ground disturbing a stable base stratum. The already present localized geological structures' fractured strata may act as drainage paths for liquid contaminants (EPA, 1998). However there can be potential for underground pollution due to the movement of the leachate. The rate of possible contamination is depended on the soil permeability which is determined by the soil structure. Sandy soils have high permeability and lower water holding capacity and are not recommended for compaction in landfills in comparison to clay soils. Soil loosening may result in ponding during the rainy season and high leachate generation. If the soil has high permeability the leachate is easily drifted from the cells lowering the moisture content of the waste. Boreholes must be constructed at a distance of approximately 0.5 km from the landfill site. The can also be used as a medium to monitor ground water pollution.

5. Impacts on the water system

The landfill site must be located as far as possible from water sources to avoid water pollution. Specific landfill design and measures for minimizing surface and ground water pollution must always be taken into consideration (Alijaradi and Persson, 2012). Regular monitoring of the leachate generated from the landfill is recommended so as to monitor any possible contaminations. There is potential for ground water pollution from the leached soils as well as oils from the equipment and vehicles. It is recommended that maintenance of equipment and vehicles be done off site to minimize this risk.

6. Impacts on vegetation and ecology

The natural environment in terms of habitat and biodiversity of the landfill site must be maintained. Trees that would have been cleared off must be re-planted around the site to provide habitat for animals as a way of ensuring the ecological integrity of the site.

7. Impact on the socio-economic environment

The creation of a landfill site presents employment opportunities which are a positive impact that has potential to improve people's standard of living. Furthermore, there is general improvement on the roads as well as infrastructure services in the local communities. Value added products like biogas, bio fertilizers and bio fuels can be realized for the use by the community at large.

8. Impacts on health

During the landfill construction and waste handling as well as during the covering of the cells dust particles are emitted resulting in air pollution (Yang et al., 2014). The dust particles have potential negative health effects on the personnel working on the landfill must always have protective clothing. Dust emissions have potential to cause respiratory diseases which are harmful to the personnel. It is recommended that the soil be sprayed before being used for compaction to minimize dust emissions.

9. Impacts on heritage resources

The construction of landfills can result in the disturbance of heritage sites like cemeteries. There is need to therefore consult the relevant authorities and update them on the potential development.

10. Conclusion

Engineered landfills are a hub for renewable energy sources like biogas, bio ethanol and briquettes. For value to be able to be achieved from the landfills they need to be designed and constructed and designed with energy recovery in mind. The construction and operation of a landfill has both negative and positive effects on the environment. Negative effects such as air and land pollution, soil degradation as well as water contamination must be minimized to ensure little damage is done to the environment. Whilst positive impacts like employment creation, production and renewable energy as well as infrastructure development must be maximized.

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Biographies

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