Sustainable Architecture
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Lecture – 32
Materials and Resources – II

Welcome back to this lecture where we are continuing to talk about materials and resources as part of the online ongoing course on Sustainable Architecture. So, in the previous lecture of this week, we discussed about different terminologies related to waste, we discussed at length about what municipal solid waste is and how it is being managed it is supposed to be managed in an integrated manner. So, what are the different components of it?

So, in the previous lecture we talked at length about solid waste management in general. Today, we will be focusing more on the different strategies of treatment of this waste and we will be focusing on the green building rating systems and their compliance criteria for the building development.

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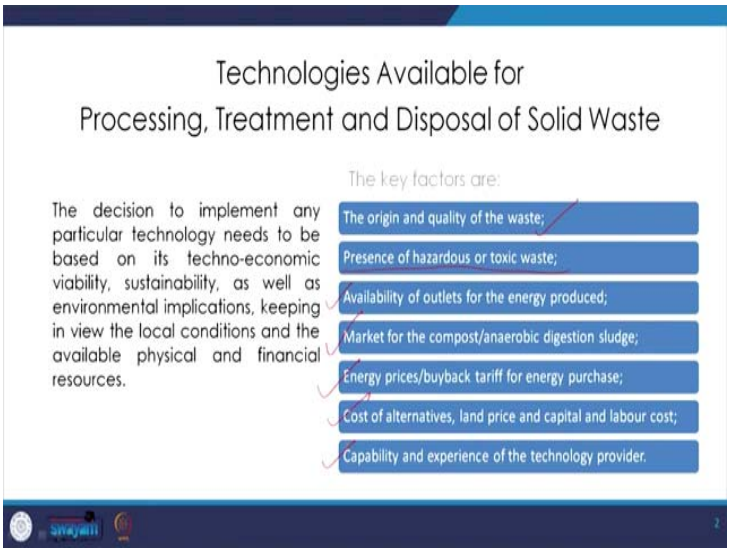

So, when we are talking about different technologies available for processing treatment and disposal of the waste, there are certain key factors which we should keep in mind when we are selecting these technologies. So, we have to know the origin and quality of the waste, we have to know whether there is presence of hazardous or toxic wastes in the

waste which is going to be treated, we have to know of the availability of outlets for the energy produced. So, there may be high energy containing items wastes and if the energy is being produced, what are the possible outlets for this produced energy? We have to look at the market for the compost or anaerobic digestion sludge.

So, which is not that we select a strategy and we keep treating it generating some sort of product. For example, the an-aerobic digestion sludge and keep stacking it storing it, we have to look at where will it be marketed. We have to look at the energy prices in case of a buy back tariffs, we have to look at the cost of alternatives. So, we have to look at the price of land, the price of technology, the capital cost, the labor cost, the cost of operations all of that has to be looked from a life cycle perspective and then we have to look at the capability and experience of the technology ~~provider.So~~provider. So, whether this technology provider has enough experience in running the technology for us for the given waste. So, based on that an appropriate technology has to be selected.

So, I will quickly take up some of the different types of waste and look at the different technologies which are available and a quick comparative.

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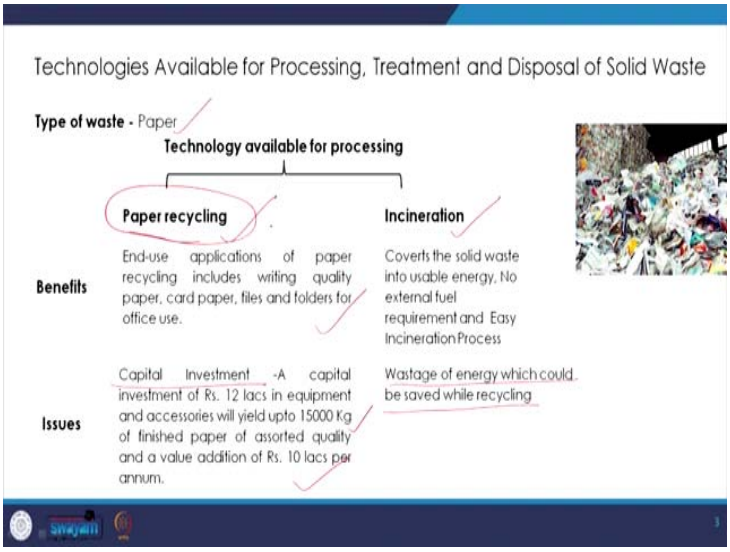

So, we have very commonly available paper waste. Now, there are two types of technologies, one we have incineration where we convert the solid waste into usable energy, the other one is paper recycling. Now the issues with incineration is that there is a lot of wastage of energy which could be saved while recycling here the benefits are that

the end use~~r~~ applications of paper recycling can be achieved. The issues with paper recycling is that it requires a capital investment of approximately 12 lakh rupees which will yield up to 15000 kg of finished paper and this actually creates a value addition of 10 lakhs per annum.

So, on the whole paper recycling comes to be a better strategy, but it requires a lot of operations and maintenance. So, ~~labour~~labor cost goes in, but then it also simultaneously provides for ~~jobs~~ job opportunities.

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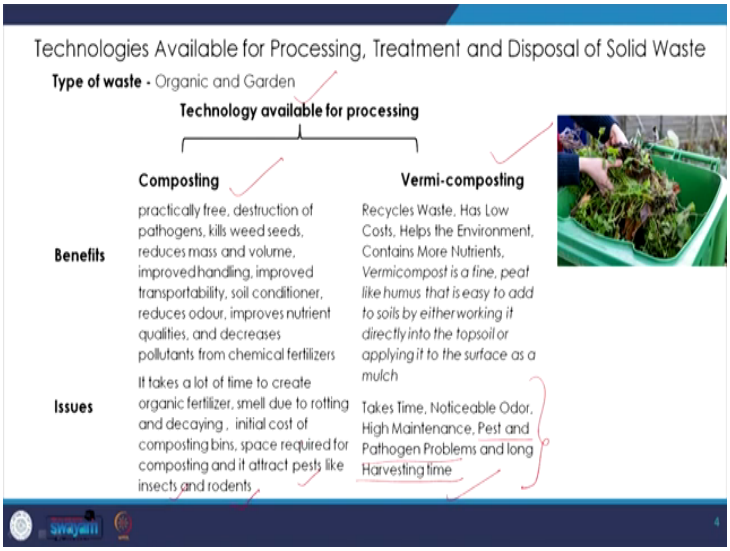

If you are looking at garden waste, we can do composting and we can also do vermi~~worming~~ composting. If we are talking about the comparison of these two vermi ~~wormy~~ composting it takes time, but as compared to composting it takes lesser time. There is odour in both the cases both composting and vermi ~~wormy~~ composting and it requires very high maintenance because it is an organic procedure.

So, there is the problem of pests and pathogens and it also has a long harvesting time. So, it requires huge area land where this biodegradable matter which is the waste, which is being staged it has to be left for treatment because it has a huge harvesting time. And both of these have difficulties for example, that of pests, insects and rodents because the waste lies there for a lot of time.

However both of these are a low on energy, but high on operations because a lot of labour cost is required. vermi ~~Worming~~ composting is more compact as compared to composting.

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We also have mechanical composers for example, for anaerobic digestion and biomethanation. So, proper mechanical composers are there with extract methane out of the organic matter and it is quite capital intensive, it is quite beneficial, but at the same time it is quite capital intensive as compared to composting.

We also have technologies such as pyrolysis, gasification or plasma pyrolysis, vitrification and plasma arc process. Again there is a lot of capital which is required capital cost which is required and it requires significant solid waste sorting and high scale personnel. Because of this very high initial cost, it is often not utilized in any area where there is huge land availability, but it is a good process good technology where there is a shortage of land specially in the urban areas and the compact system a compact system is required.

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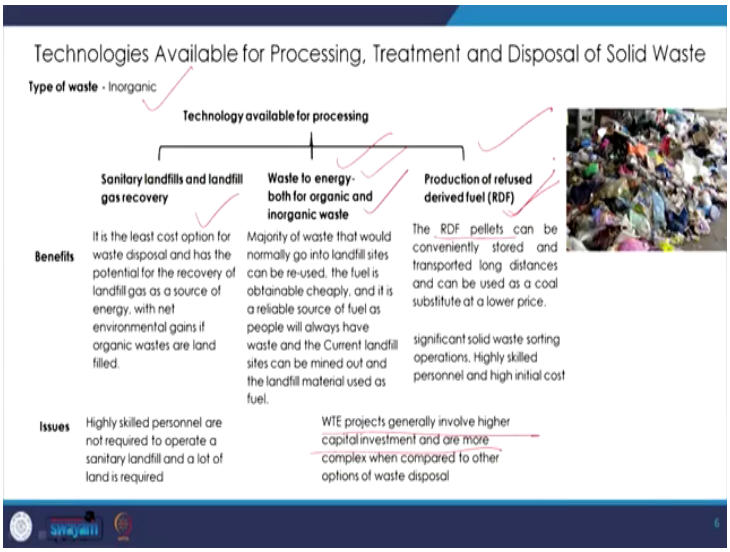

If you are talking about different and inorganic wastes, we have the regular sanitary landfills and landfill gas recovery where the methane and other greenhouse gases which are generated during the decomposition process take care; they are scientifically collected. We have waste to energy plants, which can convert both organic as well as inorganic waste into energy and we have production of refuse derived fuel where we are talking about the RDF pellets that can be conveniently stored and they can be used as fuel. They can be transported and they can be used as fuel in various industries.

In both ways energy and the RDF, they are usually high on capital investment and they are quite complex, they are not very simple. Yet in several areas especially again where one the energy contained in the fuel is quite high, waste to energy plant and both RDF they are good alternatives. They are good technologies to be used because in this manner the energy can be recovered it can be used as a fuel. However, it requires high capital in investment.

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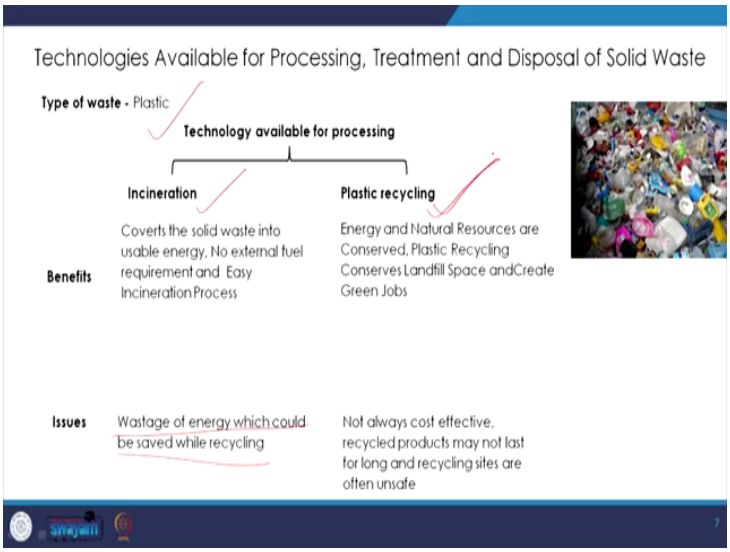

When we are talking about plastic, we have plastic recycle and incineration. Again incineration requires a lot of energy, there is a lot of wastage of energy. While when we talk about plastic recycling, we are diverting all that waste and we are also reducing the amount of air pollution which may be caused during incineration. However, it is not always cost effective because we require a complete industry to be set up and also depending upon the type of waste which is being brought into the industry.

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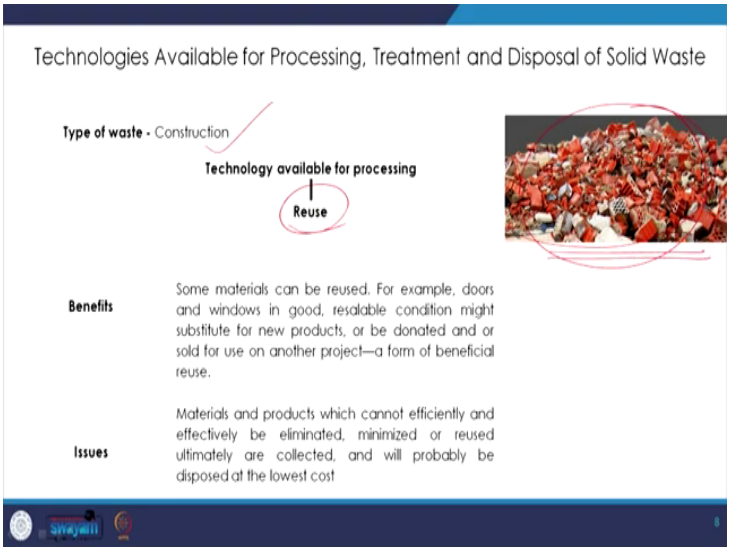

Then the construction waste: So, the only way to use construction waste is to reuse it. So, the brickbats for example, this kind of a waste which is generated on the construction site can be used as filler material for a lot of building construction processes. So, the only issue with this is that it this made this kind of a material requires transportation from one side to the other side.

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When we are talking about the chemical and hazardous waste, we are talking about hazardous waste landfill; we are talking about sequestering and isolation here. So, packing them, concentrating them and packing them in containers which will be sealed and kept away so that they are not mixed, they are not released in the environment.

Then we are talking about incineration, destruction or waste to energy where the materials the chemicals or the hazardous materials can be combusted and they are not releasing any hazardous gases. The common other treatment is to mix it with Portland cement for stabilization and solidification. However, the most commonly adopted one is the hazardous waste landfill where we sequester it and we isolated.

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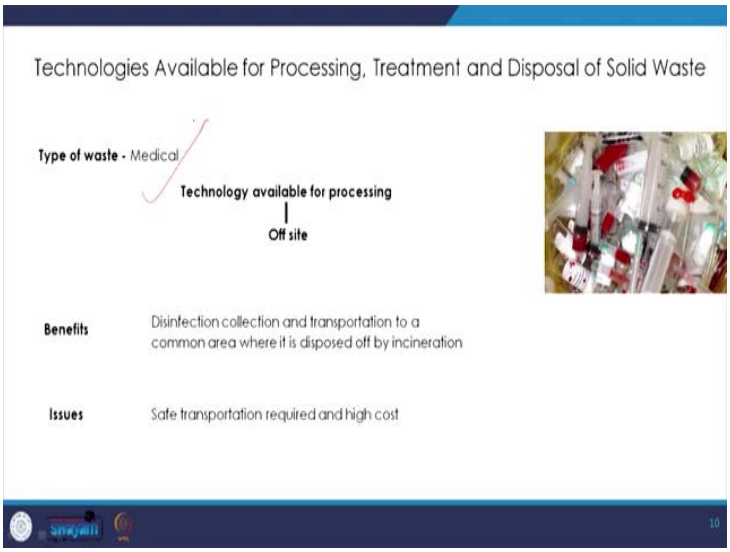

The medical waste is separately treated. So, there are incinerators one it is separately collected, transported and incinerated. There is absolutely no chance where the medical waste should be mixed with the municipal rest of the municipal solid waste.

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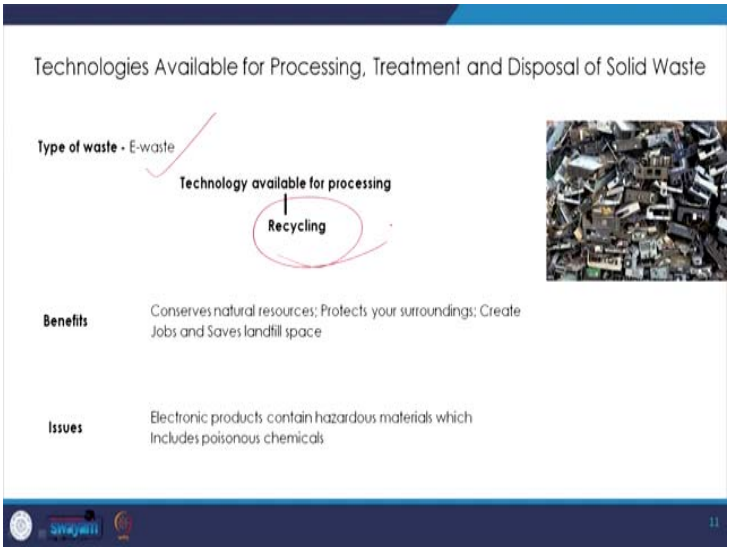

Then we have a waste a huge quantity of E-waste is being generated across the world and there is piling up of such E-waste the most effective technology is to recycle it. So, this E-waste often contains precious metals very rarely available materials and they can be extracted a lot of the metals which are contained in this E-waste can be extracted and

they can be recycled and converted into the usable products again. There is a huge amount of plastic which is going into this E-waste so; all of these different components can be separately extracted.

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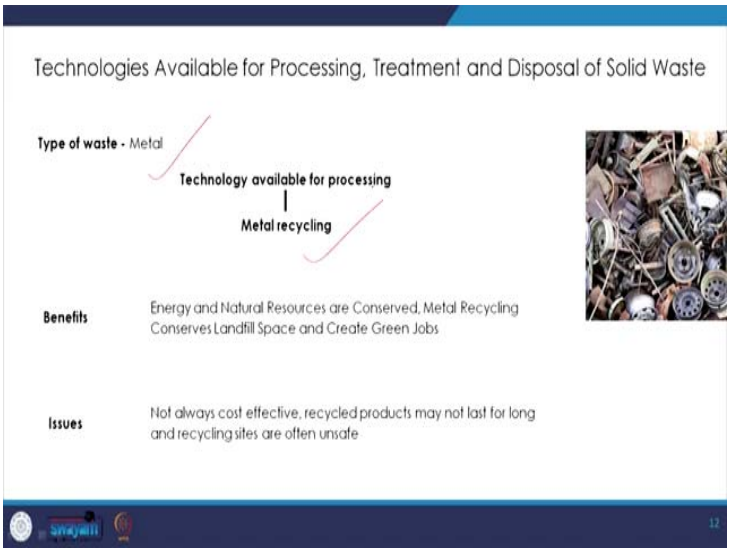

Then metal all metals almost all metals can go back to recycling iron, steel aluminum, tin. So, all of these metals go back into recycling and they require much less percentage of energy as compared to the energy which is consumed for extracting the or manufacturing the virgin material.

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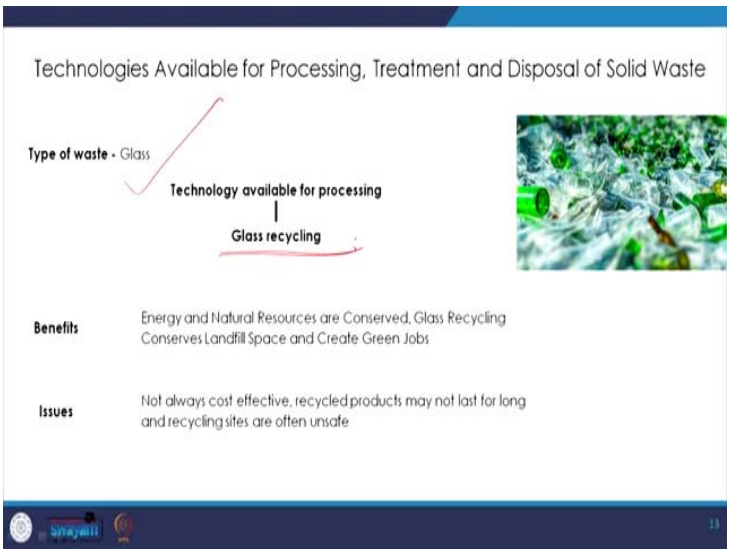

Glass again the best technology is to recycle it again just as metal it requires much less amount of energy for recycling it. But again all these recycling plants whether it be for paper or plastic or metal or gl~~l~~asst, they may not always be cost effective and also some of the types of these raw materials these waste materials may be not good enough for recycling and after recycling, they may not yield good quality product. So, a careful choice has to be made before investing.

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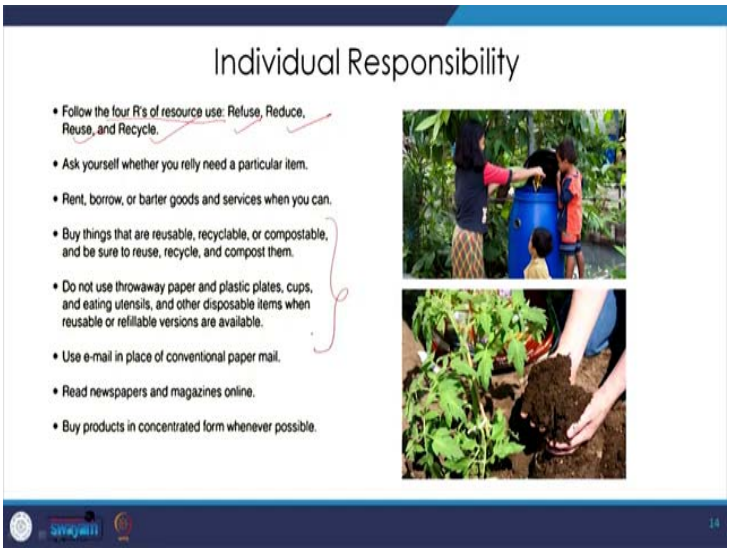

Now besides these strategies which may be available at the municipality level or at the city level, the first thing begins with an individual which is the individuals responsibility. So, first of all we have to follow the four R's of ~~Reuse,~~ Refuse, Reduce, Reuse and Recycle. So, if each individual reduces the amount of waste which is generated, reuses the products as much as they can and whatever waste is generated recycle it.

In addition to that segregate the waste into different categories and then send it out as a municipal solid waste. We will be able to reduce substantial amount of waste which is generated.

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Now, one of the most difficult categories to handle is this hazardous waste. Now here we are talking about materials which have toxic compounds, which are inflammable, which are explosive or reactive or which corrode the metal ~~conductor~~ containers. So, we are talking about batteries and drain cleaners or oven cleaners here, we are talking about the pesticides and poisonous materials, we are talking about the chemicals, the ammonia, bleach and aerosols and we are talking about flammable materials such as paint, solvents oils and all. So, in such kinds of ways they require very careful dealing.

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Here first strategy is to produce less amount of such waste. In case they are there then we convert them to less hazardous or non hazardous substances through different types of treatments. It could be thermal treatment, it could be ~~tech~~ chemical treatment, it could be incineration or land treatment.

Once that has been done we put them in perpetual storage. So, it could be salt formations, it could be converted in the form of salts and then isolated, it could be isolated in the form of waste p~~f~~iles or landfills. So, all these different types of treatments may be carried out.

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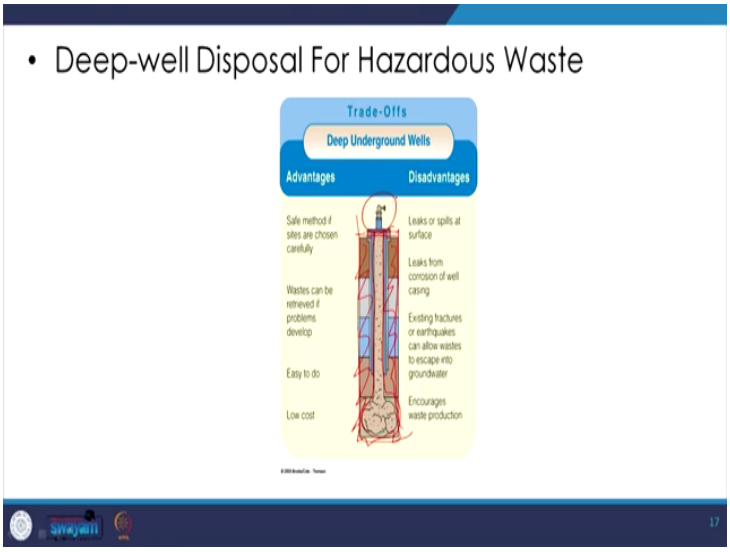

There is a very commonly practiced technique strategy which is deep well disposal, which is for hazardous waste. Now what happens is there is a deep underground well which is created and ~~its~~it's filled up with the inert construction material for example, concrete.

The hazardous waste is pumped into this well, it is stored and it is properly sealed. So, in case so, one is it is very-~~-~~very safe because the hazardous material has been properly sealed. This is the method which is largely adopted for sealing the nuclear waste which comes out of the nuclear power plants. So, even after it has been completely exhausted combusted, it is still radioactive and it should not come in contact with human beings. So, such deep well disposal is carried out for all the nuclear waste. However, if it is

required this waste can be retrieved. So, the seal can be broken and this waste can be retrieved as well.

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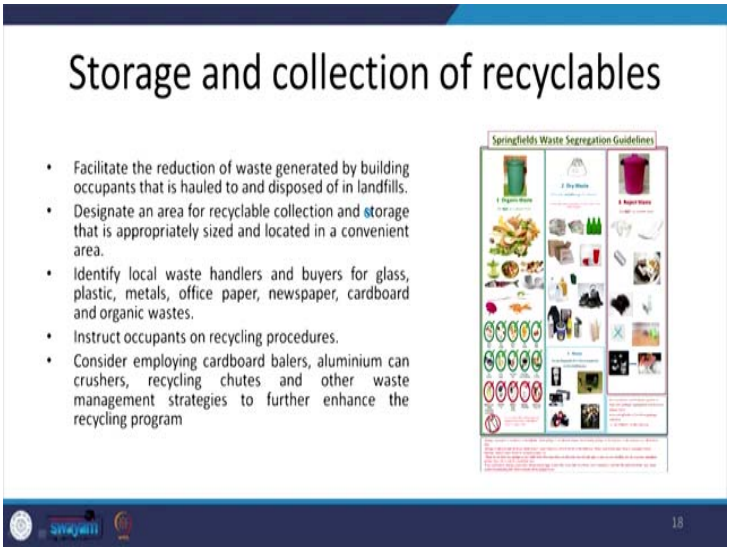

So, when we are talking about storage and collection of recyclables and we are talking about it from an architectural point of view, we are talking about provisions in the building for storage and collection of these recyclables. So, what we have to do is, we have to ensure that there is sufficient amount of space available made available through design and construction of the building, where this storage and collection of recyclable will take place.

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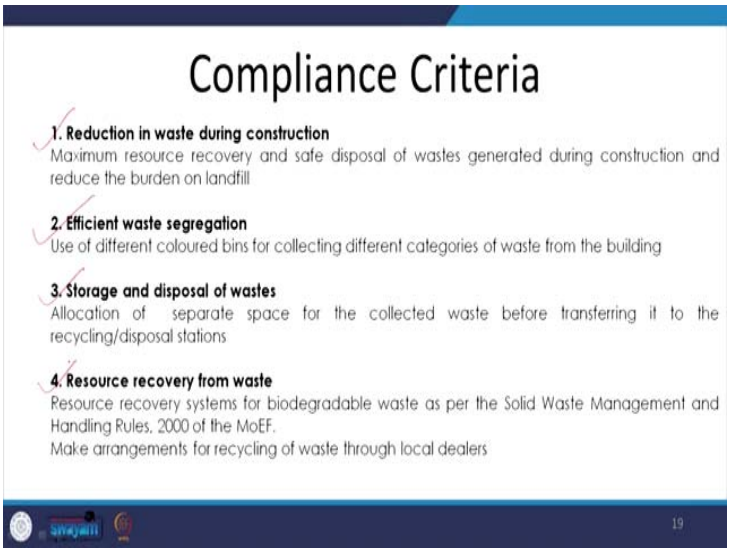

So, if we look at the compliance criteria in different rating programs and we are talking about materials and resources, the first thing that we have to ensure is that there is reduction in the waste during construction. So, we have to maximize the resource recovery and ensure safe disposal of waste which is generated during construction.

Next we have to have efficient waste segregation in place. So, whatever waste is generated, it should be properly segregated on site and for that we will require sufficient space for storage and segregation of this waste. Then storage and disposal of these wastes; we store it properly and then we dispose it in an efficient effective manner. So, if the recyclables are there, they should go to the recycling units. If it is an inert waste, it may go to some other site to be used again and like that.

And then the last is resource recovery from the waste. So, for example, biodegradable waste; so, as for the MSW rules of 2000 published by MOEF so, proper arrangements have to be made for resource recovery. For example, for biodegradable waste, it has to be converted into manure and the nutrients be extracted.

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So, when we are talking about the building level facility for the compliance criteria, we have to have the basic facilities one is providing separate bins. So, this is post occupancy. So, at each individual unit three different types of bins have to be provided; the collection should also be in a segregated format, where different types of wastes will be collected separately and they will also be disposed separately.

So, if the storage has to be there, the waste has to be stored separately in addition to that there has to be a centralized facility to collect batteries, E-waste, lanpsd, medical waste etcetera and it be sent to proper recycling units.

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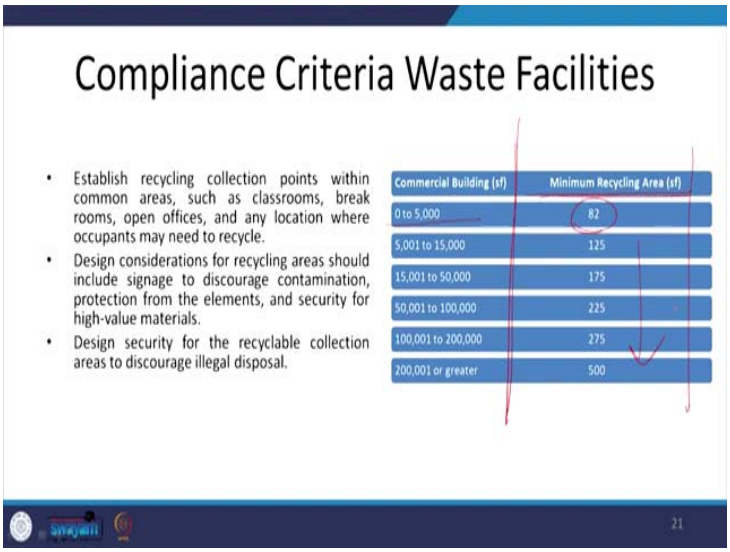

When I was talking about the waste facilities as per one of the green building rating systems, for different types of commercial buildings minimum recycling area which will be used for storage, segregation and recycling is specified.

So, if there is a commercial building which has built up area of 0 to 5000 square feet, 82 square feet of minimum recycling area has to be provided and so on. Now, ~~And~~ this ensures that this area will be used for storage and segregation of the recyclable waste. Now when we talk about the construction waste or the demolition waste, this is the waste which is generated during the construction process and from the renovation or demolition activity.

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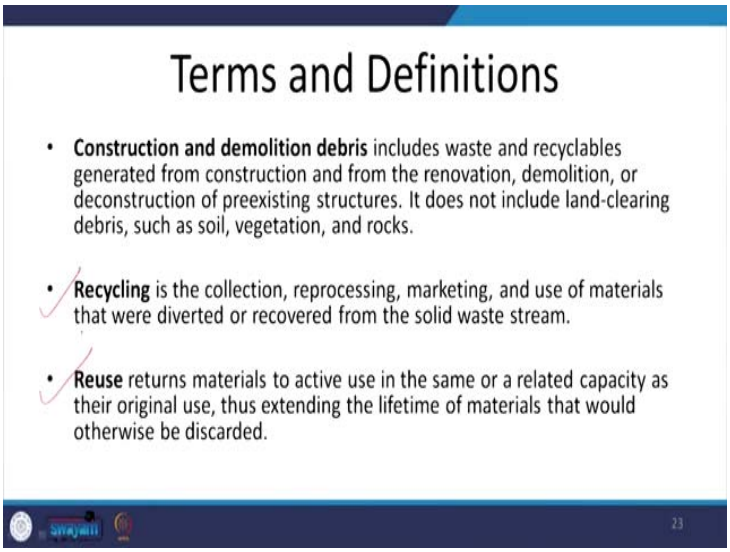

So, this may include the different types of materials such as bricks or concrete broken concrete the steel which steel bars. However, it does not include the land clearing debris such as soil vegetation or rocky outcrop if there is. Then we are talking about the recycling which is the collection, reprocessing, marketing and the use of materials which are diverted or recovered from the solid waste stream.

So, we are talking about recycling of these materials with respect to the construction and demolition waste. Reuse is returning these materials to their active use for example, a door. So, an old door might be recovered in such a manner that the same door after a little bit of painting and polishing will be reused as it is in the product project. So, when we are talking about the construction waste segregation, the intent is to divert the construction and demolition waste from going into the landfill or incineration facility.

So, here we are talking about segregation of these different types of wastes. So, bricks concretes on one side, steel on the other, wood on the other and like that and then sending it to respective recycling facilities. Now for that a proper construction waste management plans, a proper logbook has to be maintained on building site itself.

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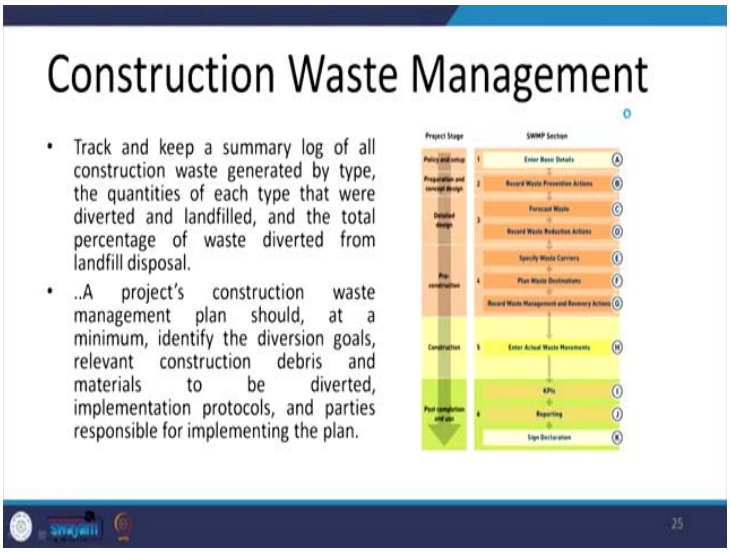

So, how much of the waste is being generated. So, what amount of material is brought in and how much of the material is going out and where is it going to?

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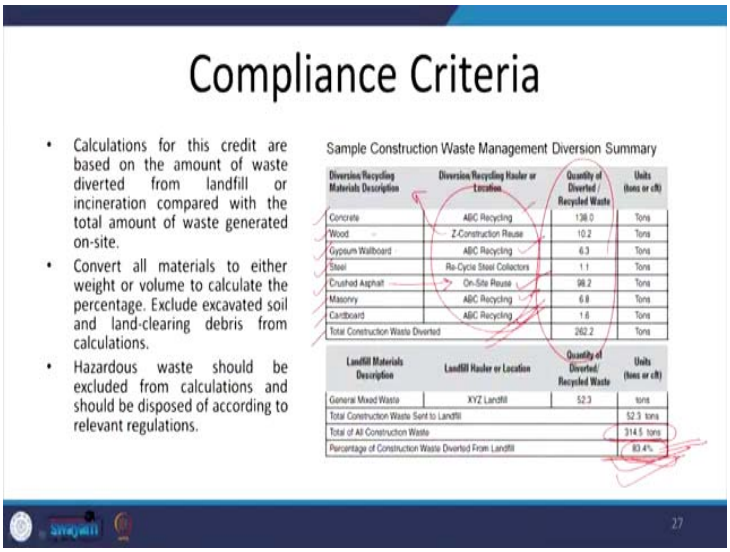

So, for example, if we look at this particular table here so, this is the; these are the different types of materials which are being sent out of the building. For example, concrete, wood, gypsum wallboard, steel, asphalt, masonry, cardboard. Now where are these materials being sent to? So, there are different types of recycling units which to which these some of these materials will be sent for recycling. In case there is an onsite

reuse. So, for example, asphalt this may be used on the site itself, there may also be cases where some of this material may go to some other site not the same site.

So, we will then calculate the overall amount of the waste which is diverted. If we calculate it from the total amount of waste which is generated and calculate how much of the percentage of this is saved, this is what will lead us to the compliance criteria. So, for different green building rating systems minimum percentages of this waste diversion are specified. We have to achieve that by proper by making proper arrangements of diverting it from landfill and incineration.

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When we are talking about organic waste management, we are talking about management of waste which comes from plants or animal sources which are organic in nature which are biodegradable.

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The two types of composting which is there, we have also discussed one is aerobic and the other one is ~~anora~~ anaerobic.

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At different levels of waste generation and building use, different types of technologies are available.

So, first of all we are talking about the reduction and reuse of this waste. So, reducing it at source, using it for different purposes for example, a lot of waste food from the hostels, from the messes where large number of people eat can be taken to piggeries or

cattle sheds where the animals can be fed on this leftover waste that is the simplest way of diverting food from going into the landfill sites or for the incineration or any other process.

The next is where we take this waste product to convert it into energy where there is a lot of calorific value contained in the waste. We can also look at commercial disposes where converting food waste to wastewater treatment and then converting into fertilizers. We also have bio digesters which are like mechanical composters. So, with the supply of energy, we are able to totally decompose them and use them as manure organic manure.

We can use simple composing methods as we have seen we can use pulpers, where we create the pulp out of it and then we convert the compost and or take it to landfill. There are dehydrators where the food can be dehydrated and it can then further be taken into the waste to energy the organic food to waste to energy or the last which is the least preferred is the trash. So, in the order if we see we depending upon different scales of this, this is the least preferred method.

So, trash where we send the food waste the organic waste to landfill and incineration should be avoided.

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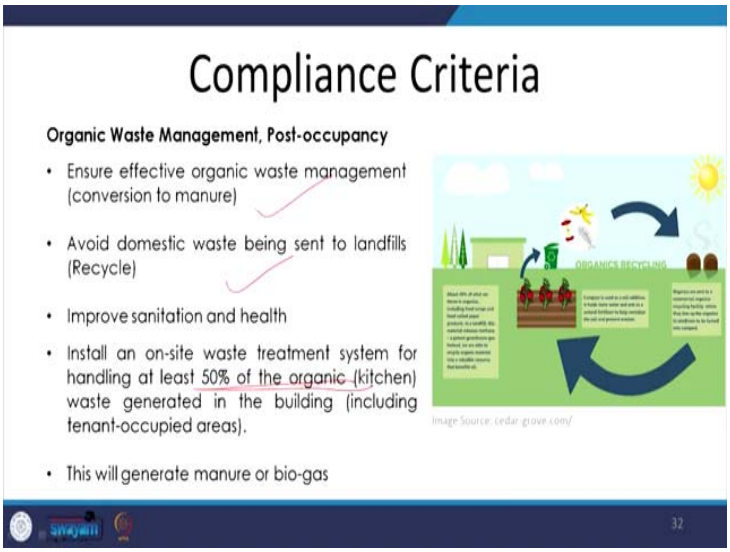

So, if we look at the building level we have the compliance criteria, where organic waste management post occupancy is a mandatory clause. Here we are talking about effective

organic waste management where we convert the biodegradable waste into manure. The intent is to avoid domestic waste to being sent to the landfills and improve sanitation and health on site. So, we have to install an onsite waste treatment system for handling at least 50 percent of the organic waste which is generated in the building. This can also be done through biogas generators.

So, composting an aerobic composting through biogas generators where the gas is also produced this can also be used. So, that was all for the lecture today and we will be coming back with more compliance criteria and the calculations related to that in the subsequent lectures on this lecture series this week on materials and resources.

Thank you for being with us. See you again tomorrow.