A STUDY OF ENERGY AS A RECOVERY AND DISPOSITION OPPORTUNITY IN REVERSE LOGISTICS

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ABSTRACT
The reverse supply chains are more complex than the forward supply chain. There are numerous reasons for the reverse movement of materials. The recovery opportunities are also varied needing comprehensive judgment. Recovery could take several diverse forms such as products, materials or even energy. Industries have begun to focus on different reclamation opportunities in Reverse Supply Chains either for monetary, consumer, and eco-friendly motives. A possible strategic opportunity is 'Recovery of Energy by burning of waste.' This paper is an effort to understand the waste burning practices been embraced by industries. This study would be helpful to recognize waste burning as a part of energy recovery. The discussion on the benefits and challenges about waste burning practices for getting energy will give further insights into recovery management in Reverse Logistics. Energy recovery by burning waste is not a sustainable solution in the long run. Other alternatives of material reclamation and waste disposition need to be adopted.
Keywords: Reverse Logistics, Recovery options, Waste burning, Incineration, Energy.

Introduction

Rogers, Ronald and Lembke (1998) have described Reverse logistics exclusively in their book. Reverse logistics covers the procedure of preparation, implementation, & control of the well-organized & cost-optimum movements of varied materials such as starting materials, work in progress inventory, final products, and related data from final user to the initial point. The final outcome is recapturing some utility value or better disposition. This may also incorporate overhauling and remanufacturing activities. The Reverse logistics process includes movements from collecting to checking, segregation up to concluding disposition. The diverse alternatives in Reverse logistics could be resending to the selling organization, use again, sell again, redistribute, reclaim, repair, overhaul, restore, remanufacture, recycle, donate, or disposition through burning of waste (incineration) or ultimately transfer to landfill.

There are several disposition alternatives possible for fulfilling financial, statutory, and community commitments. Burning of surplus waste, also known as incineration, is one of them. Incineration comprises the skillful burning of waste resulting in reduction of mass and volume of the waste and yielding energy. One key reason is to lessen landfill costs. The outcome is reduced cost and better compliance . Study of energy as a recovery and disposition opportunity by burning surplus waste through incineration is presented in this paper.

Reverse Logistics definitions

Reverse Logistics described as opposite movement of the product or materials for the objectives of generating or recapturing value or for appropriate disposition.

Stock (2001) Reverse logistics is a comprehensive concept, covering numerous activities inside and outside of logistics**.** Referring to that part of logistics in product returns, decrease of sources, substitution of materials, material reuse, material recycling, disposal of waste, overhauling, repair, and remanufacturing.

Stock (1998) Reverse logistics is that part of logistics of return of materials, reducing sources, material replacement, recycling, and disposition of unwanted waste. It likewise comprises repairing, overhauling and even remanufacturing.

Sople (2007) Reverse logistics is the flow of goods from the point of usage to the location of manufacturing either for refilling, reconversion, repairing, or finally disposition. It is a prearranged flow of supplies in the reverse direction, intended for better cost-efficiency and effectiveness, through a systematized network of channels.

Hugo (2004) Reverse logistics targets at reducing waste & related costs of the supply networks by evolving techniques of the reverse distribution processes.

Steven (2004) Reverse logistics comprises of the activities for administering, controlling, treating, and disposition of unsafe and / or harmless waste from production, packing and product usage including the redistribution process.

Vogt (2002) managing all processes related to movement of materials, demand related data and funds in the reverse direction of the regular logistics flow. It includes reducing the waste generation and collecting, transporting, disposal, and reclamation of both safe and harmful materials thereby improving the bottom line in the long run.

An analysis of the above views indicate that waste disposition is been covered under Reverse Logistics. Waste gathering, treatment & further disposition are a significant portion of the Reverse Logistics sequence. A few goods which could not be claimed back either for technological, design changes or financial reasons are finally left for disposal as solid waste. These end up in the landfills wherein they are buried. Sometimes the industry can adopt the option of burning the waste known as incineration. Under this the waste materials are treated by controlled burning at higher temperatures. The resultant ash is disposed ahead in landfills or water bodies. The energy released in this process may be utilized for other purposes.

Drivers for Reverse Logistics

A number of incentives are there for Reverse Logistics. Goods returned if failing to perform accurately or discontinued performing. Materials could have opposite movement starting from several of the channel locations in the logistics chain.

Carter, Ellram (1998) explained the forces stimulating and restraining Reverse logistics with a model. They acknowledged four forces.

1) Government
2) Suppliers
3) Customers
4) Competing businesses

Reverse activities are either done proactively for financial reasons or are forcefully done. Industries resort to Reverse logistics because they see profits from it , they are statutorily required to do or have a social motivation for performing these activities.

Brito, Dekker (2003) have pointed out the Reverse logistics triple drivers.

1) Economics (Direct & Indirect).
2) Legislative.
3) Corporate Citizenship.

Economic – these are benefits resulting on account of decrease in material consumption, added recovered value and reduced disposal costs.

Legislative - the several regulations of the government relating to production, utilization, retrieval, and disposition including acts about packing materials and their dumping.

Corporate Citizenship -covering environmental accountability including morals and beliefs been agreed by the firm to be an answerable group. It demonstrates their obligations towards community and the ecosystem. Their empathy of undertaking good for humanity and nature without any lawful compulsion.

The triple drivers shown below:

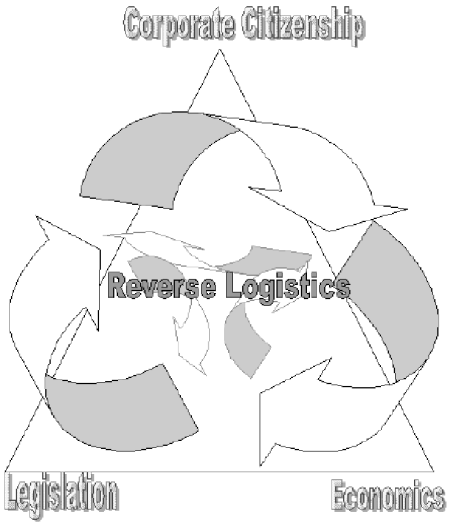

Figure No. 1 Triangle of Reverse Logistics Drivers.
Source:Brito, Dekker (2003:8)

The arrows representing the drivers are not uniform. They are intersecting and extending beyond their tasks. Diverse conditions and materials would have changing forces from them. Various states/nations enact their individual customer and ecological regulations.

The returned materials can be categorized as follows.

A) Production: starting materials, surplus supplies, rejected products, waste, secondary products.
B) Distribution: recalled products, returned inventory, returns for commercial reasons.
C) Consumer: Warranty/Guarantee returns, repairs return, returns due to end of usage / end of lifespan.

Reverse Logistics Recovery Options

The total Reverse logistics can be explained in four phases. The process of recovery in Reverse Logistics is an intermediate one wherein some portion of value is recaptured.

1) Collection: acquiring the products from customers.
2) Checking, Choosing and Segregation: After checking depending on results decision taken to send through suitable channels. If the condition is suitable, product can either be used again /sold back/distributed in other channels. Else an appropriate reclamation alternative accepted.
3) Reclamation: these comprise some trivial/big efforts needed to capture maximum value. One of the reclamation options can be adopted from the distinct stages. At product level it may be repaired, module level refurbished, component level remanufactured, selective part level retrieved, material level recycled, 'energy level burned using incineration'.
4) Redistribution: sending to appropriate intermediaries as need be. If none of the reclamation choices feasible either for technological or financial reasons, then material is sent to landfill.

The distinct levels of Recovery options are indicated in Figure No. 2 of Recovery Options Inverted Pyramid.

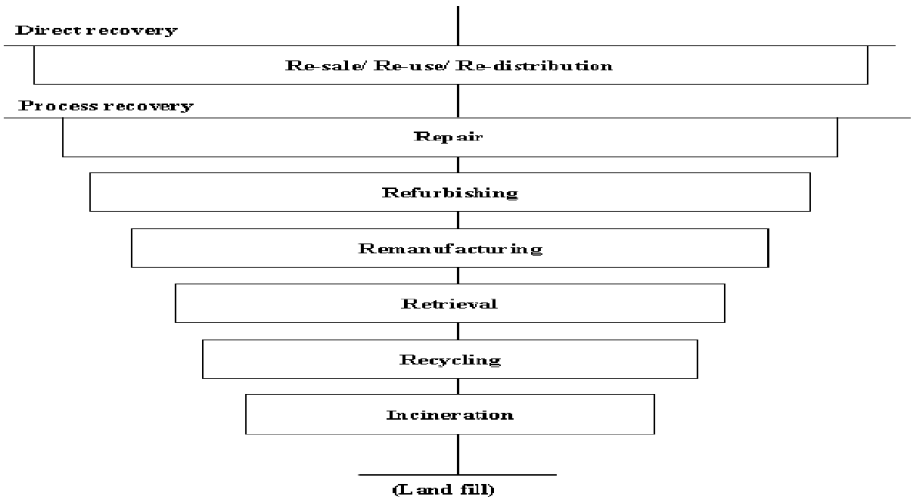

Figure No. 2 Recovery Options Inverted Pyramid
Source: Brito, Dekker (2003)

It is not necessary that the recovery alternatives at the higher end of this pyramid need be of a bigger merit or are much better ecologically friendly in comparison to the lower side alternatives. This will be determined by the total monetary worth extracted from the chosen reclamation possibility, which changes the situation and product wise. The presence of a suitable marketplace furthermore determines the final value.

Incineration / Waste Burning

Brito, Dekker (2003) Organizations can choose from any one of the recoveries stages.

- Manufactured goods
- Unit
- Component
- Particular part
- Material
- Energy

As indicated in Figure No.2 under certain conditions the items are burnt by the process called incineration before been sent to the landfills. The rationales for selecting the alternative of burning waste i.e., incineration could be financial, statutory, or societal.

The stages in the Inverted pyramid are the Hierarchy of Recovery. Reclamation by burning waste is at the energy level. Here energy is generated by burning waste objects which were not reclaimed adequately in the top side of pyramid from Manufactured goods stage level to Material stage. This recovery process is called as Incineration wherein energy is released which can be captured for appropriate use.

Definitions of Incineration

Business Dictionary[2] Incineration is destruction of waste inside a blast furnace employing directed burning at higher temperatures. This eliminates water from harmful slurry, decreasing its weight and volume converting it to ash. This residual ash could be carefully having disposal either in landfills/underground pits or in waters.

Literature Review

Ecoants (2016) There is always a dilemma for what to do with waste. All hate the massive quantity of waste going to landfills. This is unsustainable in the shorter and longer run resulting in land, water, and air pollution. Recycling has improved quantumly but not taking care of the total chunk of unwanted surplus materials. One alternative is to burn the waste at incineration plants by reducing it to ash and releasing heat energy used for heating systems or for generating electricity.

Yuan (2014) Mass burning or Incineration is the common waste disposal method worldwide afterward the landfill option. This is the most costly waste management alternative, specifically when it is having energy recovery using sophisticated technology for discharge control.

ECOCYCLE (2011) While burning waste is considered as an alternative to landfilling, the industry in US received a big kickstart during 2000 when President and Environmental Protection Agency categorized waste burning as a source of renewable energy making incineration plants eligible for tax benefits proposed for solar and wind industries. Incineration, known as mass burning, is the extremely widespread technology for getting energy from waste. This technology generates heat utilized for making steam by boiling water, which then drives a turbine generating electricity.

Zaffar (2008) Energy recovery as a Reverse Logistics alternative is an appealing technological option which is a matter of strong debate around the world. One method of Energy recovery is incineration which is regulated burning of waste with heat recovery. The pretreated waste is fed to boiler for burning and released heat used for producing steam employed for generating power by turbines.

The other two processes are Pyrolysis and Gasification which are called conversion technologies.

Pyrolysis process is used in petrochemical industry wherein natural waste is converted into burnable gasses and residual ashes.

Gasification usually runs at extreme temperatures as compared to pyrolysis in a controlled quantum of atmosphere.

Department for Environment Food Rural Affairs (2014) Energy derived from waste is using waste and converting it into a useful form of power. This is possible using several ways. Incineration/burning is the mainly recognized method. Diverting waste from landfills is the main objective of incineration.
The basic process:

Energy recovery from waste is complicated and exists in several patterns. These mainly have four phases.

i. Area to accept waste and prepare for combustion.
ii. Thermal process releasing usable power from waste.
iii. Converting to a transferable type of energy like other fuel, heat, or electricity.
iv. Discharge cleaning safeguarding that the waste gases are harmless.

Waste to Energy and Incineration are evolving. There are several components of Incineration project: the waste, which is the fuel, sources/volume of waste, availability, pretreatment, plant location, basic technology, scale of operations, by-products, social and environmental impacts, emission levels, regulations, health issues, operational issues, life of plant, Government support, Financing and Commercial viability.

Reasons for Incineration

Greentumble (2015) Use of landfills for waste disposal has aided community to resolve the challenge of where to discard it. Conversely, landfills are accompanied with several problems, like the necessity of using vast regions of land, leachate leakage from landfills contaminating groundwater. Landfills generate enormous amounts of methane, a potent greenhouse gas. To decrease the requirement for landfill spaces, various societies now have adopted burning their waste. However, this waste treatment practice is not a straightforward resolution having both advantages & disadvantages.

Advantages of Incineration

Green Tumble (2015). Two key benefits of burning process are that the volumes of waste are condensed by 80% to 95%, and land requirement for landfills is reduced substantially. This is particularly noteworthy for urban locations as there is a premium price for urban land.

Incineration facilities are generally placed nearby waste producing areas thereby reducing waste transportation costs. Incineration is used to generate heat & electricity which could be utilized for heating and electrifying neighboring houses, the leftover ash can be utilized by the construction sector. This also removes the problem of leachate which is an unwanted produce of landfills.

Partridge (2010 January) Pharmaceutical businesses are also contributing to the green Reverse Logistics movements. GENCO, a Pittsburgh based 3PLRL directs large volumes of pharmaceutical returns to incineration plants processing the waste to energy limiting negative environmental impact. This plant produces two million kilowatt hours of electricity per annum, enough to illuminate 220 homes for one year.

Ecoants (2016) The prime benefit of incineration is the noteworthy reduction in the quantum of waste entering the landfill. It can be up to 85 percent of input. Resulting in lesser air, water, and land pollution due to landfills, reduced landfills space requirements. The higher temperatures extinguish harmful chemicals and pathogens which is the powerful reason for been utilized for clinical waste. Incineration of household and industrial waste can be utilized for generating heat and / electrical energy. Current incineration technology is capable of filtering most of the harmful emissions given out during the process resulting in cleaner and safer emissions.

Pulakkat (2015) Incineration reduces pollution as compared to long term effects of landfills. It provides partly renewable energy. Terminates most of waste securely if sound technology is used. It is a satisfactory method of utilizing surplus waste which has challenges for disposal by other means.

Yuan (2014) compared to landfills the rewards of incineration are less carbon release, less land pollution, higher energy recapture. Remaining ash has a high potential for reuse. Savings in carriage costs are seen as incineration plants located nearer to the city compared to landfill locations. The long-term upkeep cost of incineration plants is lower than landfill maintenance. The energy recovery per ton of waste burnt is higher than landfill gas recovery. Incineration decreases the degradation of city land which is having higher development value. If the forthcoming environmental and economic reimbursements are considered, then the incinerator plant has more paybacks than disadvantages.

Concerns of Incineration

Green Tumble (2015). Incineration plants are expensive to install, operate and maintain, needing expert staff. The smoke and ash produced comprise of gases of acidic nature , nitrogen oxide, particulate matter, heavy metallic residues, and dioxins, which are cancer-causing agents in nature. Even though the effluence control technologies are developing it is seen certain quantum of residual toxins are still entering the environment.
Some opponents of this incineration argue that additional waste is created as plants require enormous quantum of waste for keeping their fires burning. Organizations may choose for burning waste over other recycling / waste decreasing initiatives. Recycling saves 3 to 5 times additional energy than energy from waste generation as the energy requirements for products manufactured using recycled ingredients is substantially lesser as compared to production using virgin materials.

In emerging nations, the waste burning process is not as effective as in developed economies, as a higher fraction of their burning waste is comprising of kitchen leftovers having more moistness (40 to 70%) than the waste from developed nations (20 to 40%).

Zaffar (2008). Incineration also has a certain set of difficulties and has been compelling arguments in environmental, social, and political circles. The three parameters discussed below.

1) Environment Concerns – the burning process creates two forms of residual ash. Ash from furnace bottom & fly ash coming from the exhausts which have more hazardous constituents. Ash from bottom is about 10% by capacity and 20 to 35% by input mass. Fly ash is only a few percent of the input weight. Destructive emissions may be present in the discharged ashes ,water, or gases. The higher calorific value comes from waste plastics and metals. The combustion of plastics results in rising toxic pollutants. These cannot be evaded completely but can be trapped in filters at excessive costs. Even after trapping these , the hazardous wastes need special landfills for further disposal. The leftover ash gets dispersed in the environment subsequently entering the food chain.
2) Human Health Issues -Burning produces various toxins harmful to human beings. The incineration plants, though costly, are not entirely removing poisonous emissions. The process emits harmful toxic metals, dioxins, and acidic gases. The leftover toxic ash requires special landfills which are additionally costly. Some of the pollutants have irreversible health consequences.

The health problems could be due to

- Workforces and neighboring society breathe polluted air.
- Drinking water and consuming locally produced food infected by water / air from incinerators.
- Consuming wildlife/fish affected by air/water pollutants.
  Some of these pollutants may lead to cancer, neurological impairment, disturb reproductive/respiratory systems, and numerous other health issues.

3) Financial Impacts-The incineration plants require high investments mostly for control systems aimed at reducing toxic emissions. Another concern is the availability of waste of adequate calorific value. Otherwise, supplementary fuels required for combustion thereby making the project uneconomical and

more polluting. Also, the volumes of waste required to make these plants economically feasible are remarkably high.

The leftover ash from incineration needs special landfill as this ash contains a lot of toxic ingredients. Particularly unsafe waste landfills are nearly ten times more expensive than a regular public landfill. Incineration distorts effective waste management indirectly promoting waste generation as they need volumes to be economical viable. This hinders waste prevention, reuse, recycling, and composting options.

Zaffar (2008) Due to lack of good controlling systems unsafe discharges may be released into the atmosphere, waterbodies & land having damaging effects on environment and health of human beings. Severe controls required to avert the adverse impacts.

Ecoants (2016) Incineration leads to permanent loss of vital and limited natural resources as they end up in smoke or ash. This results in increased mining to replace the already lost resources and extra energy consumption for processing these added resources. Increased mining leading to land pollution and degradation.

Incinerators destroy materials which could be recycled and hence discourage recycling and composting programs. Incineration plants require high investments and larger volumes to be financially viable. This fact encourages more incineration than recycling. Most residential areas do not prefer incineration plants to be located in their neighborhood for reasons of increased traffic, unpleasant odors, hostile effects on local lands and falling real estate prices.

Emissions from incineration plants worsen the quality of air and are harmful to the people staying in the neighborhood. The pollutants escaping into the environment lead to land, water, and air contamination. These could lead to cancer and other harmful effects on human health. The resulting ash from emissions and the furnace is having noteworthy amount of toxins which are harmful to people and environment. This needs further superior and expensive disposition.

Pulakkat (2015) Incineration leads to removal of hundreds of jobs through elimination of collecting and sorting waste for recycling processes. Issues of smell, pollution and low calorific value of waste going to incineration are major apprehensions in incineration. Higher lockup periods of capital and poor returns on investment are major challenges in incineration.

ECOCYCLE (2011) 25% of the processed waste by weight leaves the facility as ash which means that the incinerator does not eradicate the need for a landfill. Again, this poisonous ash requires further expensive disposition. To make the plants financially feasible they must run at higher capacities making them compete with recycling markets for getting valued paper and plastic materials.

Waste to energy cannot co-exist with zero waste as it takes waste as its input for producing energy. It is not climate friendly and cannot be labelled as renewable energy. Energy from Waste is rather a Waste of Energy. It cannot generate substantial electricity. Incineration facilities create far fewer jobs than reuse, recycling, and composting facilities.

Objectives of the Study

1. To understand Reverse logistics and its drivers.
2. To study Energy as a Recovery and Disposition Opportunity in Reverse Logistics.
3. To understand the benefits and challenges of incineration.

Research Methodology

The findings in this research paper are the conclusions of a study done by the researcher. A study of the secondary data in the domain of recovery management in Reverse Logistics was done. Different research papers and articles related to Reverse logistics and Recovery of Energy were referred. Websites of applicable resources were explored for getting insights into the different waste burning / incineration practices developed and followed. Appropriate keywords were used to get relevant information from search engines. The outcome of the review of these waste burning / incineration practices and their benefits and challenges are given in further sections.

Secondary Data Analysis

After the review of literature, the analysis of secondary data was done and given in this section. The objectives of this paper functioned as the guiding stars during the exploration of secondary data. This section gives the outcomes of the analysis of secondary data.

Reverse Logistics described as opposite movement of the product or materials for the objectives of generating or recapturing value or for appropriate disposition.

Reverse logistics is complex involving several activities with distinct reasons for the reverse movements. Reverse Logistics is serving the objective of recapturing value and its scope is up to final disposition of the product. This is done for reasons of improving profitability along with responsibility towards community and environment. Reverse Logistics driving forces are financial, statutory or community driven. Different definitions of Reverse Logistics been given by authors and researchers covering the several activities undertaken for distinct reasons. Reverse Logistics is having movement from the consumer side heading towards the supplier's direction. All businesses do have some or the other returns of varying quantum resulting either due to forceful legislation or voluntary commitments towards community. One way of classification of returns is as per their point of origin in the reverse supply network. They are either from production, distribution from any of the intermediaries or from end customers. If the quality of the goods is appropriate, then those can be reused or resold or distributed to other probable users. Reclaiming of value can be done by resorting to the appropriate recovery options.

Reverse logistics have three drivers.

Economics (Direct & Indirect) these are benefits the organizations get on account of decrease in material consumption, added recovered value and reduced disposal costs.

Legislative – these are due to the several regulations of the government relating to production, utilization, retrieval, and disposition including acts about packing materials and their dumping.

Corporate Citizenship -these cover the environmental accountability including morals and beliefs been agreed by the firm to be an answerable group. It demonstrates their obligations towards community and the ecosystem. Their empathy of undertaking good for humanity and nature without any lawful compulsion.

Under certain conditions the items are burnt by the process called incineration before been sent to the landfills. The rationales for selecting the alternative of burning waste i.e., incineration could be financial, statutory, or societal.

Recovery can be at product/module/component/selective part / material/energy levels. The alternatives available can be represented by an inverted pyramid. It makes business sense by giving priority for using upper-level alternatives in the inverted pyramid. Recycling is mostly preferred for getting value reclamation at the material level. Still, this does not take care of all unwanted surplus waste. Hence burning waste is also a viable option for waste disposition along with the recovery of energy. In the absence of any alternative of recapturing value then the goods are sent for disposition by burning or dumping in landfills. Landfill is at the bottom of recovery pyramid. Landfills have several limitations and challenges for the environment. They are unsustainable in shorter and longer runs resulting in land / water / air pollution.

Incineration reduces pollution as compared to long term effects of landfills. It provides partly renewable energy. Terminates most of waste securely if sound technology is used. It is a satisfactory method of utilizing surplus waste which has challenges for disposal by other means.

After landfills incineration is the most common wast

e disposal method employed by businesses. Incineration/burning of waste with or without recovery of energy done in case recovery at product to material levels not feasible. The primary driver for incineration is to divert waste from landfills. Incineration covers waste receipts, treatment, energy recovery and disposal of ash and other emissions. The US classified burning waste as a renewable energy source giving benefits to incineration plants.

Incineration has many benefits to businesses. This results in substantial reduction of mass and volume of waste thereby saving valuable land space. It reduces waste transportation costs. It is the best option for clinical and

pharma waste. The residual ash may be used for construction purposes cutting down some construction costs. Land/water/air pollution due to landfills avoided. Energy generated by burning waste is used for heating or generating electricity. Also, the energy recovery per ton is greater than that of landfill. Incineration reduces landfill costs. It reduces degradation of valuable city lands. The issues of leachate created due to landfills are taken care of.

This process is good for harmful chemicals and pathogens as these are destroyed by elevated temperatures making them harmless. The long-term upkeep costs of incineration are lower than landfill costs.

As compared to landfills the rewards of incineration are less carbon release, less land pollution, higher energy recapture. Remaining ash has a high potential for reuse. Savings in carriage costs are seen as incineration plants located nearer to the city compared to landfill locations. The long-term upkeep cost of incineration plants is lower than landfill maintenance. The energy recovery per ton of waste burnt is higher than landfill gas recovery. Incineration decreases the degradation of city land which is having higher development value. If the forthcoming environmental and economic reimbursements are considered, then the incinerator plant has more paybacks than disadvantages.

Incineration has certain challenges which cannot be overlooked. The incineration process has certain disadvantages. The initial construction costs of the incineration facilities are high. They are normally located near the waste generation areas of urban neighborhoods. The land costs are quite high, leading to higher costs. The operational and upkeep expenses are higher as they need sophisticated equipment for taking care of the harmful discharges. The basic fuel which is the waste needs to be of proper quality having required calorific values. The facilities need expert staff for regular operations and maintenance. Once decided to go for burning of waste the process discourages recycling which is more energy saving. It leads to encouraging more waste generation for viable running of plants. The plants need a huge quantum of waste for continuous feeding of the plant. The plants, even though create few employment opportunities but reduce overall employment which could be generated for recycling. More people required for the recycling option in Reverse Logistics.

Burning of waste leads to permanent loss of materials and increased mining activity. The waste is burnt with the scare metals been permanently destroyed and ending up in ashes. To get new input metals mining is undertaken with its own unsustainable consequences. The emissions from incineration facilities have certain adverse health and environmental impacts. There is a problem of smell and traffic in the plant vicinity. The leftover ash also needs landfill/water bodies for further disposition. This ash is also unsafe for direct use or disposition and requires special costly measures. There is a concern of contamination of water and air affecting fish and wildlife due to the discharges from incineration plants.

Few other learnings gathered during the review of secondary data. The energy recovery option is strongly debated across the world. The incineration project has strategic and tactical dimensions like selecting appropriate location, deciding the technology to be employed for burning, the scale of operations to be adopted , the requirement of fuel of suitable quality, the energy generation and distribution processes. The emission regulations for the solid and gaseous discharges from the plants. Pyrolysis and Gasification technologies are also used for energy recovery. Both landfills and incineration are having adverse impacts on society and the environment. These need to be understood properly before deciding amongst the available alternatives. Proper alternatives for landfill and incineration needed in the long run. Reuse /repairs/recycle are better alternatives to incineration and landfills.

Conclusions

The area of Reverse logistics is growing in scope and also the number of recovery options available for recovery of materials and energy. The issue of recovery of energy from waste is a complex one needing a sound analysis. Organizations are adopting the path of energy recovery either for economic or environmental reasons. Incineration is one such method resulting in energy recovery.

There are no easy answers to dealing with the huge amount of waste generated from domestic households and commercial businesses. Is energy from waste the right answer? We must adopt the best option in the interest of environment, people, and economy. Even the incineration process has its own environmental burden.

The advantages of incineration are reduced landfill costs, as the weight and volumes of waste are considerably reduced. It releases energy as heat or electricity for further use. Destroys waste effectively as compared to landfills. Reduced transportation costs, less long-term maintenance costs as compared to landfill maintenance. Energy recovery per ton higher than landfill gas recovery. Reduction in degradation of land, reduced emissions

than landfills with lesser air and water pollution. Use of residual ash for construction activity. It is the best option for clinical waste as it destroys harmful chemicals and pathogens.

Here are some concerns in adopting incineration as a recovery option. The incineration plants are costly to construct, run and maintain, requiring skilled staff. Emissions are harmful to human beings and nature. It encourages more waste as plants need high volumes for viable running. It discourages recycling which is actually more energy saving. Leads to permanent loss of scarce resources which are burnt up, ending in ash and smoke. Results in additional mining and energy consumption for mining new materials. The problem of smell and traffic in plant vicinity leading to dropping real estate prices. Reduced employment potential as compared to recycling. Process needs more costly equipment to be environmental compliance for emission norms. The process giving harmful gases and toxic ashes which are having separate disposal challenges. Availability of waste of adequate calorific value hampers efficiency of the plant.

The incineration option in Reverse Logistics should be decided after all the other material recovery options from Product recovery till material recovery are not feasible. Once Incineration has been decided we need to find the appropriate technology for doing this process. There are Economical and Environmental benefits of Incineration as compared to landfills. Also, the public image of the organization is enhanced by following a cleaner recovery process.

The ideal waste management solution is to prevent its creation. Otherwise, it is important to push the recovery option to the higher end of Recovery Hierarchy i.e., towards recycling, reuse, and prevention. This hierarchy of Prevention, Reuse, Recycle, Energy Recovery and disposal is flexible and needs to be planned for the long term. While evaluation weightage to be given to long term environmental and social impact.

Government to support for Incineration projects and give other tax benefits to make it more viable with minimum adverse environmental impact. Reduction/reuse/ recycling to be encouraged so that there is no need for incineration and landfill as both these options have their own sets of environmental issues, human health concerns and adverse financial impacts. Recycling rates need to increase to prevent unnecessary waste of natural resources in incineration and landfills. Incineration can never be fully acceptable to society and business due to reasons of costs, health, and environmental factors. It could be a short-term solution but not a long-term answer to the problem of recovery of materials and energy.

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